Asian Fisheries Science **18** (2005): 1-14
ISSN: 0116-6514
https://doi.org/10.33997/j.afs.2005.18.1.001
Asian Fisheries Society, Manila, Philippines

Population Dynamics and Stock Assessment of *Labeo rohita* (Hamilton) in the Kaptai Reservoir, Bangladesh

K.K.U. AHMED[1], S.M.N. AMIN[2], G.C. HALDAR[1], S. DEWAN[3] and M.M. HOSSAIN[4]

[1]*Bangladesh Fisheries Research Institute*
Riverine Station, Baburhat
Chandpur-3602
Bangladesh

[2]*Institute of Marine Science*
University of Chittagong
Chittagong

[3]*Department of Fisheries Management*
Faculty of Fisheries
Bangladesh Agricultural University
Mymensingh-2202, Bangladesh

[4]*Bangladesh Fisheries Research Institute*
Riverine Sub-Station
P. O. Box-8, Rangamati-4500
Bangladesh

Abstract

The dynamics and stock assessment of *Labeo rohita* in Kaptai lake, Bangladesh are studied using length-frequency based analysis in order to evaluate growth parameters, mortality rates, exploitation rate, maximum sustainable yield (MSY) and the corresponding fishing pressure at this level. The study reveals that the fishery is harvested at a higher level than the optimum fishing pressure. This fishing pressure may be reduced near to 1.34/yr from the present level of fishing pressure 1.48/yr to obtain MSY of 51.90 tons.

Introduction

Among the freshwater fish, major carp play a significant role because of their taste, high market price and commercial importance. They are distributed in the Indian subcontinent. Though the total fish production showed gradual increase, the production of major carp in the Kaptai reservoir decreased rapidly after 1975. The members of Cyprinidae (*Labeo rohita, Catla catla, Cirrhinus migala, Labeo cabasu*) were found to predominate at the advent of post-impoundment condition (78.84%; 1965-66) that has been shifted to Clupeidae (*Corica soborna, Gudusia chapra, Gonialosa manmina*) over time. Based on information about the mean average length, yield rate, body condition, length-weight relationship and maturity of major carp, it is evident that they are in danger of becoming stunted. Due to various reasons spawning of all the members of major carp did not occur successfully, which reduced recruitment through auto-stocking over the years (Ahmed 1999). Thus it has become a great concern about carp fishery to the lake management authority and the researchers as well. As a strategy of fish conservation in the Kaptai lake, fisheries of all sorts are banned for the months of July-August of each year.

L. rohita is ubiquitous in Bangladesh with its wide and versatile distribution in the freshwaters. At the advent of harvesting after impoundment of the Kaptai reservoir, successful recruitment of this species occurred. For the last two decades availability of this fish in the lake environment has drastically declined due to several factors such as siltation caused by deforestation, over fishing, indiscriminate killing of supplemental fingerlings and use of various types of destructive fishing methods including fish aggregation device (FAD) (Ahmed and Hambrey 1999). Effective management of any fishery requires considerable knowledge on population parameters and stock position of important species. The ultimate goal of this study is to evolve a sound management and conservation policy for the development of this fishery based on the results obtained on the important population parameters and stock position.

Materials and Methods

Kaptai lake (Latitude 22° 22' - 23° 18' N; Longitude 92° 00' - 92° 26' E) (Fig.1) is one of the most important freshwater fisheries in Bangladesh. It is the largest man-made reservoir in the Southeast Asia (Fernando 1980). It was impounded in 1961 by damming the Karnafuli river at Kaptai in the Rangamati Hill Tracts, mainly for the generation of hydroelectric power while keeping fisheries, navigation, flood control and irrigation as secondary options. The river Karnaphuli, originating from the hills of Assam (India), flows through this area. The river basin and surrounding low area have been inundated due to the blockage of the river flow by the dam. The lake is fed by the rivers, Karnafuli, Chengi, Mayani, Kasalong and Riankhiang. The average water surface of the lake is approximately 58,300 ha (Ali 1985). The maximum and mean depths of the lake are 35 m and 9 m respectively. The present annual fishery yield of Kaptai Reservoir varies between 5000 and 6000 mt. The shoreline of the lake is rocky and covered with the remains of submerged dead trees and wooden logs, which are still obstacles to fishing and navigation. The soil in the valley bottoms on level ground is clay-loam while that of the hills is sand or sandy-loam. The bottom of the reservoir is mostly uneven with less clay except in the main riverbed. The present reservoir area was once part of undulating valleys, which were mostly cultivated. Major land uses around the reservoir are slash and burn agriculture and forestry (teak plantation) (Ahmed 1999).

