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# Freshwater fish population estimation of major carps (Cyprinadie family) from Marathwada Region, Maharashtra, India by Delury (1947) catch- Effort method

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**Abstract**
The present paper deals with the estimation of freshwater fish population of major carps (family-Cyprinadie) from Marathwada Region. Estimation of population by catch - effort method is very effective in closed type of water resources. During the study period, it was observed that population of Major carps are decline (Cyprinadie family was dominant) from Marathwada region, major carps are having commercial as well as good food value and use as a substitute food for common people, but due to habitat destruction, water pollution, unregulated fishing practices and lack of awareness regarding fishing techniques are probably playing an important role in declining fish population of major carps and need to conserve.

**Keywords:** Fish Population, Marathwada region, Cyprinadae, Decline and Catch-effort Method.

## 1. Introduction
Fish population estimation has largely depended on indirect method. The techniques of indirect estimation of standing fish population depend on reduction in the catch per unit of effort (or in successive trials) as a result of diminution of the population by the fishing. (Delury method 1947) [6].

The fish diversity is correlated with biological and various physical – chemical parameters that regulate the productivity and distribution of different species of the fishes. Freshwater fishes are the most diverse group of India's vertebrates with a minimum of 600 species (Talwar and Jingran, 1991) [18]. The freshwater fishes are distributed among approximately 20 orders 100 families and 300 genera, (Daniels, 2000) [5].

Fish population regulation is fundamental to long-term persistence of populations and their responses for harvesting, habitat modification, and other management interventions (Turchin, 1999) [19]. India is world's second the largest producers of freshwater fish which contribute a significant amount of economy (Chauhan, 1994) [3]; changes in fishery productivity in turn effect the human population.

The total area of Marathwada region is 64,813 km. and is bounded by Vidarbha region on the North, by Andhra Pradesh on the East and South East, Karnataka on the South and by Western Maharashtra on the West. The entire region is situated at an average height of about 300-650 m. above mean Sea level gradually sloping from west to east, and is traversed by hill ranges originated from the Sahyadri's in the East and the Satpuda's in the North. Different ranges derive their names from local sources, the northern being Ajanta-Satmala ranges and the southern the Balaghat ranges.

Fishes are a rich source of protein with high nutritive value and an excellent food for poor people and provide protein, fat, minerals and vitamin A and D. It is also essential for the good health of the human population for thousands of years and vitally important as a protein source in developing counties. In developing countries like India, fish provide a food source. They have a good taste and are easily digestible and hence faith a good market value and numerous recreational opportunities. Loss of productivity in the world fisheries could result in increasing food and fish marketing strategies for developing countries.

## 2. Material and Methods

To study the characterization of fish population, during the study period October 2006 to September 2008, fish samples were collected from six sampling sites (site I, site II, site III, site IV, site V and site VI) from five districts (Aurangabad, Jalna, Parbhani, Nanded and Beed). Perennial sampling sites were selected from five districts which were distributed to cover complete area under Marathwada region to study the abundance of fish species.

Weekly data was collected throughout the year, by successive netting with the help of skilled local fishermen. Locations were changed for the collection of freshwater fish species according to the season. Individual kg/effort was recorded to calculate the frequency of occurrence and relatively abundance of fish species where the number of efforts were 4.

To estimate fish population, during the study period October 2006 to September 2008 indirect regression method was used. (Delury, 1947) [6]. The regression method employs data on catch per unit of effort to arrive at an estimate of population.

The procedure cannot be applied unless the population shows a reduction per fishing effort. The reduction is proportional to the extent of the depletion. The simplest means of estimating population number by this method is to graph the data into straight regression line. In such a graph, the catch per unit of effort lies at the ordinate while total catch including the latest sample at the abscissa. Extrapolations of the regression line to its intercept with the 'x' axis gives a value, which is an approximation of population number.

According to the author, rests the assumptions based on Delury method are

1. The population is closed, i.e the effects of migration and natural mortality is negligible.
2. The units of efforts employed do not compete with one another, and they are constant during the study period involved.
3. The response of the fish to the gear i.e., catching ability remains constant for the period under investigation.

