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POPULATION DYNAMICS OF REBA CARP *CIRRHINUS REBA* FROM INDUS RIVER, SUKKUR, SINDH, PAKISTAN

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Abstract: Present work was done from Indus River, Sukkur, Sindh, Pakistan to evaluate the present stock of *Cirrhinus reba* Suhni (Reba carp) for first time. Since the assessment of stocks deliver the important knowledge of stocks of commercially important fish species to the fisheries managers to make better strategic plans for sustainable exploitation. Data based on length-frequency was obtained from October 2015 to March 2016, a total of 463 pairs of length-weight were measured. Minimum length was measured to 13cm, maximum length was 29cm and the average length of 17cm was measured with minimum weight of 15g, maximum weight of224g and67g was the average weight. Obtained results of length-weight relationship wereR^2 = 0.817, a = 0.037 and b = 2.557. Growth parameters were computed as $L_\infty = 29.40$ cmand$k = 0.240 year^{-1}$using ELEFAN method in FISAT computer package. Growth performance index ($\emptyset'$) was calculated as$\emptyset' = 2.317 year^{-1}$. Total mortality Z, natural mortality M and fishing mortality F was estimated as$Z = 0.630 year^{-1}$, M= $0.617 year^{-1}$and$F$=$0.012 year^{-1}$ respectively. Using ($E = F/Z$) the exploitation ratio was obtained as E=$0.019 year^{-1}$. Current fishing mortality rate of 0.012 was smaller than the target biological reference points (F_{opt}) of M (0.617). While MSY was recorded as; 8.144 tonsyear^{-1} which showed the higher results than 0.031 tons year^{-1}ofcurrent catch. This study concluded that the *C. reba* confronting poor health though the stocks found not to be overexploited in the region.

Key-words: Stock Assessment, *Crirrhinus reba,* Growth, Biological Reference Points, Length-Weight Relationship, Mortality

INTRODUCTION

Pakistan freshwaters are home of About 186 inland fish species (Khan *et al.*,2008). Amongst them Palla (*Taenualosa ilisha),*Rohu (*Labeo rohita)*, Dahi (*Labeo calbasu)*, Common carp (*Cyprinus carpio*), Morakhi (*Cirrhinus cirrhosus*), Thaila (*Gibelion catla)*, Mahseer (*Tor putitora*) Mundha/Shakur (*Amiacalva),* Silver carp (*Hypophthhalmichthys molitrix)*, Grass carp (*Ctenopharyngodon idella*), Khagga (*Rita rita*), Seengara (*Sperata sarwari)*, tilapia (*Oreochromis mossambicus)*, Reba carp (*Cirrhinus reba)* have most significant commercial values (Khan *et al.*, 2008). In comparison of mutton, beef and chicken fish meat is considered as safe, healthy diet and one of the main sources of protein, swifter fat, vitamins and minerals (Astawan 2004). Many of the fishermen families rely economically on fisheries (MFD 2012), about 180000 people depends for their livelihood on fisheries sector (Fourth National Report 2009).

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The products of this sector are not only sent to the country side markets but they are also sent to the international markets for earnings but since last few decades in Pakistan the fisheries resources not only marine but freshwater as well are going to decline (Akhtar 2010). The reason may be the fisheries resources of Pakistan utilized improperly. No stock assessment surveys were conducted as well as they were exploited extraordinarily. It is necessary to improve this situation and proper stock assessment surveys may be conducted, otherwise it is a prediction that the stocks will be collapse up to 2048 (Worm *et al.*, 2006). Since assessment of stocks predicts the best available information for managers of fisheries sector, through which they can make better planning for the sustainable utilization of the fisheries resources of the region (Ecoutin *et al.*, 2005). This is because this study was conducted to know the stocks in Indus River Sukkur, Sindh, Pakistan of this commercially important fresh water fish species *Cirrhinus reba* (Hamilton 1822). The collection of age structured in tropical fisheries of developing countries is quite hard due to that the length-weight was obtained, because these types of data are commonly applied in fisheries for stock assessment purposes (Sparre and Venema, 1998). For estimation of growth rates, mortality rates, biological reference points and growth performance index of the species, this technique is generally applied (Kohlers *et al.*,1995).

