Journal of Research in Ecology

An International Scientific Research Journal

Original Research

Biomass distribution of kingklip (*Genypterus capensis*) species in the Benguela Ecosystem of Namibia

Authors:
Nashima FP and Chilamba VJ.

Institution:
Department of Fisheries and Aquatic Sciences
University of Namibia,
Windhoek, Namibia.

Corresponding author:
Nashima FP.

ABSTRACT:

The biomass distribution of kingklip in bottom trawling was investigated in the Namibian waters between Oranjemund and Kunene river area. A systematic transects design; perpendicular to the coast was used for sampling along latitude gradients (29°S-17°S) at different seafloor depths (100-700 m). In total 2323 stations were sampled for a period of ten years. At each trawled station the whole catch were sorted to species level and the total body mass (kg) of each fish was recorded. Environmental factors, consisting of bottom water temperature, salinity and dissolved oxygen were recorded automatically by the Conductivity and Temperature Depth instrument. Results indicated a non-significant difference in the kingklip biomass over the years, while a significant result was observed with changes in depths and latitudes. Environmental factors significantly influenced kingklip biomass distribution. It was concluded that biomass distribution of kingklip species is influenced by depths, latitudes and environmental conditions although not significant with years.

Keywords:
Biomass distribution, environmental conditions, Kingklip species.

Email Id:
fnashima@unam.na,
fabiochilamba@yahoo.com

Web Address:
http://www.ecologyresearch.info
documents/EC0013.pdf.

Article Citation:
Nashima FP and Chilamba VJ.
Biomass distribution of kingklip (*Genypterus capensis*) species in the Benguela Ecosystem of Namibia.
Journal of Research in Ecology (2013) 2(1): 067-074

Dates:
Received: 15 Feb 2013 **Accepted:** 25 Mar 2013 **Published:** 29 Apr 2013

Journal of Research in Ecology

INTRODUCTION

The Namibian marine environment is characterized by dynamic processes that cause dramatic changes in the distribution and biomass of demersal fish species (Gordoa *et al*., 2006). The ecosystem is highly influenced by the productive Benguela ecosystem which provides favourable conditions for most species. Kingklip (*Genypterus capensis*) is regarded as a commercial demersal species found in the Benguela ecosystem and it normally occurs as bycatch of other demersal species such as hake and monk (Kainge *et al.,* 2010). Hence, its biomass and distribution can highly be affected by the ecosystem biological productivity, ecosystem instability, catches by fisheries and changes in environmental conditions and other ecological processes that can affect its recruitment and growth (Lalli and Parson, 1997). As an important by-catch commercial species, kingklip biomass or stock size has declined during the past few years (Lesch, 2002).

The ecosystem with considerable climatic and environmental variability is the driving force of anomalies in productivity which influence biomass changes along the Namibian coast. Like many other demersal fish species, kingklip biomass distribution is not evenly distributed along the Namibian coast (Lesch, 2002). Therefore, this study attempts to estimate and compare the biomass of kingklip along the Namibian coast over the years (2000-2010) and relate it to various environmental factors.

LITERATURE REVIEW

Biology of Kingklip (*Genypterus capensis*)

The kingklip is a bony fish that belongs to the family ophidiidae which contains 135 species (Van der Elst, 1988). The species belongs to the major class of Actinopterygii (Ray-finned fishes). The family is distributed through temperate and tropical waters around the world and ten (10) species of this family are known to occur in southern Africa including Namibia (Van der Elst, 1988). The *Genypterus capensis* is said to be endemic to Southern Africa, and in Namibia it is found in deep waters of about 200-500 m (Van der Elst, 1988).

The body shape of kingklip is more like that of an eel, but unlike most eels which have round cross section bodies; kingklip is moderately or laterally compressed. The colour is normally pink but, sometimes paler with irregular mark and with brown blotches on the upper flanks. Fins are also darker brown in colour. The body is normally covered with small scales that do not overlap one another and the scales are not firm and this soft body is rather slimy to touch (Branch *et al.,* 2002).