### 2.1 Correlation coefficient (r)

The correlation coefficient (r) and Regression equation were as described by, Mungikar (2003) [10].

$$r = \frac{\sum\left(X - \overline{X}\right)\left(Y - \overline{Y}\right)}{\sqrt{\sum\left(X - \overline{X}\right)^2\left(Y - \overline{Y}\right)^2}}$$

$$\text{i]}\ \sum\left(X - \overline{X}\right)^2 = \sum X^2 - \frac{\left[\sum X\right]^2}{N}$$

$$\text{ii]}\ \sum\left(Y - \overline{Y}\right)^2 = \sum Y^2 - \frac{\left[\sum Y\right]^2}{N}$$

$$\text{iii]}\ \sum\left(X - \overline{X}\right)\left(Y - \overline{Y}\right) = \sum XY - \frac{\left[\sum X\right]\left[\sum Y\right]}{N}$$

Where

- X and Y are the two variables.
- While 'N' denotes number of observation.

**Regression equation**

$$y = a + bx$$

**Simultaneous equation to derive the values of a and b**

$$na + \sum Xb = \sum Y$$
$$\sum Xa + \sum X^2 b = \sum XY$$

**Population of fish was then calculated as:** $p = \frac{a}{b}$

Where:

- P= population of fish
- 'a' and 'b' are constants
- X and Y are variables
- n = number of observations.

### 2.2 Population density of fish

Density of fish population at each site was estimated following the formula of abundance index as described by JatindraNath Bhakta, (2007).

$$A_1 = \frac{n(k)}{N} \text{X} 100$$

Where:

$A_1$ =Abundance index, n (K) = number of individual of species k caught at each site and N= Number of individual of all fish species caught at that site.