Length-based stock assessment methods were used for the present study. Length-frequency data of *L. rohita* was collected monthly from the commercial catches at different landing sites of Kaptai Lake and retailing markets of Rangamati Hill Tracts from September 1993 through May 1999. Random samples of 6,456 specimens were collected. Fishermen used a wide range of mesh sizes of gillnet (6-14 cm). The samples were taken randomly from mixed catch of gillnets of different mesh sizes as well as lift nets and hook and line. Thus, the question of mesh selectivity in the sample does not arise and there is no chance of predominance of particular size/age groups in the samples. Total length was measured to the nearest cm and the weight was measured to the nearest g. Length and weight were pooled from different landing sites by month and grouped into 2 cm length groups. The FiSAT software (FAO-ICLARM Stock Assessment Tools as explained in detail by Gayanilo Jr. et al. 1996) was used for data analysis. Asymptotic length (L_∞) and growth co-efficient (K) of the von Bertalanffy equation for growth in length were estimated by means of ELEFAN-I (Pauly and David 1981, Saeger

Fig. 1. Map of Kaptai lake

and Gayanilo 1986). Additional estimate of L_∞ and Z/K values were obtained by plotting $\bar{L}$ minus L' on ‘L (Wetherall 1986 as modified by Pauly 1986), i.e.,

$$\bar{L} - L' = a + bL'$$

where, L = -a/b and Z/K = -(1 + b)/b

where, $\bar{L}$ is defined as the mean length, computed from L' upward, in a given length-frequency sample while L' is the limit of the first length class used in computing a value of $\bar{L}$.

The growth performance of *L. rohita* population in terms of length was compared using the index of Pauly and Munro (1984). i.e,

$$\phi' = \text{Log}_{10} K + 2 \text{ Log}_{10} L_\infty$$

Total mortality (Z) was estimated using length converted catch curve method as implemented in ELEFAN II. Natural mortality rate (M) was estimated using Pauly’s empirical relationship (Pauly 1980) i.e.,

$$\text{Log}_{10} M = -0.0066 - 0.279 \text{ Log}_{10} L_\infty + 0.6543 \text{ Log}_{10} K + 0.4634 \text{ Log}_{10} T$$

where, L_∞ is expressed in cm and T, the mean annual environmental temperature in°C which is 27°C, here

Fishing mortality (F) was obtained by subtracting M from Z and exploitation rate (E) was obtained from F/Z [E = F/Z = F/ (F+M)] (Gulland 1971). Recruitment patterns were obtained by backward projection on the length axis of a set of length-frequency data as described in the FiSAT routine. To estimate length at recruitment (L_r) the mid point of the smallest length group in the catch was taken as length at recruitment (Murty et al. 1992).

Relative yield per recruit (Y/R) and relative biomass per recruit (R/B) values as a function of E were determined from the estimated growth parameters and probability of capture by length (Pauly and Soriano 1986). The calculations were carried out using the complete FiSAT software package.

The estimated length structured virtual population analysis (VPA) and cohort analysis were done according to the FiSAT routine following the method of Fry (1949). Pauly (1984) and Jones (1984) gave the practical reviews of VPA. The values of L_{∞}, K, M, F, a (constant) and b (exponent) for the species were used as inputs to a VPA analysis in the FiSAT routine. The t_0 value was taken as zero.

The total annual stock, average standing stock and MSY of *L. rohita* were also estimated. For this purpose, at first exploitation rate (U) was estimated using the equation given by Beverton and Holt (1957) and Ricker (1975) as $U = F/Z\ (1 - e^{-z})$. Then, using the values of U, F and estimated annual catch (Y), the total annual stock (Y/U) and average standing stock (Y/F) were determined. The approximate MSY was then calculated using the equation proposed by Cadima (in Troadec 1977) for exploited fish stocks.

$$MSY = Z_t\ .05.\ B_t.$$

where, Z_t is the exponential rate of total mortality in the year t and B_t is the standing stock size in the year.

The total length-total weight relationship of *L. rohita* was estimated using the formula:

$W = aL^b$ where ‘a’ is a constant and ‘b’ is an exponent.