Kingklip are apparently nocturnal feeders and subsist on considerably less food per unit body mass than most other fish, they are occasionally cannibalistic (McIntyre, 2010). Since it feeds on some other demersal species, high biomass of kingklip normally occurs in areas with high food (prey) abundance (Levition, 2001). Van der Elst (1981) stated in a preliminary research that among small kingklip there is a higher percentage of male than female, and this possibly indicates dissimilar growth rate for sexes. Sexual maturity of the *Genypterus capensis* is reached at 4-5 years (50-60 cm), and spawning takes place from August to October (Van der Elst, 1981).

Kingklip catches in the Benguela Ecosystem of Namibia

Considerable numbers of Kingklip are trawled off from the Namibian coast, within the 200 Nautical Miles of the country's EEZ. Catches are mainly by bottom trawls although long lines are also becoming common (Branch, 1995). It is believed that catches were considerably high in the 80's not as today due to overexploitation by foreign fleet before the Namibia independence; hence considerable catches occur in the south than in the northern region of Namibia (Branch, 1995).

According to Branch (1995), kingklip (*Genypterus capensis*) is probably the second most valuable ground fish species caught off from the Southern African coast in terms of unit fish price, therefore successful attempts have been made to establish a directed fisheries for the species due to high demand, but still constitutes only a minor portion of the total ground fish catch because of the dominance of hakes. For many years kingklip were taken almost entirely as bycatch in the hake fishery. It is believed that higher catches of kingklip could only be obtained if fishermen were willing to risk their trawl nets close to rocky outcrops; such areas are usually avoided by trawl fishers because of damage they can cause to nets (Branch, 1995).

MATERIALS AND METHODS

Study area

The study area is located along the entire Namibian coast which falls within the Benguela ecosystem, exclusively between Oranjemund (28°S) and Kunene river mouth (17°S). About 220 stations were sampled each year during summer, in total 2323 station were sampled over the period of ten years (2000-2010).

Sampling design

Sampling was based on a systematic transect design, arranged in a semi-random distribution of stations that run perpendicular to the coast. Stations within transects were selected in such a way that each 100 m bottom depth had at least one station (Nashima, 2012). Transects were usually 20-25NM (nautical miles) apart and covers a distance between 20-80NM. In the southern part where the shelves were wide, stations on the shelf were typically 10NM apart.

Biological and environmental data collection

Biomass and environmental data used for this study were obtained from the Ministry of Fisheries and Marine Resources, Swakopmund, Namibia. The *MFV Blue Sea I* research vessel was used for sampling using a Gisund Super two-panel bottom trawl net towed behind the vessel.

For biomass determination at each trawled station, the whole catch of kingklip was brought on deck and measures their total body mass (kg). The state of the environment was monitored with a *Seabird SBE 19plus* Conductivity-Temperature-Depth (CTD) instrument. Spatial information, in particular trawling bottom depth, bottom temperature, dissolved oxygen and salinity were monitored and recorded automatically by the CTD instrument. The CTD instrument collects measurements at 1-meter interval but for the purpose of this study they were all selected for bottom depths (m) of each station.

Data manipulation and analysis

The statistical packages *SPSS 16*.0 and *GENSTAT* for Windows were used to analyze the data pertaining to biomass distribution and relation with environmental conditions. The One-way Analysis of Variance (ANOVA) was performed on SPSS to test for significant differences in biomass of kingklip over the years. Furthermore, to determine relation between biomass of kingklip and the environmental conditions (i.e. temperature, salinity, and dissolved oxygen) a regression analysis, using linear model was performed using *GENSTAT* statistic software.

RESULTS

Biomass distribution of kingklip over the years

Considerable numbers of kingklip species were caught over the years, ranging from 0.1 to 0.43 tones per square nautical miles. The biomass of kingklip samples varied with depths (100-700 m) and latitude (29°S - 17°S).

A comparison of means biomass of kingklip species was highest in 2008 followed by 2000 and least in 2002 with an average of 0.8, 0.6 and 0.2 t/NM^2, respectively. Analysis of variance (ANOVA) indicated non-significant differences in mean biomass distribution over the years (F= 0.45, df =76, p=0.918).