**Table 1:** *Labeo rohita*

| Week | Site I | | Site II | | Site III | | Site IV | | Site V | | Site VI | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **2006-2007** | **2007-2008** | **2006-2007** | **2007-2008** | **2006-2007** | 2007-2008 | **2006-2007** | **2007-2008** | **2006-2007** | **2007-2008** | **2006-2007** | **2007-2008** |
| 1 0 | 23.5 | **18.5** | 33.2 | **32** | 27 | 28 | 39 | **36** | 72 | **68** | 56 | **69** |
| 2 | 22 | **17** | 32 | **31** | 26.5 | 27.6 | 38.5 | **35** | 70 | **66.5** | 54 | **65** |
| 3 | 21.6 | **16.5** | 31.2 | **30** | 25.3 | 26.5 | 37.6 | **34.6** | 68.2 | **65** | 53 | **63.2** |
| 4 | 20.5 | **16** | 30 | **29.6** | 24.6 | 25.4 | 36.5 | **33.5** | 67 | **64.2** | 55 | **60** |
| 5 | 20 | **15.5** | 29.6 | **28.6** | 23.5 | 25 | 35 | **32.5** | 66.8 | **62** | 54 | **59** |
| 6 | 19.6 | **15** | 28.5 | **27** | 25 | 24 | 34.2 | **31.6** | 68.5 | **60** | 52.2 | **58** |
| 7 | 19.5 | **14.6** | 27 | **29** | 24 | 23.5 | 35 | **30.2** | 68 | **58** | 51.6 | **52** |
| 8 | 18.6 | **15** | 26.5 | **27.5** | 23 | 22.6 | 36 | **33.2** | 66 | **60** | 50.3 | **51** |
| 9 | 18 | **14** | 25.5 | **26.3** | 21 | 21.5 | 33.2 | **29.5** | 65 | **59** | 49.5 | **50** |
| 10 | 17.3 | **13.4** | 28 | **26** | 20.5 | 20.5 | 32 | **28** | 64 | **57.6** | 48 | **49** |
| 11 | 17 | **14** | 26.5 | **25.3** | 19.6 | 19.6 | 30 | **27** | 62 | **56** | 47 | **52** |
| 12 | 16.5 | **13** | 26 | **25** | 19 | 19 | 29.6 | **26** | 60 | **54** | 45 | **51** |
| 13 | 16 | **12.5** | 25 | **24.5** | 18.6 | 18.6 | 28 | **25** | 65 | **53** | 44 | **49** |
| 14 | 15.6 | **12.1** | 24.5 | **23.6** | 18.2 | 18 | 26.5 | **26** | 62 | **51** | 42 | **45** |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 15.4 | **12** | 23.5 | **23** | 19.5 | 19.5 | 25.4 | **23.5** | 59 | **49** | 39.5 | **44** |
| 16 | 15 | **11.5** | 23 | **22.5** | 19 | 19 | 24.3 | **22.5** | 58 | **47** | 37 | **43** |
| 17 | 14.3 | **11.4** | 22.5 | **21.6** | 18 | 17.6 | 23.5 | **21** | 57 | **43** | 36.2 | **42** |
| 18 | 14 | **10.9** | 21 | **21** | 17.6 | 17.1 | 21.3 | **20.6** | 55 | **40** | 34.5 | **41** |
| 19 | 13.5 | **10.6** | 20.5 | **19.5** | 17.1 | 16.5 | 21 | **19.5** | 54.3 | **38** | 33.2 | **40.5** |
| 20 | 13 | **10** | 19.5 | **20.5** | 16.6 | 16 | 20.5 | **19.8** | 51 | **37.6** | 32 | **38.6** |
| 21 | 12.8 | **9.8** | 18.6 | **18** | 16 | 15.4 | 19.6 | **19** | 50 | **36** | 30 | **35** |
| 22 | 12.7 | **9.5** | 18 | **17.5** | 15.2 | 15.3 | 18.5 | **18.6** | 48 | **35** | 29 | **34** |
| 23 | 12 | **9.1** | 17.6 | **16.5** | 14.8 | 14.6 | 20 | **18** | 46 | **34** | 26 | **33** |
| 24 | 11.6 | **8.8** | 17 | **17** | 14 | 14.2 | 16.5 | **17.6** | 45.2 | **33.2** | 25 | **31** |
| 25 | 11 | **8.6** | 16.5 | **15.5** | 13.5 | 13.5 | 15.5 | **16.5** | 43 | **30** | 23.2 | **28** |
| 26 | 10.6 | **9** | 15.6 | **14.6** | 13 | 12 | 14.6 | **15** | 42 | **29** | 21 | **27** |
| 27 | 10.2 | **8** | 16 | **14.1** | 12.5 | 11.5 | 14 | **16.5** | 40 | **28.5** | 19.5 | **26** |
| 28 | 11.2 | **9** | 17 | **15.2** | 13 | 10.6 | 15 | **16** | 37 | **26** | 20 | **28** |
| 29 | 12.6 | **10.5** | 18 | **18** | 15 | 12 | 17 | **17.5** | 42 | **30** | 22 | **32** |
| 30 | 13.5 | **11** | 20 | **19** | 17.5 | 14.5 | 18.6 | **19** | 45 | **32** | 26 | **35** |
| 31 | 14.6 | **12.5** | 22.5 | **20** | 18 | 16 | 19.5 | **21** | 48 | **34** | 29 | **37** |
| 32 | 15 | **14** | 24 | **22** | 20 | 18 | 20 | **23.5** | 50 | **40** | 30 | **40** |
| 33 | 13.5 | **12** | 20 | **19** | 18 | 15.6 | 18.5 | **20** | 45 | **35** | 26.5 | **33** |
| 34 | 12 | **10.2** | 18 | **17.6** | 16.5 | 13.4 | 18 | **16.5** | 40 | **30** | 24.3 | **30** |
| 35 | 10.5 | **9** | 17.6 | **15** | 13.2 | 11.2 | 17.6 | **14.2** | 37 | **27** | 23.2 | **26** |
| 36 | 9.5 | **8** | 15 | **13.2** | 12.3 | 10 | 17 | **13.2** | 36.5 | **26.5** | 23 | **22** |
| 37 | 9.2 | **6.8** | 13.2 | **12** | 12 | 9.8 | 16.5 | **12** | 35 | **25** | 21 | **19** |
| 38 | 9 | **6** | 12 | **11.6** | 11.6 | 9 | 16 | **11.5** | 34 | **24** | 18 | **18.5** |
| 39 | 8.6 | **7** | 11 | **10.3** | 10.5 | 8.6 | 15.5 | **10.4** | 31 | **23** | 17.5 | **18** |
| 40 | 8.4 | **5.4** | 10.6 | **9.6** | 10 | 8 | 14 | **9.5** | 30 | **20** | 16 | **16** |
| 41 | 7.6 | **5.2** | 10 | **8.6** | 9.6 | 7.5 | 13.5 | **8.6** | 28 | **19.5** | 15 | **14.5** |
| 42 | 7.2 | **5** | 9.8 | **8** | 9 | 7.2 | 12 | **7.6** | 26 | **17.6** | 14.6 | **12** |
| 43 | 6.5 | **4.6** | 9 | **7.6** | 8.5 | 6.8 | 11.5 | **6.5** | 24 | **15** | 13.2 | **11** |
| 44 | 6 | **4** | 8.6 | **7.2** | 8 | 6.5 | 10 | **5.6** | 22.1 | **14.2** | 12 | **10** |
| 45 | 5.6 | **3.6** | 8 | **6** | 7.5 | 6 | 9.5 | **5** | 19 | **13.5** | 11 | **9.5** |
| 46 | 5 | **3** | 7.5 | **5.6** | 7 | 5.5 | 8 | **4.6** | 18 | **12** | 10.5 | **8.5** |
| 47 | 4.3 | **2.5** | 6 | **5** | 6.5 | **5** | 7.5 | **4** | 15 | **10.5** | 9 | **7** |
| 48 | 4 | **2** | 5 | **4** | 5 | **4.2** | 7 | **3.5** | 12.2 | **8.6** | 7.6 | **6** |