The freshwater fish species Reba Carp locally known as sunee or suhnee and scientific name is *C. reba* (Hamilton 1822) have a great economic value (Afroz and Begum 2014; Narejo 2006).The published maximum length ranges from 30 to 32.5cm is an omnivorous bottom feeder species feeds on plankton, detritus, larvae of insects, mud, vegetables and crustacean fauna (Rahman 1989; Talwar and Jhingran 1991; Lashari *et al.*,2010). Ponds, swamped fields, canals, lakes, reservoirs, streams and rivers are home of this species (Menon 1999). In mountainous areas *C. reba* may tolerate in very low temperature of 8°C. The breeding months of *C.reba* are May to October (Mathialagan and Sivakumar 2012; Lashari *et al.*, 2007; Hossain 2001). The previously reported fecundity of this species is 22356-437,400 and 20722-211200 (Lashari *et al.*, 2007).It is distributed throughout India, Nepal, Bangladesh and Pakistan (Mirza and Alam 2002). In literature some previously reported work is accessible on stock assessment of different species of marine waters from Pakistan such as: Memon *et al.*, 2015 and 2016. While Narejo (2006) andMuhammad *et al.*, (2016) reported length-weight relationship of *C. reba* from fresh waters of Manchar Lake Dadu, Sindh and Taunsa barrage at the Indus River, Punjab, Pakistan respectively, but no published work is yet reported from Indus River Sukkur, Sindh, Pakistan.

MATERIAL AND METHODS

Collection of Data: For the collection of data the fishermen were requested on charges to collect the samples from different sampling sites such as Alif Kacho, Bay Kachoand JeemKacho at Indus River bi-monthly from October 2015 to March 2016. Generally for fishing these sites are preferred by fishermen. The Bottom trawl (Ghaao) or (Rachh) net having a length of 300 feet with mesh size of 4″ was used for collection of samples. The available literature, accounts and

keys given by Talwar and Jhingran, (1991); Jayaram (1999) and Shrestha, (1981- 1994) were used for identification of collected samples.
Data Analysis: The computer software package FiSAT II (FAO-ICLARM) was applied for computation of length frequency data (Gayanilo *et al.*, 2003). The target parameters of selected fish species were growth rate, mortality rates and biological reference point and growth performance index.

*Length-Weight Relationship***:** The Le Cren (1951) formula was applied to compute Length-weight relationship of *C. reba*.

"$W = aL^b$"

Where:W= weight, L= length, a = constant condition factor and b = allometric growth parameter (Le Cren1951).

Growth: The length with age of *C. reba* was estimated applying the von Bertalanffy Growth Function (VGBF).

"$L_t = L_\infty(1 - \mathrm{e\,x\,p}\,(-k(t - t_0)))$"

Whereas L_t = length at age t,L_∞ = asymptotic average maximum length, K= growth coefficient andt_0= theoretical age with length at zero (Haddon, 2011). It was calculated applying the equation of Pauly (1983):

"$\log_{10}(-t_0) = -0.3922 - 0.275\log_{10} L_\infty - 1.038\log_{10} k$"

Mortality: The length-converted catch curve estimation technique was used for the computation of total mortality Z (Pauly 1983).

"$\mathrm{In}(N_i/\,\Delta t_i) = a + b.t_i$"

Whereas:N_i= the number of observed fish in length class i, Δt_i= the time required for the fish to grow accordingly through length class i, t_i= the age (or the relative age, computed with t_0 = 0) corresponding to the middle length of class i, and b with sign changed, is an estimate of Z.
Natural Mortality M was computed using the Pauly's formula:

"$\log_{10}(M) = 0.006 - 0.279\log_{10}(L_\infty) + 0.654\log_{10}(k) + 0.6434\log_{10}(T)$"

Where$L_\infty$was in cm and k was in year^{-1}. Taws the average water temperature.

The obtained natural mortality M was subtracted from total mortality Z to estimate the fishing mortality (F), the F/Z was applied to obtained the exploitation ratio E.

Biological Reference Point: Gulland's formula was used for the estimation of biological reference point (Gulland, 1969).

"$F_{opt} = M$"

Growth performance index: It was estimated applying the formula of Pauly and Munro (1984).

"$\emptyset' = \log_{10} k + 2 \log_{10} L_{\infty}$"

Maximum sustainable yield: The formula of Gulland (1979) was used for the computation of Maximum sustainable yield.

"$M\ S\ Y = Z \times 0.5 \times B$"

Z= total mortality, *B*= biomass. The Y/F was used for estimation of biomass (*B*), whereas (*Y*) = the total observed yield in tons of the species of current studies and (*F*) = the fishing mortality.

RESULTS AND DISCUSSION

Length Frequency Distribution:
Total 463 specimens were collectedwith a minimum length of 13cm and maximum length of 29cm (Fig.1), while the obtained average length was 17cm, meantime the computedminimum weight was 15g and maximum was224g, while the average observed weight was 67g, and total weight of all catches were 0.031 ton (31.468kg).