The mean biomass distribution of kingklip was greatest at the depth of 400 m followed by 300 m with

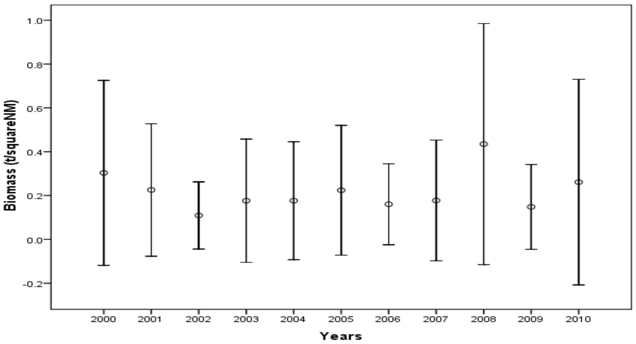

Figure 1: Comparison of mean biomass of kingklip over the years (2000-2010). Error bars indicate 95% confidence interval of the mean.

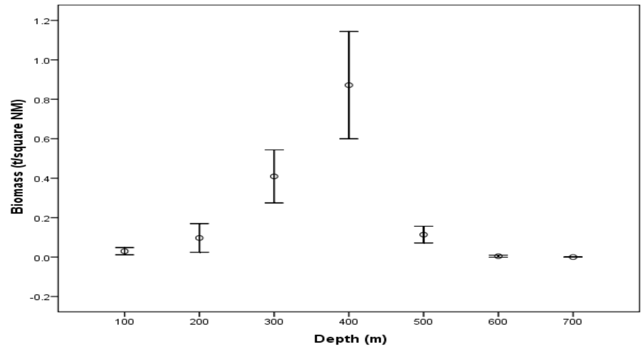

Figure 2: Mean biomass distribution of kingklip at different depths (100-700 m). Error bars indicate 95% confidence interval of the mean.

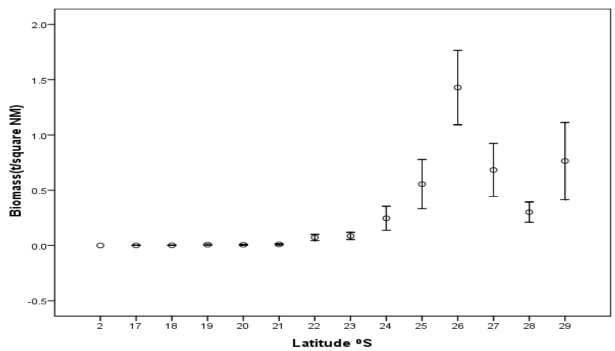

Figure 3: Comparison of mean biomass of kingklip at different latitudes (17^0S-29^0S). Error bars indicate 95% confidence interval of the mean.

0.9 and 0.4 t/NM² respectively. The Analysis of Variance (ANOVA) indicate significant differences in biomass distribution with changes in depths (F=35.98*,* df=76, *p=0.01*). Dennett's post-hoc test indicated that biomass at 300 m and 400 m were significantly different from each other and again with the rest of the depths (100 m, 200 m, 500 m, 600 m and 700 m).

Biomass distribution of kingklip with changes in latitudes

The general trend observed in Figure 3 depicts a relatively low mean biomass at lower latitudes (i.e. 17-23°S) and a relative higher biomass at higher latitudes (i.e. 24-29°S).

Significant differences in mean biomass of kingklip with changes to latitudes were observed (ANOVA: F=197.6, *df* =2321, *p*<0.05). Dunnett's post-hoc test indicated that biomass at 26°S latitudes was significantly different from the rest of the latitudes (Figure 3).

Environmental influences on biomass distribution of kingklip

A significant relationship was observed between environmental factors (bottom water temperature, salinity and dissolved oxygen) and kingklip biomass. The observed relationships on statistical analysis yielded the following model: $Y=28.5-0.09x_1-0.793x_2+0.113x_3$ which showed a negative, non linear correlation for temperature (x_1), salinity (x_2) and biomass while dissolved oxygen (x_3) showed a positive correlation with the biomass. Kingklip biomass tends to be highest at temperatures between 7 and 10°C (Figure 4).

There is a linear significant relationship between temperature and biomass (ANOVA: *F=10,* df*=22, p =0.01*). The model (y = -0.019x+0.445) indicates a negative correlation between temperature and biomass. Figure 5 shows the kingklip biomass distribution with change in salinity. The model (y=-0.793x+28.02) indicate a negative correlation between biomass and salinity. However, a significant relationship between biomass distribution and salinity was observed (ANOVA: *F=46.34, df =1256, p=0.01*).