Results and Discussion

Kaptai reservoir, a productive major carp reservoir, contributed over 53% to the total landings in the first decade, of which the contribution of *L. rohita* was only 6.8%. This species collapsed subsequently with the age of post-impoundment nature and other related factors that contributed 4.6% in the second decade and only 1.5% in the last decade. For the last decade, fish composition is dominated by Clupeidae (41%), of which *C. soborna* accounted for 24%, *G. chapra* and *G. manmina* jointly contributed 17% and catfish contributed 6% (Ahmed 1999). Between the first and second decade major carp were the primary target species of the professional fishers. As seen from the present fish production statistics and species composition, over 60% of the total fish production is based on mosquito seine nets, small meshed seine nets, monofilamentous gill nets, lift nets, hooks and lines and most recently developed fish aggregating device (FAD), the brush shelter locally called *Juk jal.*

Growth parameters

Growth parameters of von Bertalanffy growth formula *viz.* L_∞ and K were estimated for *L. rohita* in Kaptai Lake. The L_∞ values obtained were found to range from 93.28 to 101.00 cm. The range of estimated K values was 0.68 to 0.92/yr. (Table 1). For these estimates through ELEFAN-I the response surface (Rn) used for both the curves were 0.134. The computed growth curves of *L. rohita* produced with these parameters have been shown over the restructured length distribution of individual species in figures 2a and 2b.

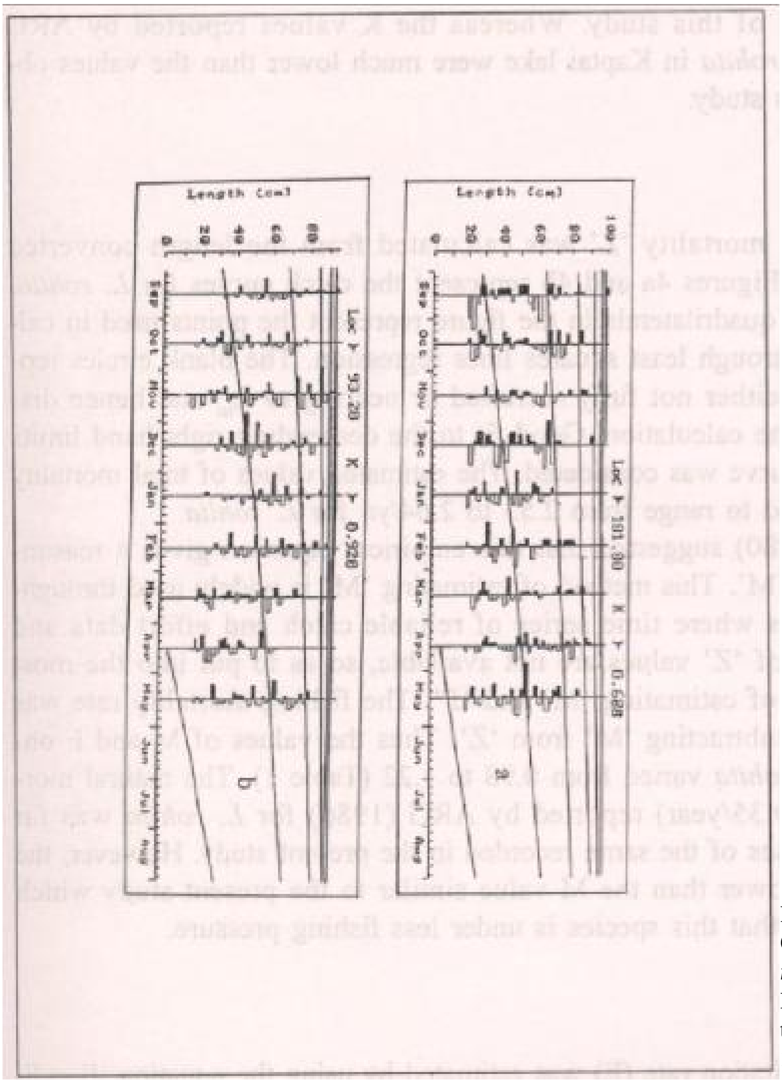
The L_∞ and Z/K values were also estimated for *L. rohita* using the methods of Wetherall (1986) (Figs. 3a and 3b). The values of L_∞ and Z/K obtained for this species were found to range from 93.92 to 103.82 cm and 2.79 to 3.34 cm for the studied years (Table 1). This additional estimate of L_∞ values was almost close to the L_∞ values estimated through ELEFAN-I.

The growth performance index (f) obtained for *L. rohita* (3.841 to 3.903 cm) in Kaptai lake was found to be excellent (Table 1). More or less similar values of L_∞ estimated by ELEFAN-I and Wetherall Plot methods were also obtained by Azadi et al. (1995), Azadi et al. (1997) and Zafar et al. (1998) in their study.