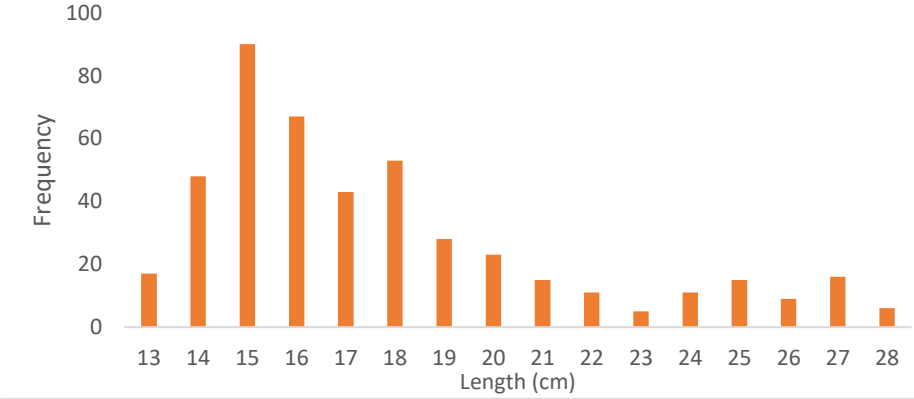

Fig.1: Shows the Length Frequency of *Cirrhinus reba* from Indus River Sukkur, Sindh, Pakistan

Length-Weight Relationships: Physical well-being of the fish species can be determined with the help of length-weight relationship. As per the given standard values for the well-being of fish species, i.e. obtained b values of 3 indicate the isometric growth of the fish, b value less than 3 determine the negative allometric growth of the fish and b values greater than 3 shows the

positive allometric growth of the fish Gayanelo and Pauly (1997). Since the obtained values of length weight relationship in present study were a = 0.037, b = 2.557 and R^2 = 0.817 (Fig. 2). The b values of 2.557 were less than 3, which indicate the negative allometric growth of the fish at the study area.

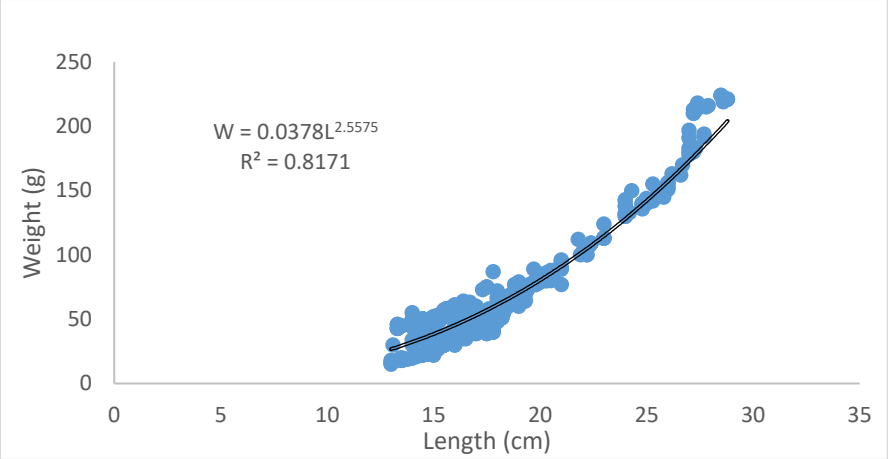

Fig.2: Shows the Length-Weight Relationship of *Cirrhinus reba* from Indus River Sukkur, Sindh, Pakistan

Growth Parameters: The growth parameters can be calculated using length-frequency data or they can be obtained using the absolute or relative age of the fish species. In present work the obtained results of growth parameters were L_∞ = 29.4 cm, K=0.240$year^{-1}$ and theoretical age $t_0 = -0.703 year^{-1}$as (Fig.3). Obtained results of K = 0.240 year-1determined the low growth rate of fish species. There is a high relation between K and L_∞. Natural mortality (M)demonstrated direct relation to the (K) growth coefficient and indirectly related to the (L_∞) asymptotic length and the lifecycle (Beverton and Holt, 1956). Simply the fishes having higher growth coefficient have smaller lifespan and greater natural mortality. In this study the smaller $L_\infty$and lower growth coefficient (K) indicates longer life span and lower natural mortality.

Mortality: In present study the obtained results of total mortality, natural mortality and fishing mortality for *C. Reba* were Z = 0.63$year^{-1}$ (Fig. 4), M = 0.617$year^{-1}$and$F$ = 0.012$year^{-1}$ respectively. The obtained exploitation ratio was E= 0.02$year^{-1}$ that isless than the optimum exploitation ratio (E) of 0.5 (Gulland 1971) which indicates that the stocks of *C. reba* were not over exploited in the region.