*** Negligible population All values are in kg--- Not Available Effort = 4**

**Table 2:** *Cirrhinus mrigala*

| | **Site I** | | **Site II** | | **Site III** | | **Site IV** | | **Site V** | | **Site VI** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Week** | **2006-2007** | **2007-2008** | **2006-2007** | **2007-2008** | **2006-2007** | **2007-2008** | **2006-2007** | **2007-2008** | **2006-2007** | **2007-2008** | **2006-2007** | **2007-2008** |
| 1 | 22 | **22.5** | 23 | **22.4** | 34 | **32** | 32.5 | **30** | 40.5 | **36.5** | 29.6 | **20.5** |
| 2 | 21.8 | **21** | 22 | **22.1** | 33 | **31.5** | 31.5 | **29.6** | 38 | **35.2** | 28.5 | **19.5** |
| 3 | 21.1 | **20.8** | 21.5 | **21.7** | 32 | **30.2** | 30.2 | **28** | 37.5 | **34** | 28 | **17** |
| 4 | 20.8 | **20.6** | 20.5 | **21** | 31.5 | **29.5** | 29.5 | **27.5** | 37 | **33.5** | 29 | **18.2** |
| 5 | 21 | **20** | 22.5 | **20.5** | 31.1 | **29.1** | 29.1 | **26.3** | 38.5 | **33** | 28 | **17.2** |
| 6 | 19.3 | **19.5** | 21 | **22.5** | 30 | **28.2** | 28.2 | **25.2** | 36.1 | **32** | 26.5 | **16.3** |
| 7 | 20.5 | **21** | 21 | **21.5** | 33 | **29.5** | 29.5 | **24.3** | 35.2 | **31.6** | 27 | **15** |
| 8 | 21.5 | **20** | 19 | **19.7** | 32.5 | **30** | 30 | **25** | 34.3 | **34** | 26 | **14.2** |
| 9 | 19 | **20.1** | 18.5 | **19** | 29.6 | **27.4** | 27.4 | **25.5** | 36.5 | **30** | 25 | **13.2** |
| 10 | 18.5 | **19.2** | 18.2 | **18.5** | 28.4 | **26.3** | 26.3 | **23.5** | 37.2 | **29** | 24.1 | **15.5** |
| 11 | 18.1 | **19.1** | 17.5 | **17.2** | 27.3 | **25.2** | 25.2 | **22.1** | 33.2 | **28.5** | 26 | **13.6** |
| 12 | 17.9 | **18.2** | 17 | **16.5** | 26.5 | **24.3** | 24.3 | **21** | 33 | **27** | 23.6 | **13** |
| 13 | 17 | **18** | 19.5 | **15** | 25.4 | **23.8** | 23.8 | **20.3** | 31.6 | **25.5** | 22.1 | **12** |
| 14 | 16.5 | **17.5** | 19 | **14.3** | 24.3 | **23.1** | 23.1 | **19.5** | 30.5 | **26** | 21.6 | **12** |
| 15 | 16 | **18.5** | 16.7 | **15.5** | 26 | **22** | 22 | **19** | 29.7 | **23.5** | 21.5 | **11.4** |
| 16 | 15.5 | **19** | 16.2 | **16** | 25.5 | **24.5** | 24 | **18.6** | 29.1 | **22.5** | 20.5 | **11** |
| 17 | 16.5 | **20** | 16 | **13.7** | 23 | **25.5** | 25.5 | **18.1** | 28.5 | **21.2** | 19.8 | **12** |
| 18 | 17 | **16.3** | 15.5 | **13.1** | 22.1 | **26** | 26 | **17.6** | 28 | **20.6** | 19.4 | **11.2** |
| 19 | 18.5 | **15.7** | 15 | **12.9** | 22 | **21** | 21 | **17** | 26.5 | **20** | 19.1 | **10.2** |
| 20 | 15 | **15** | 16.5 | **12.3** | 21.7 | **20** | 20 | **16.5** | 27 | **19.5** | 20.5 | **9.6** |
| 21 | 14.3 | **14.4** | 17 | **12** | 21.3 | **19.7** | 19.7 | **16.2** | 25 | **19** | 18.6 | **9.2** |