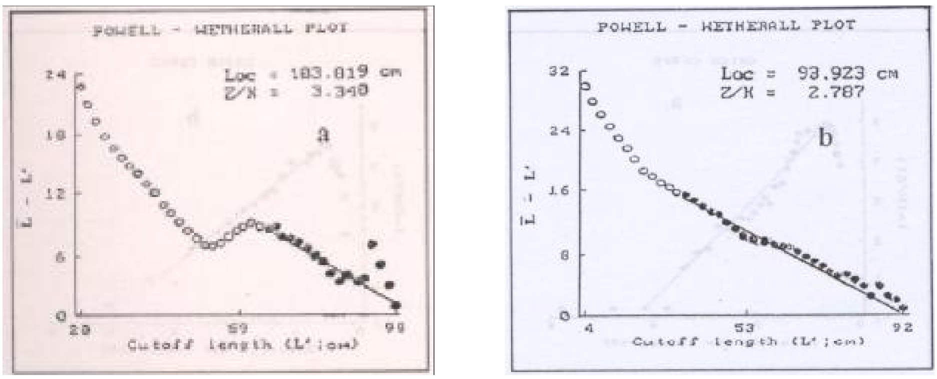
The asymptotic length (L_∞) of *L. rohita* recorded by ARG (1986) in Kaptai lake was 105.7 cm which is higher than the values of the same obtained in the present study. But the values of the same recorded by Khan (1972) for this species in Indian waters (101.5 cm) is almost close to the values of this study. Whereas the K values reported by ARG (1986) for *L. rohita* in Kaptai lake were much lower than the values obtained for this

Table 1. Population parameters of *L. rohita* in Kaptai lake

Parameters	*L. rohita*	
	1993-96	1996-99
Asymptotic length (La) in cm	101.00	93.28
Growth coefficient (K)/yr	0.68	0.92
La (P-Weth. Plot) in cm	103.82	93.92
Z/K (P-Weth. Plot)	3.34	2.79
Total mortality (Z)/yr.	2.64	2.53
Natural mortality (M)/yr.	0.98	1.22
Fishing mortality (F)/yr	1.66	1.31
Exploitation rate (E) = F/Z	0.63	0.52
Exploitaiton lavel for maximum allowable limit of Y/R (E_{max})	0.50	0.50
Length at first capture (L_c) in cm	28.28	26.12
Recruitment size (L_r) in cm	21.00	15.00
Growth performance index (f´)	3.841	3.903
Response surface (Rn)	0.134	0.134
Sample size (N)	4389	2067
Length range (Lr)	20-100	14-92



Figs. 2a and b. Growth curves of *L. rohita* in Kaptai Lake ('a' for 1993 to 96 and 'b' for 1996 to 99)



Figs. 3a and b. Estimation of L_∞ and Z/K using the methods of Powell-Wetherall plot for *L. rohita* in Kaptai Lake ('a' for 1993 to 96 and 'b' for 1996 to 1999).

study.

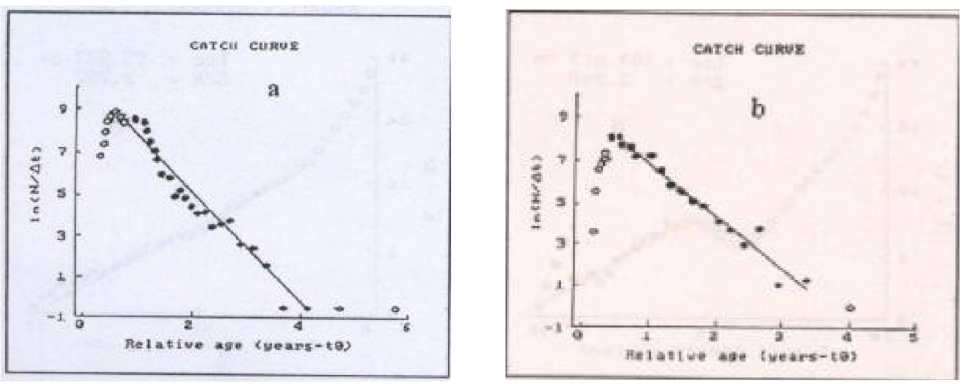
Mortality

The total mortality ‘Z’ was calculated from the length converted catch curves. Figures 4a and 4b represent the catch curves for *L. rohita*. The darkened quadrilaterals in the figure represent the points used in calculating ‘Z’ through least squares lines regression. The blank circles represent points either not fully recruited or nearing to L_∞ and hence discarded from the calculation. Good fit to the descending right hand limits of the catch curve was considered. The estimated values of total mortality (Z) were found to range from 2.53 to 2.64/yr. for *L. rohita*.