The model shows a positive correlation between the species biomass and oxygen, where y =0.113x+0.043. Significant linear pattern was observed with regard to biomass distribution and dissolved oxygen

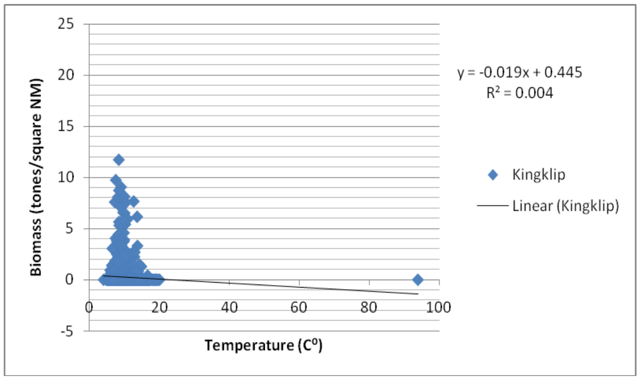

Figure 4: The relationship between temperature and biomass distribution

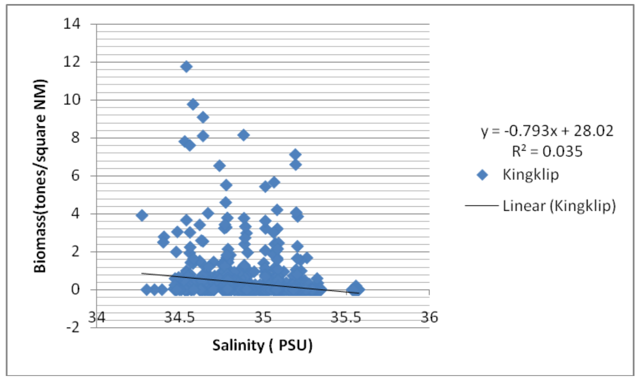

Figure 5: The relationship between salinity and biomass distribution

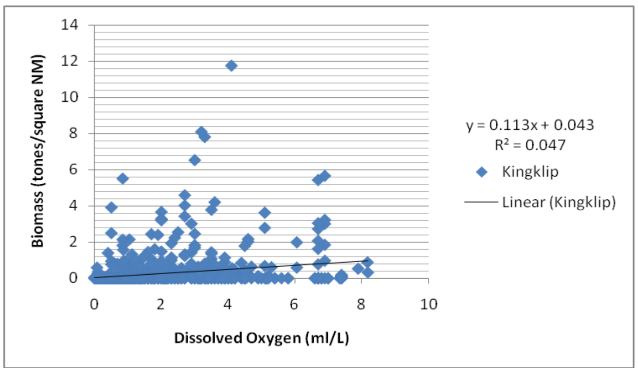

Figure 6: The relationship between dissolved oxygen and biomass distribution

(ANOVA: F=45.37, df=1.9, p=0.01).

DISCUSSION

The present study investigated several pattern of biomass distribution of kingklip species over the years and with regard to changes in latitudes, depths and environmental conditions.

Kingklip biomass distribution over the years

Over the past ten years (2000-2010), the biomass distribution of kingklip from the Namibian coast was not significant. This is due to the fact that no Total Allowable Catch (TAC) was allocated for kingklip during that period as it has continued to be caught as bycatch. Although a non-significant difference in biomass was observed, the biomass fluctuated during the years and catches were considerably high in 2002 and 2008. These fluctuations might be a result of changes in upwelling intensities with years, since upwelling of new nutrients is the key to high biological productivity in the marine ecosystem (Mann and Lazier, 2008). Another possible factor that might have caused slight differences in biomass over years is the differences in trawling time. Branch (1995), stated that kingklip is a nocturnal feeder, and with inconsistence in trawling time this factor explains the slight biomass fluctuations over the years.

Biomass distribution with changes in depth and latitudes

The comparison of mean biomass in relation to depths was significant. According to Van der Elst (1988), kingklip occurrences are mostly at depths between 250-400 m in the South Eastern Atlantic and this is in line with the observed results (Figure 2). Higher biomass occurred at depths of 400 and 300 m. At 200 and 500 m the biomass was moderate low although considerable numbers were caught at these depths. Noteworthy, observation was that at 600 and 700m, results shows 0.0 t/NM² of biomass caught (Figure 2) and this has been supported by Smith (1847) who reported that kingklip don't occur in that depth ranges.