| 22 | 13.2 | **13.8** | 16.2 | **14.5** | 21 | **19.2** | 19.2 | **15.4** | 24.6 | **18.6** | 18 | **9** |
| 23 | 12 | **13** | 14.3 | **15.5** | 20.5 | **18.7** | 19 | **15** | 23.2 | **18** | 17.6 | **10** |
| 24 | 11.2 | **15** | 14.1 | **15** | 20 | **18** | 18 | **14.6** | 22.1 | **17.5** | 17.2 | **8.5** |
| 25 | 10.5 | **12.5** | 14 | **11.2** | 19.5 | **19.5** | 17.6 | **14** | 20 | **16.8** | 17 | **8.1** |
| 26 | 10 | **12** | 13.5 | **11** | 19 | **17.5** | 17 | **13.6** | 19.5 | **15.2** | 16.5 | **8** |
| 27 | 9.7 | **11.5** | 13.2 | **10.5** | 18.5 | **18** | 16.5 | **13** | 18 | **16** | 16 | **9** |
| 28 | 9.6 | **10.3** | 13 | **11** | 19.5 | **19.5** | 17 | **14.5** | 17 | **17.2** | 17 | **10.2** |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 29 | 10.5 | **9.7** | 14 | **12.5** | 20.5 | **20.2** | 18.5 | **15.2** | 21 | **17.5** | 18.5 | **11.2** |
| 30 | 11.2 | **9** | 15.5 | **13** | 22.5 | **21.5** | 19 | **16.3** | 22.5 | **20** | 19.5 | **12.3** |
| 31 | 13.5 | **11.2** | 16 | **14.5** | 24 | **22.5** | 21 | **17** | 23 | **21.5** | 20.2 | **13** |
| 32 | 15.6 | **13.5** | 17 | **15** | 25.5 | **23.6** | 22.5 | **19.6** | 24.6 | **24** | 23 | **14.5** |
| 33 | 13 | **16** | 14.3 | **13.2** | 23.5 | **24** | 20 | **16.5** | 21 | **21** | 24 | **12** |
| 34 | 11.2 | **12.5** | 12 | **11** | 22 | **23** | 17 | **14** | 17.5 | **17** | 19 | **10.2** |
| 35 | 10.2 | **10.2** | 11.5 | **10.5** | 19 | **21** | 16 | **13.2** | 17 | **13.2** | 15 | **9.5** |
| 36 | 9.4 | **9** | 11 | **9.8** | 18.5 | **19.2** | 15.5 | **12.5** | 18 | **13** | 14.6 | **8.6** |
| 37 | 8 | **8.5** | 10.6 | **9.2** | 18 | **17** | 14.3 | **12** | 17.5 | **12.5** | 14 | **8** |
| 38 | 7.6 | **8** | 10.2 | **8.6** | 17.6 | **16.5** | 13.2 | **11.4** | 16.5 | **12** | 11.4 | **6.5** |
| 39 | 7 | **7.6** | 9.5 | **8.1** | 17 | **15** | 12.5 | **11** | 16 | **11.5** | 10.5 | **6** |
| 40 | 8.6 | **7.4** | 9 | **7.5** | 18.5 | **14.3** | 11 | **10.5** | 15 | **10.2** | 10 | **5.5** |
| 41 | 8.2 | **7** | 8.5 | **7** | 16 | **12** | 10.2 | **9.8** | 14.5 | **9.6** | 9.5 | **5** |
| 42 | 7.9 | **6.5** | 8 | **6.4** | 15.2 | **10.5** | 9.5 | **9** | 12 | **9** | 9 | **4.6** |
| 43 | 7 | **6** | 7 | **6.2** | 14.2 | **9.5** | 8.6 | **8.5** | 11.5 | **8.5** | 8.5 | **4.2** |
| 44 | 6.8 | **5.5** | 6.5 | **6** | 13.2 | **8.5** | 7 | **7** | 11 | **8** | 8 | **4** |
| 45 | 6.5 | **5** | 5.2 | **5.1** | 11.2 | **7** | 6.4 | **6** | 10.5 | **7.6** | 7.5 | **3.6** |
| 46 | 5.5 | **4.6** | 5 | **5** | 10.4 | **6.5** | 6 | **5.5** | 9.5 | **7** | 6 | **3** |
| 47 | 5 | **4** | 4.3 | **4.6** | 9 | **5** | 5 | **4** | 9 | **6** | 5.5 | **2.5** |
| 48 | 4.4 | **3.5** | 4 | **4** | 6 | **4** | 4.3 | **3** | 8 | **4** | 5 | **2** |