Pauly (1980) suggested that this empirical equation gives a reasonable value of ‘M’. This method of estimating ‘M’ is widely used throughout the tropics where time series of reliable catch and effort data and several years of ‘Z’ values are not available, so as to put into the most usual method of estimating ‘M’ and ‘F’. The fishing mortality rate was estimated by subtracting ‘M’ from ‘Z’. Thus the values of M and F obtained for *L. rohita* varied from 0.98 to 1.22 (Table 1). The natural mortality value (0.35/year) reported by ARG (1986) for *L. rohita* was far below the values of the same recorded in the present study. However, the F value was lower than the M value similar to the present study which also indicates that this species is under less fishing pressure.

Exploitation rate

The exploitation rate (E) was estimated by using the equation, E = F/Z (F+M). The E values so far obtained for *L. rohita* varied between 0.52 and 0.63 and the E_{max} values recorded were 0.50 for the studied years (Table 1). The values obtained for *L. rohita* from 1993 to 1996 were fairly above



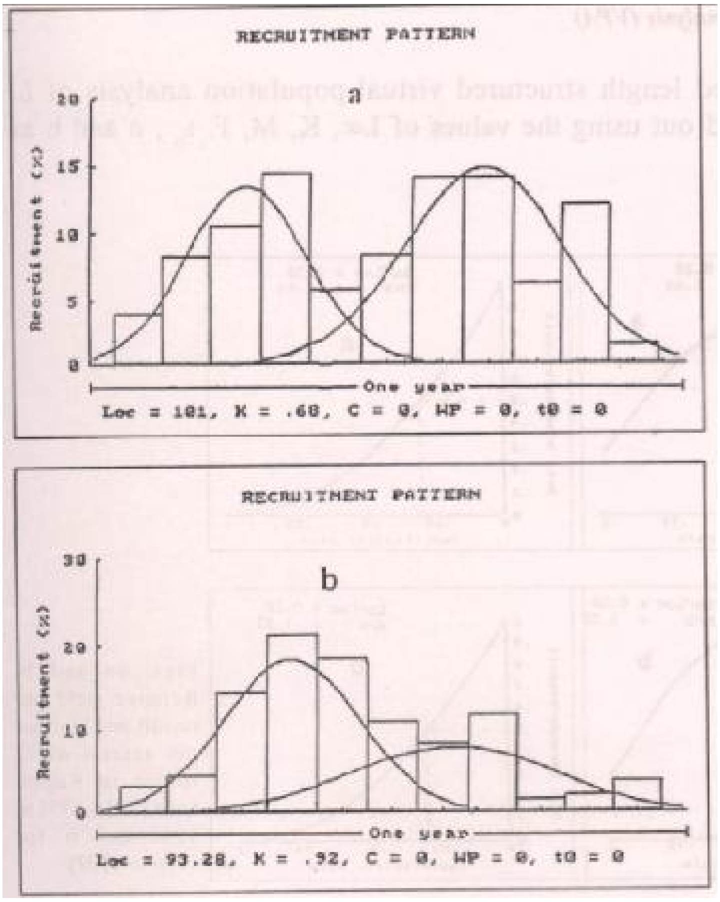
Figs. 4a and b. Length converted catch curve of *L. rohita* in Kaptai Lake (‘a’ for 1993 to 1996 and b for 1996 to 1999).

than the optimum values indicating over fishing pressure on stock during that period. But later on (1996 to 99) this value decreased to 0.52 which is almost close to optimum value (0.5) indicating optimum fishing pressure on stock. This assumption is based on Gulland (1971) as he stated that suitable yield is optimized when F = M i.e., when E is more than 0.5, the stock is generally supposed to be under over fishing.

Recruitment pattern

Figures 5a and 5b show the recruitment patterns of *L. rohita* in Kaptai Lake. For *L. rohita*, recruitment was found to occur twice annually. Two peaks were found, one in April another in August. The first recruitment occurred between March to June and the second occurred between July to September (Figs. 5a and 5b). Mustafa (1994), Mustafa et al. (1998) and Zafar et al. (1998) also recorded two pulses of recruitment for some fishes.

The length at first capture (L_c) estimated for *L. rohita* ranged from 26.12 to 28.28 cm whereas the recruitment sizes (L_r) ranged between 21 and 15 cm



Figs. 5a and b. Recruitment pattern of *L. rohita* in Kaptai Lake ('a' for 1993 to 1996 and 'b' for 1996 to 1999).

during the investigation period.

