Journal of the Andaman Science Association Vol. 20(2):213-219 (2015)
ISSN 0970-4183, Printed in India

www.asapb.org

Estimates of Length- Based Population Parameters of the Bigeye Snapper (*Lutjanus lutjanus* Bloch, 1790) off Madras coast along South-east coast of India.

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Abstract

This studies analyses some of the population parameters of Bigeye snapper (*Lutjanus lutjanus*, Bloch 1790) off Madras coast along south- east coast of India based on length-frequency data. The samples were collected from the trawl catches of the vessel *M.F.V. Samudrika* (OAL: 28.8m, GRT: 151T, BHP: 650) from January 2007 to June 2009 between the area Lat.12°30' N to 13° 32' N and Long. 80° 12'E to 80°30'E. A total of 858 specimens in the length range of 38-203 mm total length (TL) were analysed with the help of electronic package FiSAT.

The parameters L∞ and K were 213.2 mm ,0.28/year . The von Bertalanffy (1938) growth equation for *Lutjanus lutjanus* is $L_t = 213.2[1- e^{-0.28(t-t_0)}]$. The recruitment pattern is unimodal and the period was from February –May with peak during March. The longevity of the species was calculated as 7years. After 1st, 2nd , 3rd, 4th,5th , 6th and 7th year the length attained by the species is 51.2, 91.7, 121.5, 144.9, 159.9, 172.7 and 183.3 mm respectively. The mortality parameters were Z=0.71, M =0.44, F=10.27 and the exploitation ratio was 0.38. The virtual population analysis(VPA) for *Lutjanus lutjanus* indicated that the natural morality due to natural cause was upto 138mm length, however the fishing pressure was observed at 143 mm size and it increased thereafter.

Key words: Age, Growth, Mortality, Longevity, Bigeye snapper.

Introduction

The Snappers (Family: Lutjanidae) are important targets for fisheries in several regions worldwide. The family Lutjanidae comes under the order Perciformes and class Actinopterygii. They inhabit inshore waters within the boundary of the continental shelf in tropical waters around the globe and are often associated with reef habitats (Allen 1985). These small to medium sized fishes are of high commercial value throughout the world and are regularly taken in artisanal, recreational and commercial fisheries. Due to their high fisheries values, concerns are being raised about the level of harvest and sustainability of fishing lutjanid populations. Their aggregative behavior and reef based distribution make lutjanids particularly vulnerable to exploitation. Tamil Nadu is one of the major contributor of perch landings in India. Snappers formed 0.6% of the total landings in Tamil Nadu (6.6 lakh t) and was mainly landed by trawlers (64%). They comprised mainly of *Lutjanus lutjanus, L. fulvus, Pristipomoides filamentosus, Lutjanus ehrenbergii, L. indicus, L. fulviflamma, L. madras and L. quinquelineatus* (CMFRI,2014).

Determination of age and growth of commercially important fish is significant as it contributes in understanding the age class structure of the stock and role played by various year classes in the fluctuations of the fishery. Estimation of mortality rates is an essential requirement for the judicious exploitation and management of fishery resources. Mortality of an unexploited stock is caused by natural forces (all possible causes of death except fishing like diseases, predators, spawning stress, starvation etc). whereas in an exploited stock besides the natural causes additional factors responsible for the mortality is the fishing. Mortality estimates viz, total mortality, natural mortality and fishing mortality are highly required in the exploited fish stocks for better understanding on the optimum levels of exploitation.

The population parameters like age, growth and mortality of tropical red snappers (*L. adetii, L. quinquelineatus*, *L. erythropterus, L. malabaricus* and *L. sebae* from central Great Barrier Reef by Newman et al. (1996 & 2000); *L. fulviflamma* in the southern Arabian Gulf (Grandcourt et al. 2006); Growth rates of Lutjanidae in tropical Australian waters (Druzhinin et al. 1980); Population dynamics of *L. lineolatus* from Suez Canal, Egypt (Mehanna, 2003 & Amin et al. 2006). In Indian waters publications is mainly on commercial fishery (Chacko & Rajendran, 1955; Alagaraja et al. 1994 and James et al. 1994). The biological aspects like food and feeding of *L. lineolatus* of Madras coast was studied by Job (1940) and nutrition of the young stages by Chacko (1949). Length –weight relationship of *L.rivulatus* off Tutucorin, Gulf of Mannar was studied by Ameer Hamsa et al.(1994). Ramachandran et al. (2013) studied the age and growth of *L. vitta* from the South-west cost of India (Arabian Sea). In this present study an attempt has been made to study some of the population parameters like age, growth, mortality, recruitment, L_r , $L_{50,}$ L_{75} and VPA of *Lutjanus lutjanus* from Madras coast along south-east coast of India based on the length frequency data.