With changes in latitudes, results have showed significant differences in biomass of kingklip, with increased biomass observed toward higher latitudes (i.e. 22°S to 29°S), with the highest at 26°S. This observed result was reported that increased biomass of kingklip occurs in the south than in the northern part of the Namibian coast. These differences can be explained by the higher biological productivity in the south than in the north associated with the upwelling cell (Reddy, 2007).

Environmental influences on biomass distribution of kingklip

Significant influences of environmental factors on kingklip biomass distribution were observed. Bottom water temperature significantly influences the biomass of kingklip. It is well-known that temperature plays an important role in the physiology of fish species, which involves a multiple of processes such as metabolism, reproduction and distribution. Consequently, temperature determines what kinds of fish species can survive and how well the various species can function. Furthermore, it is believed that increases in temperature double the rate of chemical reactions and this may have some bearing on the activities of fish cells (Jobling, 1995). Notably, temperature has direct relation with the dissolved oxygen concentration. Warm water is relatively less oxygenated than cooler water. As a result, temperature is significant in determining fish abundance and distribution (Macpherson *et al.,* 1991).

Hence, a negative correlation between water temperature and biomass of kingklip was observed (Figure 4). Biomass was observed to be higher at around 11°C and then decreases with increasing temperature. Even though the optimum growth temperature for kingklip is 13°S, where high abundance is expected, the observed pattern can highly be influenced by the prey abundance and availability (Levition, 2001). Water temperatures above or below the optimum growth temperature is believed to affect the physiology of the fish (Levition, 2001). This observation can therefore explain the poor growth of kingklip stock present in the Namibian water.

A very weak negative relationship was observed between salinity and biomass distribution. Sarma *et al*. (2005) report's that several fish species are adapted to different salinity levels, thus this can explain the observed relationship. Though, salinity has a significant influence on the biomass distribution. The salinity recorded at the bottom depths ranges from 34.5-35.6 PSU and within this range biomass decreases with increasing salinity. Lower salinity (34.5 PSU) show higher biomass than higher salinity levels (35.6 PSU). The reason for the observed results might be that low salinity is preferred by the kingklip as reported that higher salinity levels have negative effects on the physiology of most fish (Reddy, 2007). In addition, salinity affects the solubility of oxygen in water in such a way that solubility of oxygen decreases as salinity increases (Reddy, 2007).

The biomass of kingklip was observed to increase with increasing level of dissolved oxygen (Figure 6) and this observation is in support with King (2006), who report`s that oxygen level in the marine environment is important to organisms for cellular respiration. Conversely, this can further explain the absence of kingklip distribution at 600 and 700 m depths. Studies have concluded that oxygen decreases with increased bottom depth due to higher primary productivity on the upper layers of the water column that can affect oxygen solubility (McIntyre, 2010; Mann and Lazier, 2008). A significant relationship between biomass and dissolved oxygen was observed. This is because dissolved oxygen is essential in marine ecosystems for respiration, and enabling fish to liberate energy from organic compounds (Kramer, 1987). Though, it is documented that oxygen-depleted water is a characteristic feature of the Namibian coast (Hamukuaya *et al*., 1998).

Thought this study is limited to physical parameters, other factors such as climatic influences, species interaction and fishing activities can also play a major influence on the distribution of kingklip. There is evidence that the Benguela system has highly been impacted by climate change over the past half century (Hampton *et al.,* 2003). According to Bartholomae

(2008), several signals of changes in climate have been observed to affect the Benguela system. These include a reduction in coastal upwelling, increased frequency and severity of Benguela *El Niño* events and an increase in average summer wind stress. The likely consequences of these changes could lead to changes in fish distributions, composition and abundance Bartholomae (2008). Species interaction is another factor that can plays a major role in determining the distribution of kingklip (Levition, 2001). With a decline in fish stock (especially for hake mainly preyed by kingklip) caught off from the Namibian coast since 1999 (Kainge *et al*., 2009) this can also influence the biomass of kingklip with regard to food shortage and availability to support their population. Furthermore, due to the fact that kingklip is caught as bycatch mostly in hake catches this can involuntarily reduce their biomass in consequence influencing their distribution.