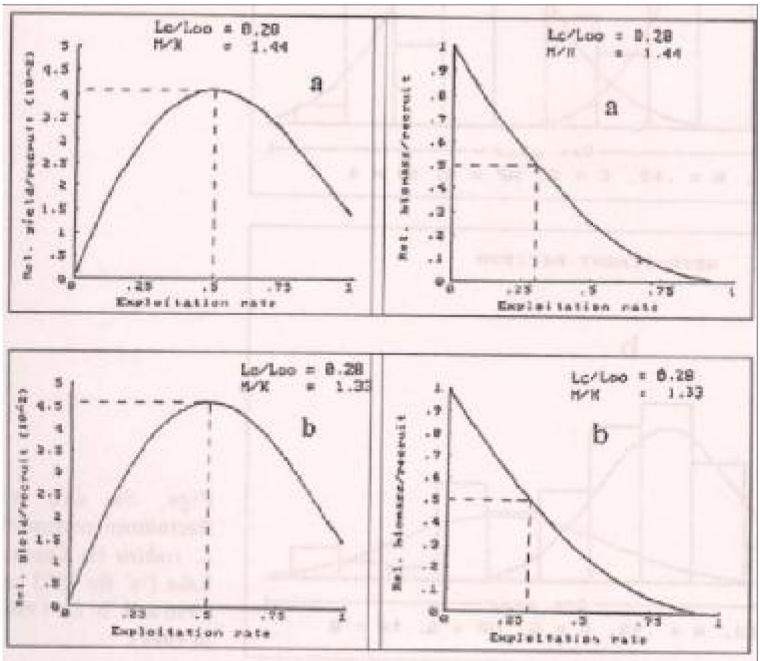
Yield-per-recruit and biomass-per-recruit

The relative yield-per-recruit (Y/R) and biomass-per-recruit (B/R) were determined as a function of $L_c/L\infty$ and M/K respectively. The $L_c/L\infty$ values recorded were 0.28 for the studied years and M/K values were 1.33 and 1.44 for *L. rohita*. Figures 6a and 6b show the maximum allowable limit of yield per-recruit for *L. rohita* in different years.

The exploitation rates for *L. rohita* recorded from 1993 to 96 exceeds the maximum allowable limit of the yield/recruit (Fig. 6a), but the value of the same from 1996 to 99 (Table 1) is almost close to the maximum allowable limits of the yield per recruit as shown in figures 6a and 6b, which indicate that the stock of this species is more or less under optimum exploitation level. So, fishing mortality does not seem to be a great concern for this fish stock at the moment.

Virtual population analysis (VPA)

The estimated length structured virtual population analysis of *L. rohita* was carried out using the values of L∞, K, M, F, t_o , a and b as inputs. The results of length structured VPA analysis are depicted in figures 7a and 7b. These figures show fishing mortality in relation to mean



Figs. 6a and b. Relative yield per recruit and biomass per recruit of *L. rohita* in Kaptai Lake ('a' for 1993 to 1996 and 'b' for 1996 to 1999).

length. The length range of fishes for higher fishing mortality was found to vary from species to species and year to year. For *L. rohita* higher fishing mortality was found to occur between 41 and 60 cm from 1993 to 96 and 32 and 77 cm from 1996 to 99 (Figs. 7a and 7b).

Estimation stock and MSY

The results on the estimation of stock and MSY for *L. rohita* in Kaptai lake are shown in table 2. The average values of total annual stock, standing stock and MSY recorded were 94.26 mt, 40.08 mt and 51.90 mt respectively (Table 2). So to obtain MSY from this stock, the fishing mortality rate needs to be reduced to 1.34 from 1.48 mt.

Length-weight relationship

The sample sizes with length and weight ranges of *L. rohita* used to determine length-weight relationships for different years are presented in table 3. The length-weight relationship was established using the formula:

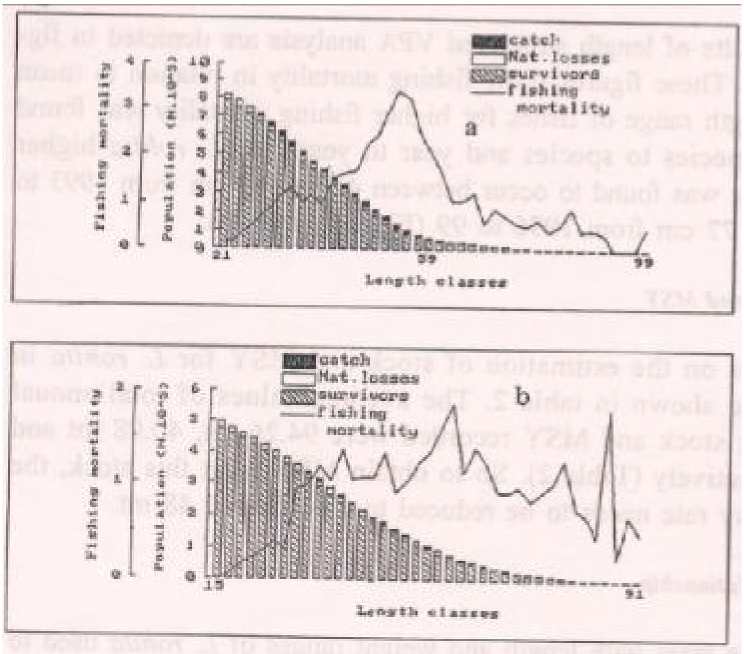
$$W = aL^b \text{ in logarithmic form } \mathrm{Log}W = \mathrm{Log}\ a + b\ \mathrm{Log}L$$

The exponential forms of equations obtained for the species in different years are shown in table 3. The exponent ‘b’ values estimated in different years for this species under study were close or slightly above and below 3 indicating more or less isometric growth pattern. Generally in length-weight relationship of fish, when the value of ‘b’ is equal to 3, the growth of the species is assumed to be isometric and if it is above or below, the growth is assumed to be allometric. The values of ‘b’ seem to be equal to 3 indicating that the studied fish weight in Kaptai lake increases following the cube of the length. The values of ‘r’ for this species recorded in the present study were 0.990 indicating highly significant relationship between total length and weight of this species. This finding agrees with the findings of Ahmed and Saha (1996) and ARG (1986).

The value of ‘b’ recorded for *L. rohita* by ARG (1986) was lower than the values of the present study for this species. Khandker and Huq (1970),

Table 2. Estimation of stock and MSY for *L. rohita* in Kaptai lake

Species	Year	Catch (mt)	Annual stock (mt)	Av. Standing stock (mt)	MSY (mt)
L. rohita	1993-96	41.92	71.05	34.36	45.36
	1996-99	59.89	124.77	45.72	57.84
	Average	50.90	94.26	40.08	51.90



Figs. 7a and b. Length structured Virtual Population Analysis of *L. rohita* in Kaptai Lake ('a' for 1993 to 1996 and 'b' for 1996 to 1999).

Table 3. Length-weight relationship of *L. rohita* in Kaptai lake

Species	Year	Sample size (N)	Length range (cm)	Wt. range (g)	Exponential form of equation	r
L. rohita	1993-96	1552	21-90	120-1320	$W=0.0108L^{3.0591}$	0.999
	1996-99	1730	16-88	81-10450	$W=0.0154L^{2.971}$	0.997

Hossain (1995) and Ahmed and Saha (1996) also reported almost similar values of 'b' for *L. rohita.*

Conclusion

From the above results it can be concluded that the stock of *L. rohita is* now under optimum exploitation level. Any major change in the existing fishing level/exploitation will most likely result in a reduction in the yield per recruit and thereby hamper the MSY.

References

Ahmed, K.K. 1999. Options for the Management of Major Carp Fishery in the Kaptai Reservoir, Bangladesh. Ph.D. dissertation, April, 1999, School of Environment, Resources and Development, Asian Institute of Technology, Bangkok, Thailand.

Ahmed, K.K. and S. B. Saha. 1996. Length-weight relationships of major carps in Kaptai Lake, Bangladesh. Naga ICLARM Quarterly 19(2): 22.

Ahmed K.K. and J.B. Hambrey. 1999. Brush shelter: a recently introduced fishing method in the Kaptai Reservoir fisheries in Bangladesh. Naga ICLARM Quarterly 22(4): 20-23.

Ali, L. 1985. Proceedings of the National Conference on Fisheries Development in Bangladesh. 15-19 January, sponsored by Fisheries and Livestock Division, Ministry of Agriculture, Bangladesh. 41pp.

Aquatic Research Group (ARG). 1986. Hydrobiology of the Kaptai Reservoir. FAO/UNDP Final Report No. DP/BGD/79/015/FI. 192.

Azadi, M.A., M.G. Mustafa and M.S. Islam. 1995. ELEFAN based populaiton dynamics of *Parapenaeopsis sculptilis* (Heller) from the Kumira estuary, Chittagong, Bangladesh. Chittagong University Studies Part II: Science, 19(2): 181-90.