Materials and Methods

The monthly samples of *Lutjanus lutjanus* were collected during January 2007 to June 2009 from the Madras coast along the south-east coast of India (Lat.12°30' N to 13° 32'N and Long. 80° 12'E to 80°30'E) from the depth range of 20 to 100 m during the exploratory surveys of the stern trawler, *M.F.V. Samudrika* (OAL: 28.8 m, GRT: 151T, BHP: 650)of Fishery Survey of India, Chennai using fish trawl (27.5 m; coded mesh size:30 mm). The samples were also collected from Royapuram fish landing centre and the fishing gears employed by the local fishermen for harvesting these resources are mainly bottom trawl and hook & line. A total of 858 specimens in the length range of 38-203 mm were taken for population parameters studies. Length frequency data collected were grouped into 5mm class intervals was used for the estimation of growth parameters. The L∞ and K was estimated using the ELEFAN I of FiSAT (FAO-ICLARM Stock Assessment Tools, Ver. 1.2.2,2005) and t_0 was taken as 0. In addition to this the L∞, K and Z/K were also estimated by Shepherd's (1987) and Powell & Wetherall (1979, 1986) methods. Longevity was calculated by the formula tmax = 3/K+ t_0 (Pauly, 1983).The length at first recruitment (Lr) was taken as the smallest length in the length frequency distribution. The length at first capture L_{50} (the length at which 50% of the fishes are vulnerable to capture) was estimated as a component of the length converted catch curve analysis. This was carried out by the probability of capture method of FiSAT software. The length structured Virtual Population analysis (VPA) was carried out to ascertain the loss due to natural causes, the fishing pressure at different length class, catches as well as the survivors. Natural mortality (M) was calculated from Pauly's (1980) empirical formula (ln (M) = -0.0152 - 0.279 ln (L∞) + 0.6543 ln (K) + 0.463 ln (T)) and the total mortality(Z) from length converted catch curve by taking the mean habitat temperature as 27°C (Pauly,1983). The fishing mortality was calculated as F= Z-M. The exploitation rate E was obtained by dividing F by Z.

Results

Growth parameters

The growth parameters estimated for *Lutjanus lutjanus* by using the length frequency data in ELEFAN I programme gave the best fit for L∞= 213.2 mm and K = 0.28/year. Keeping the same L∞ value the growth constant 'K' obtained by the Shepherd's method was 0.21/year.

The same length frequency data of *L. lutjanus* was analyzed by Powell and Wetherall method (1979, 1986) of FiSAT programme and the values of L∞ and Z/K obtained were 207.1 mm and 1.734 respectively. The growth curve generated by ELEFAN I employing FiSAT programme for *L. lutjanus* is shown in the Fig. 1. The values of L∞ and the growth rates obtained by ELEFAN I appear to be the best considering the maximum length observed (203 mm) in the sample. Hence, the values obtained in the ELEFAN I were taken as input in further analysis of the growth parameters. The von Bertalanffy (1938) growth equation for *L. lutjanus* can be written as follows:

$$L = 213.2[1- e^{-0.28(t-t_0)}]$$

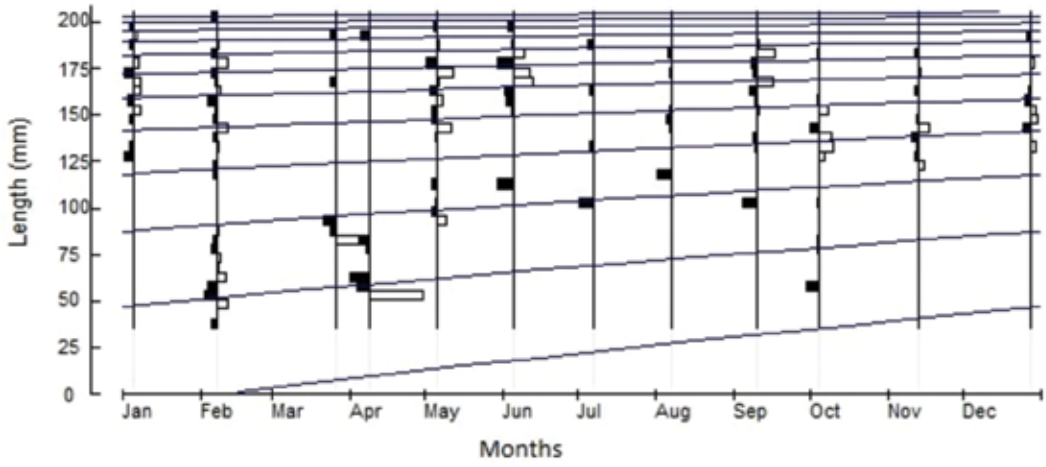

Fig. 1. ELEFAN growth curve of *Lutjanis lutjanus* in Madras waters

Recruitment Patterns

The recruitment pattern of the species *L. lutjanus* is unimodal as shown in Fig.2. One peak was observed during the month of March while observing the recruitment period from February to May. During March the percentage of recruitment was 32.6% followed by April (24.3%) and February (18.8%).

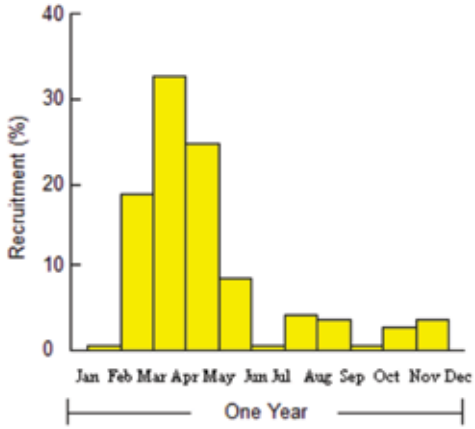

Fig.2. Recruitment pattern of *Lutjanus lutjanus* in Madras waters

Length at first capture (L_c) and length at recruitment (L_r)

The length at first recruitment (L_r) was taken as the smallest length in the length frequency distribution and the length at first capture (L_c) was obtained by probability of capture analysis (the length at which 50% of the fish are vulnerable to capture). The length at first recruitment was found to be 27 mm and the length at first capture was estimated as 180.5 mm. The length at which 75% of the fish are retained in the gear was estimated as L_{75}= 187.8 mm.

Longevity

Taking t_0 as 0 the longevity of *L. lutjanus* was calculated as 7yrs. After 1st, 2nd, 3rd, 4th, 5th, 6th and 7th year the length attained by individual of the species *L. lutjanus* is 51.2, 91.7, 121.5, 144.9, 159.9, 172.7 and frequency distribution and the length at first capture (L_c) was obtained by first capture was estimated as 180.5 mm. The length at which 75% of the fish are retained in the gear was estimated as L_{75}= 187.8 mm.

183.3 mm (Fig.3) respectively. The growth rates of 4.3 and 3.4 mm/month registered during the first and second year and later decreased thereafter.