CONCLUSION

This study has highlighted several trends in biomass of kingklip over the years with regard to latitudes, depths and environmental conditions. The biomass distribution of kingklip varied insignificantly over the years, however significant with depths, latitude and environmental conditions. The kingklip biomass distribution along the Namibian coast increases with increased latitudes due to the influence of ecological and environmental factors. Environmental factors affect the species biomass distribution such that areas with optimum bottom water temperature, dissolved oxygen and salinity within their habitats, contain increased biomass.

ACKNOWLEDGEMENTS

We gratefully acknowledge the Ministry of Fisheries and Marine Resources, Namibia, for providing scientific data used for this study.

REFERENCES

Bartholomae CH. 2008. Effect of climate change on fisheries needs more research. http:// www.namibian.com.na.

Boyer DC, Botes F, Burmeister L, Cloete R, Fossen I, Holtzhausen H, Kirlchner C. 1998. *First regional workshop: Benguela Current Large Marine Ecosystem (BCLME) Programme.* UNDP. Pretoria.

Branch GM, Griffiths CL, Branch MC, Beckley LE. 2002. *Two oceans: A guide to the marine life of Southern Africa*. 5th edition. David Philip publishers. Pretoria.

Branch MG. 1995. *The Living shores of Southern Africa*. 8th edition. Struik publishers. Pretoria.

Gordoa A, Heirich L and Rodergas S. 2006. Bycatch: Complementary information for understanding fish behaviour. Namibian Cape hake (*M. capensis* and *M. paradoxus*) as a case study. *Journal of Marine Science*. 63:1513-1519.

Hampton I, Boyer DC, Penney AJ, Pereira AF, Sardinh M. 2003. *Integrated overview of fisheries of Benguela current region.* A synthesis commissioned by the United Nations Development Programme (UNDP) as an information source for the BCLME Programme. Windhoek.

Hamukuaya H, O'Toole MJ, Woodhead PMJ. 1998. Observations of severe hypoxia and offshore displacement of cape hakes over the Namibian shelf in 1994. *South African Journal of Marine Science.* 19:54-59.

Jobling M. 1995. *Environmental Biology of Fishes*. Fish and Fisheries Series 16. Chapman and Hall. London.

Kainge P, Kathena J, Itembu J & Van der Plas A. 2009. *Cruise Report No 1/2009*: *Surveys of the hake stocks*. Government printers, Windhoek.

Kainge P, Kathena J, Itembu J & Van der Plas A. 2010. *Cruise Report No 1/2010, FV Blue Sea 1, Surveys of the hake stocks.* Government printers. Windhoek.

King MG. 2006. *Fisheries Biology and Management*. 2nd edition. Blackwell publishing. London.

Kramer DL. 1987. Dissolved oxygen and fish behavior. *Environmental biology of fishes*. 18(2): 81-92.

Lalli CM and Parson TR. 1997. *Biological Oceanography: An introduction.* 2nd edition. Elsevier Butterworth-Heinemann. Oxford.

Lesch CH. 2002. S*tate of the Environment*. Government printers. Windhoek.

Levition JS. 2001. *Marine Biology. Functions, Biodiversity Ecology*. Oxford University press. Oxford.

Macpherson E, Maso M, Barange M & Gordoa A. 1991. Relationships between measurement of hake biomass and sea surface temperature off southern Namibia. *African Journal of Marine Science*. 10:213-16.

Mann KH and Lazier JRN. 2008. *Dynamics of Marine Ecosystem. Biological-physical interactions in the ocean*. 3rd edition. Blackwell publishing. London.

McIntyre AD. 2010. *Life in the world's ocean. Diversity, distribution, and abundance*. Blackwell Publishing. London.

Nashima FP. 2012. Changes in diversity and composition of fish species in the Southern Benguela Ecosystem of Namibia. *Journal of Research in Ecology*. 1: 037-043.

Reddy MPM. 2007. *Ocean, Environment and fisheries*. Science publishers. New York.

Sarma SSS, Beladjal L, Nandini S, Cerón-Martínez, G and Tavera-Briseño K. 2005. Effect of salinity stress on the life history variables of *Branchipus schaefferi Fisher, 1834 (Crustacea: Anostraca).* http:// www.salinesystems.org/content/1/1/4.

Van der Elst R. 1988. A *guide to the common sea fishes of Southern Africa*. 2nd edition. Struik publishes. Pretoria.