Azadi, M.A., M. G. Mustafa and A.S.M.S. Rahman. 1997. ELEFAN based populaiton dynamics of two clupeids, *Gudusia chapra* (H.) and *Gonialosa manminna* (H). from Kaptai reservoir, Bangladesh. Chittagong University Studies Part II: Science, 21(2): 125-32.

Beverton, R.J.H. and S.J. Holt. 1957. On the dynamics of exploited fish populations. Fishery Investigations, 2(9): 533.

Fernando, C.H. 1980. The fishery potential of man made lakes in South-East Asia and some strategies for its optimization. *In* BIOTROP, Anniversary Publications, Bogor, BIOTROP, 25-38.

Fry, F.E.J. 1949. Statistics of a lake trout fishery. Biometrics, 5: 27-67.

Gayanilo, F.C.Jr., M. Soriane and D. Pauly. 1996. The FAO-ICLARM stock assessment tools (FiSAT) users guide. FAO Computerised Information. Series (Fish), 7: 126.

Gulland, J.A. 1971. The fish resources of the oceans. West by fleet survey. Fishing News (Books) Ltd., for FAO: 255.

Hossain, M.I. 1995. Studies on the growth, production and fishery of six major and exotic carps in a selected baor. A thesis submitted for M.S. degree in Fisheries Biology and Limnology, BAU, Mymensingh, 110 p.

Jones, R. 1984. Assessing the effects of changes in exploitation pattern using length composition data (with notes on VPA and cohort analysis). FAO Fisheries Technical Paper, 256, 175-192.

Khan, R.A. 1972. Studies on the biology of some important major carps. Thesis, Department of Zoology, Aligarh Muslim University, Aligarh, 185.

Khandaker, N.A. and A. Huq. 1970. Length-weight relationships of *L. rohita*. 21st and 22nd Pakistan Science Conference Abstract, II, Fisheries, B-36.

Mustafa, M.G. 1994. Length-based estimates of vital statistics in threadfin bream (*Nemipterus japonicus*) from Bay of Bengal, Bangladesh. Naga ICLARM Quarterly, 17(1): 34-37.

Mustafa, M.G. and M.G. Khan. 1998. Studies on some aspects of the population dynamics of Lizard fish, *Saurida tumbil* (Blotch) from the Bay of Bengal. Bangladesh Journal. Zoology, 16(2): 77-84.

Murty, V. and M. Srinath, P. Livingston, Y. Appannasastry and S. Srinivasarengan. 1992. Stock assessment of silverbellies of India with particular reference to Andhra Pradesh and Tamil Nadu. Indian Journal Fisheries, 39(1,2): 42-64.

Pauly D. 1980. On the interrelationship between natural mortality, growth parameters and mean environmental temperature in 175 fish stocks. Journal CIEM, 39(3): 175-92.

Pauly, D. 1986. On improving operation and use of the ELEFAN programs. Part II. Improving the estimation of L_{∞}. Fishbyte, 4(1): 18-20.

Pauly, D. and N. David. 1981. ELEFAN-I basic program for the objective extraction of growth parameters from length frequency data. Meeresforsch, 28(4): 205-11.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. *Bulletin Fisheries Research Board Canada,* 191-382.

Pauly, D. 1984. Fish population dynamics in tropical waters: manual for use with programmable calculators. ICLARM studies Review, 8: 325.

Pauly D. and J.L. Munro. 1984. Once more on growth comparisons in fish and invertebrates. Fishbytes, 2 (1): 21.

Pauly, D. and M.L. Soriano. 1986. Some practical extensions to Beverton and Holt's relative yield-per-recruit model. *In* First Asian Fisheries Forum (eds. J.L. Maclean, Dizon L.B. and Hosillos L.V.). Asian Fisheries Society, Manila, Philippines, 149-495.

Saeger, J. and F.C. Gayanilo Jr. 1986. A revised graphic orientated version of ELEFAN-0, I and II basic programs for use on HP 86/87 microcomputers. Technical Report Department Marine Fisheries Technical Report, 8: 233.

Troadec, J.P. 1977. Methods semi-quantitatives devaluation. FAO Circular Peches, (701): 131-141.

Wetherall, J.A. 1986. A new method for estimating growth and mortality parameters from length frequency data. Fishbyte, 4(1): 12-15.

Zafar, M., M.G. Mustafa, S.M. Nurul Amin and S. Akhter. 1998. Studies on population dynamics of *Acetes indicus* from Bangladesh Coast. Journal Noami, 14(1,2): 1-13.

Manuscript received 8 August 2003; Accepted 11 February 2004