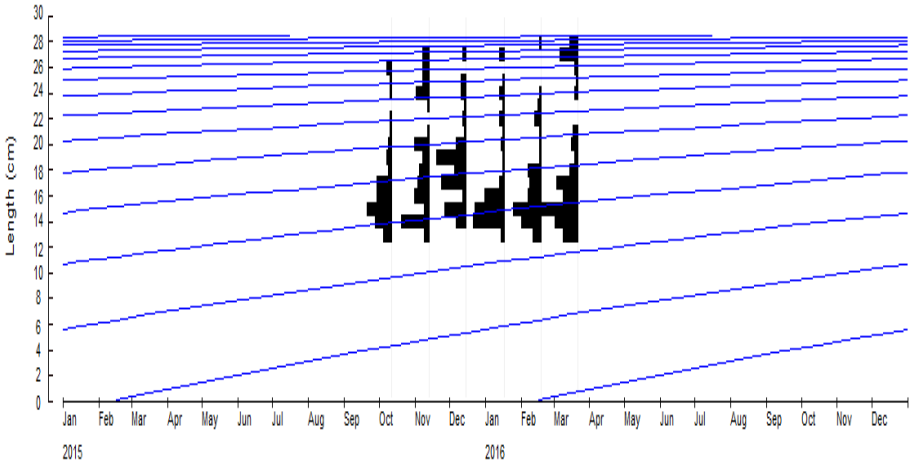

Fig.3:Shows the Length frequency distribution data and growth curve estimated using ELEFAN method of *C. reba* from Indus River Sukkur, Sindh, Pakistan

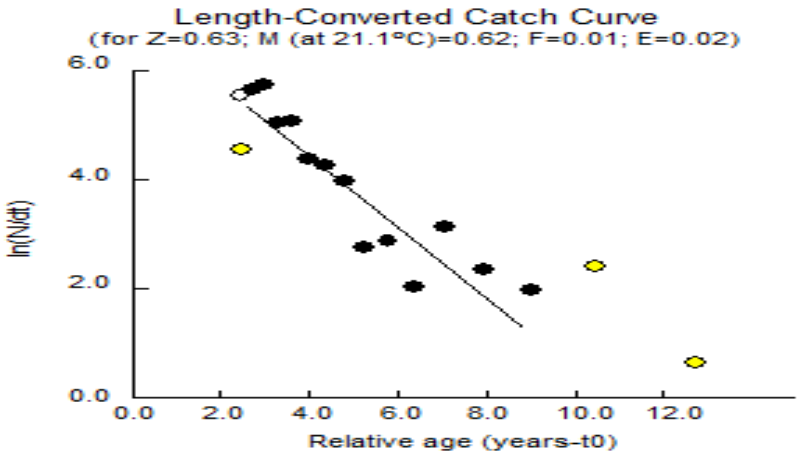

Fig.4: Shows the Length converted catch curve analysis of *C. reba* from Indus River, Sukkur, Sindh, Pakistan

Biological Reference Points: The calculated values of 0.617 for biological reference points were higher than the fishing mortality rate of $0.012 year^{-1}$.

Growth Performance Index: Obtained values of growth performance index for *C. reba* were $\emptyset' = 2.317 year^{-1}$.

Maximum Sustainable Yield: The obtained values of MSY of 8.144 tons $year^{-1}$ were higher than recent catch of 0.0314 tons $year^{-1}$ (31.468kg). *Length-Weight Relationship:* Information about the seasonal changes, about

definite location about the well-being of fish species can be obtained using the data of length-weight relationship. Beside this it is also describes the allometric or isometric growth of fish which is said to be the significant characteristic for fish population dynamics. Obtained results of length-weight relationship of current work were matched with the previously published values of length-weight relationship (Table 1). The acquired results of Narejo (2006) for length-weight relationship were b=3.32andR^2 =0.99,which were higher than the results of present study and determined the positive allometric while the obtained values of length-weight relationship of Mathialagan *et al.*,(2014) for *C. reba* from India were b=2.385 andR^2=0.871, which near to similar of our results of b = 2.557 andR^2= 0.817 and described the negative allometric growth(Allen 1938). The results of different authors were shown in (Table 1) which indicated that some individuals of fish species do not fit in the cube law because these fishes may have changed their form with growth (Javaid and Akram 1972; Sinha 1975). This may be due to several reasons such as presence of food, spawning and maturity conditions and due to sex differences (Le Cren 1951; Naeem *et al.*, 1992; Salam *et al.*, 1994; Ali *et al.*, 2000).