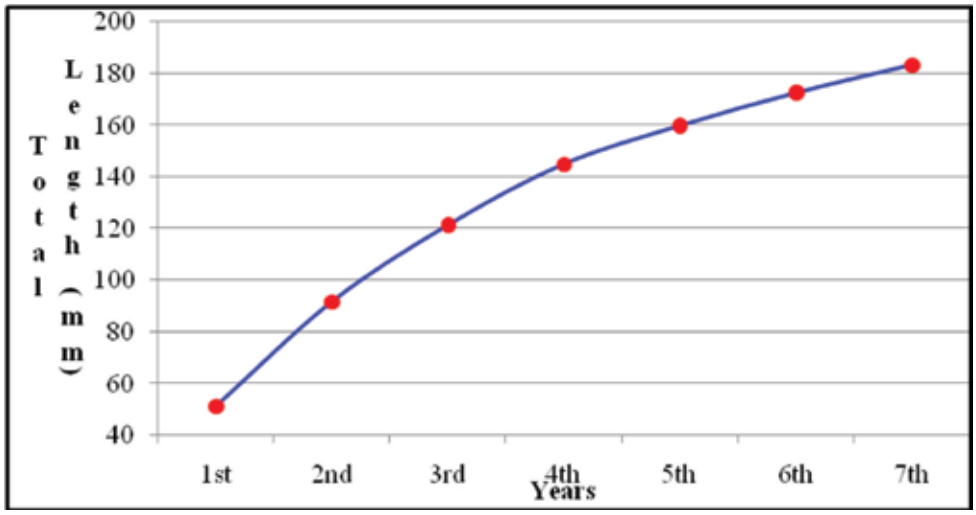

Fig.3.Von Bertalanffy's growth curve of *Lutjanus lutjanus* in Madras waters

Mortality

The natural mortality (M / year) as per Pauly's empirical formula keeping the habitat temperature as 27°C was found to be 0.44 for the species *L. lutjanus*. Total mortality coefficient (Z) was estimated from the length converted catch curve (Fig.4.3.5.1) as 0.71. The natural mortality was 0.44 hence, the fishing mortality (F) was found to be 0.27. The exploitation ratio (E)was found to be 0.38.

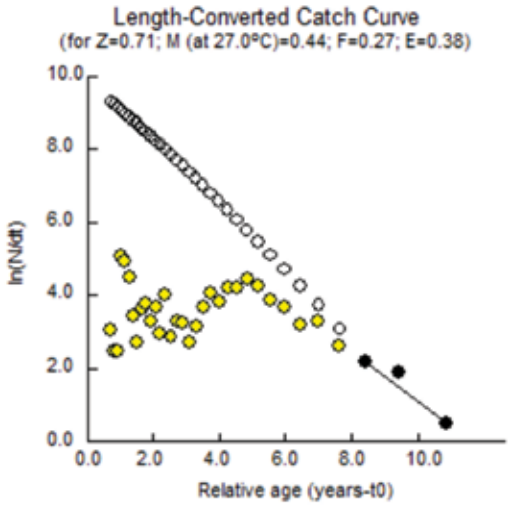

Fig.4. Powell & Wetherall plot of *Lutjanus lutjanus* in Madras waters

Virtual Population Analysis(VPA)

The virtual population analysis (Fig.5) indicated that upto 138 mm length the mortality was due to natural causes only however the fishing pressure was observed at 143 mm size and it increased thereafter.

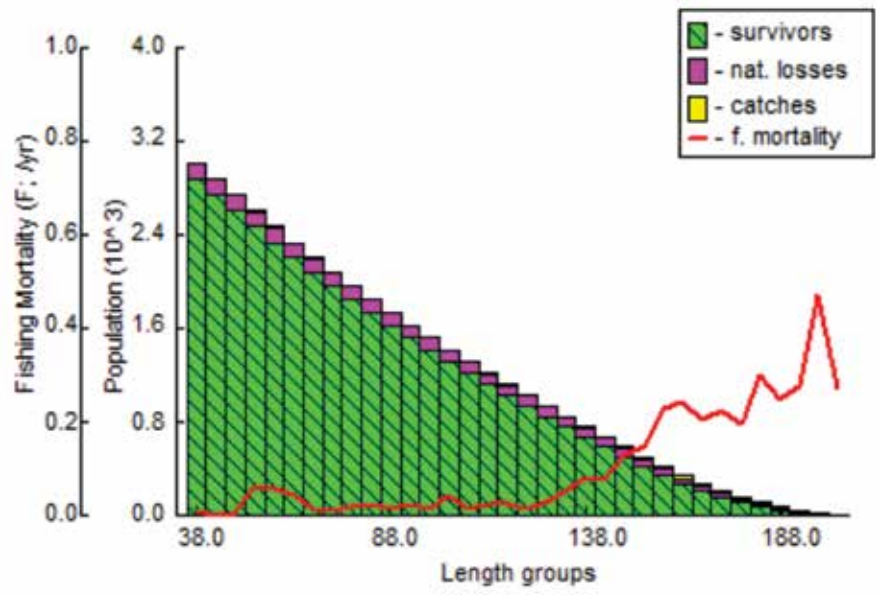

Fig.5. Virtual Population Analysis (VPA) of *Lutjanus lutjanus* in Madras waters.

Discussion

In peninsular India lot of work has been done on the growth and population parameters of *Nemipterus japonicus* (Krishnamoorthi,1971; Vivekanandan and James, 1986); *Priacanthus hamrur* (Philip, 1995). However the work done on the growth and population parameter of the family Lutjanidae is limited few species, the length weight analysis of *Lutjanus rivulatus* (Ameer Hamsa et al.,1994). Age and growth of *L.vitta* along south-west coast of India by Ramachandran et al.(2013).