Table 1: The compared Length-weight parameters of C. reba with other species from different countries of world

Location	Species	*a*	*b*	r^2	Source
Bangladesh	*C. reba*	0.002	3.523	0.968	Hossain *et al.*, 2013
India	*C. reba*	0.007	3.2	- -	Muralidharan *et al.*, 2011
Pakistan	*C. reba*	0.024	3.32	0.99	Narejo, 2006
Pakistan	*C. reba*	-2.07	3.02	0.95	Muhammad *et al.*, 2016
India	*C. reba*	0.015	2.385	0.871	Mathialagan *et al.*, 2014
Pakistan	*C. reba*	0.037	2.557	0.817	Present study

Growth Parameters: To calculate the growth parameters of fish species VBGF is generally applied which is formulated to study the anabolic and catabolic process in species and the growth as equilibrium (Pauly 1980). Computed values of growth parametersL_∞ = 29.40 cm and$K$ = $0.240 year^{-1}$were shown in (Table 2).The obtained results of the study of Gheorghe *et al.*, (2012) for *Carassius gibelio* were L_∞ = 39.38and$K$= 0.63,from Romania,which were higher than computed values of *C. reba* in present study. The low growth rate of the species was determined from present study with $K(0.240 year^{-1})$. The t_0 with negative results describes that juveniles grew faster than the predicted growth curve for adults and the juvenile fish species grow slowly if the t_0 results found to be positive (King,1995). In this work estimated values of $t_0$were$t_0 = -0.70 year^{-1}$.

Mortality: Previously published values of mortality of different authors were compared with the obtained results in present study (Table 3). The obtained results of *Carassius gibelio* of Gheorghe *et al.*, 2012 for total mortality, natural

Table 2: The compared Growth parameters of C. reba with different species of the world

Location	Species	$L\infty$ cm	k year^{-1}	Source
India	*Tor khudree*	120.2	0.23	Raghavan *et al.*, 2011
Bangaladesh	*Cirrhinus cirrhosus*	85	0.43	Ahmad *et al.*, 2004
Pakistan	*Cyprinus carpio*	80.33	0.6	Mirza, 2012
Romania	*Carassius gibelio*	39.38	0.63	Gheorghe *et al.*, 2012
Pakistan	*Cirrhinus reba*	29.4	0.24	Present work

mortality and fishing mortality were 2.29 year^{-1},1.46 year^{-1}, 0.826 year^{-1}and exploitation ratio was 0.63 year^{-1}, the results of Mirza 2012 for *Cyprinus carpio* from Pakistan were Z = 1.22 year^{-1}, M = 0.890 year^{-1}, F = 0.330 year^{-1}and$E$ = 0.690 year^{-1}. The obtained results from different countries were higher than the obtained results of present study. Meantime the obtained exploitation rate of $0.02 year^{-1}$ was smaller than that of the standard exploitation rate of $0.5 year^{-1}$(Gulland 1971).

Table 3: The compared Mortality rates of C. reba with different species of world

Location	Species	Zyear^{-1}	Myear^{-1}	Fyear^{-1}	Eyear^{-1}	Source
Romania	*Carassius gibelio*	2.29	1.46	0.826	0.63	Gheorghe *et al.*, 2012
Pakistan	*Cyprinus carpio*	1.22	0.890	0.330	0.690	Mirza, 2012
India	*Tor khudree*	0.350	0.220	0.130	0.340	Raghavan, 2011
Pakistan	*Cirrhinus reba*	0.630	0.617	0.012	0.019	Present study

Biological Reference Points: In present study the computed values of biological reference pointsfor *C. reba* were $0.618 year^{-1}$and the obtained results of fishing mortality were $0.012 year^{-1}$which indicates that the studied fish species were at a sustainable level.

Growth Performance Index: The results of growth performance index ($\emptyset'$) provides the diverse biological information about thestatus of various stocks or population (Baijot and Moreau, 1997). In present study the obtained values for growth performance index were$\emptyset' = 2.317 year^{-1}$.Since, in current work the data is not enough so that it cannot be compared to the parameters of lifespan of other studies. This may raise some concerns for the fishery managers.

Maximum Sustainable Yield: Computed results of MSY in present work were 8.144 tons $year^{-1}$. The obtained values were greater than the present catches of 0.031 tons $year^{-1}$ (31.468kg), which indicates that the stocks of this species may be at a sustainable level in the region.

CONCLUSION

Estimated values of fishing mortality (*F*) and maximum sustainable yield (MSY) indicated that the studied fish species of *C. reba* were at sustainable level in Indus River Sukkur, Sindh, Pakistan.

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