The species *Lutjanus lutjanus* also known as *Lutjanus lineolatus* by previous authors(Fish Base) and few references are available in this regard. Mehanna (2003) reported the L∞ as 24.45 cm, K = 0.4/year and t_0 = -0.6 for the species *Lutjanus lineolatus* in the Gulf of Suez. Amin (2006) reported the L∞ as 22.92 cm and t_0 as -0.27 in the Gulf of Suez. Mohammad et al. (2001) studied the growth parameters of *Lutjanus lineolatus* in the west coast of peninsular Malaysia (off Sarawak) and reported the L∞ as 22.50cm and K as 0.33/year. In east coast of peninsular Malaysia the L∞ value was 27.6 cm and K value was found to be 0.54/year. Corpuz et al, (1986) estimated the L∞ and K value as 252 mm and 0.75/year from Philippines waters. Allen (1985) recorded the L∞ and K values were 315 mm and 0.27/year from the Indo-Pacific. Mansor et al. (1996) reported the size of the species in between 73-170mm from the east coast of peninsular Malaysia. The cohort analysis of the above study indicated 2 cohorts for *L. lutjanus* and the mean length were 88.7 and 160.0 mm respectively. In the present study the observed highest length in the population is 203 mm and the predicted length is 206.8 mm. The ELEFAN I growth curve appears more realistic with L∞ value as 213.2mm and K value as 0.28/year which agreement with the previous studies.

Although Lutjanids species are found in similar habitats, typically tropical and subtropical marine regions and many species grow to similar sizes, it is impossible to make generalization about the life history of member of this family due to their differences in growth and longevity. Lutjanids are known to be fast growing in their first year of life (Newman et al. 1996 & 2000; Kritzer 2004 and Grandcourt et al. 2006). Sanders et al. (1984) stated that the young stages of *L. lineolatus* are characterized by a higher growth rate than old ones. Mehanna (2003) also reported highest growth rate for the species in the first year of life after which a gradual decrease in growth increment was noticed with further increase in age in the Gulf of Suez. In the present study the age of the species was estimated at 7 years. The average growth rate of the species was faster during the first year with 4.3 mm, 3.4 mm per month during second year and later slowed down to 2.5 and 2 mm per month respectively after 3rd and 4th

year. This agrees well with the previous studies that the Lutjanids are fast growing in their first years of life.

(Mehanna, 2003) indicated that the length at first capture i.e the length at which 50% of the population becomes vulnerable to fishing (L_{50}) as 10.8 cm. Amin (2006) reported the same as 11.1 cm. In the present study the Lc was observed to be 180.46mm which corresponds to an age of 5.74 years. The length at first recruitment(L_r) was estimated as 38 mm. The virtual population analysis indicated that upto 138mm length the mortality was due to natural causes however the fishing pressure stared at 143mm size and it increased thereafter.

Mehanna(2003) reported the total mortality for the species as 1.37, natural mortality as 0.31 and fishing mortality as 1.06/year suggesting an over exploitation in the Gulf of Suez. Amin(2006) reported the total mortality as 2.5, natural mortality as 0.6 and fishing mortality as 1.9/ year which also indicates the over exploitation in the Gulf of Suez. Mohammad et al. (2001) studied the mortality parameters of *Lutjanus lineolatus* in the west coast of peninsular Malaysia (off Sarawak) and reported the natural mortality as 0.97, fishing mortality as 0.72 and total mortality as 1.69. In the present study the total mortality was 0.71, the natural mortality was 0.44 and the fishing mortality was 0.27/ year which indicates the exploitation level i.e the fishing pressure is less on the species off the Madras coast and is not over exploited. Hence, the resource can be harvested upto the optimum level.

Acknowledgements

The author is grateful to Late Dr. V.S.Somvanshi, Ex. Director General, Fishery Survey of India, Mumbai for suggesting this research topic, encouragement and guidance throughout the study period. I also express sincere thanks to the present Director General, FSI for his encouragement during the study period, Dr. A.B. Kar, Scientist, FSI, Vizag; Scientists of Chennai Zonal Base of FSI ; the Skipper & staff of *MFV Samudrika* for their support during the studies.

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