*** Negligible population All values are in kg--- Not Available Effort = 4**

**Table 3:** *Catla catla*

| | **Site I** | | **Site II** | | **Site III** | | **Site IV** | | **Site V** | | **Site VI** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Week** | **2006-2007** | **2007-2008** | **2006-2007** | **2007-2008** | **2006-2007** | **2007-2008** | **2006-2007** | **2007-2008** | **2006-2007** | **2007-2008** | **2006-2007** | **2007-2008** |
| 1 | 23 | **25** | 23.5 | **25** | 29.6 | **30.2** | 26 | **32** | 43 | **47** | 34 | **31** |
| 2 | 22.5 | **24.3** | 23 | **24.6** | 29 | **29.2** | 25 | **31** | 42.5 | **46.3** | 33 | **30.6** |
| 3 | 22 | **24** | 22.6 | **24** | 28.6 | **28** | 24.3 | **30.5** | 41 | **46** | 32 | **30** |
| 4 | 21 | **23** | 22.1 | **23.6** | 28.1 | **28.5** | 24 | **29.6** | 40.3 | **45.5** | 29.6 | **29.6** |
| 5 | 22.6 | **22.6** | 21.5 | **23** | 27.4 | **27.5** | 25 | **28.5** | 39 | **45** | 29 | **29** |
| 6 | 22 | **22.1** | 23.5 | **22.5** | 27 | **27.2** | 23.6 | **28** | 38.6 | **44.3** | 28 | **28.6** |
| 7 | 20.8 | **22** | 23 | **22** | 28.5 | **26** | 23.1 | **27.3** | 37 | **44** | 27.6 | **28.1** |
| 8 | 20 | **23.5** | 22 | **21.3** | 28 | **27** | 22.4 | **26.2** | 40 | **43** | 27.1 | **27.5** |
| 9 | 19 | **23** | 21.8 | **21** | 26.5 | **25.5** | 22 | **25.3** | 39.5 | **42.1** | 26.5 | **27** |
| 10 | 18.6 | **22.6** | 21.5 | **20.5** | 25 | **24.3** | 21.5 | **24.5** | 36 | **44.5** | 26 | **26** |
| 11 | 18 | **20.4** | 20.6 | **20** | 24.3 | **23** | 20 | **23.2** | 35.1 | **41** | 25.1 | **25** |
| 12 | 17.5 | **20.1** | 20 | **19.6** | 24 | **25.5** | 19.5 | **22.1** | 34.2 | **40** | 27 | **27.5** |
| 13 | 17 | **19.5** | 21.5 | **19.4** | 23.1 | **23** | 19 | **21.5** | 33.5 | **39.5** | 25.5 | **27** |
| 14 | 16.5 | **19.1** | 21 | **18.5** | 22.5 | **22.4** | 18.5 | **20.3** | 32.8 | **38** | 24 | **24.3** |
| 15 | 16.2 | **18.4** | 19.5 | **18** | 22 | **21.2** | 18 | **19.6** | 31.2 | **37** | 23.6 | **24.1** |
| 16 | 16 | **18** | 19 | **17.7** | 24 | **21** | 17.4 | **18.5** | 30.2 | **35** | 23.4 | **23.6** |
| 17 | 15.4 | **17.3** | 18.4 | **17** | 21.5 | **20.5** | 17 | **18** | 29.5 | **34.2** | 22.1 | **22.5** |
| 18 | 15 | **17** | 18 | **16** | 21 | **20** | 16.2 | **17.6** | 29 | **32** | 21 | **21.6** |
| 19 | 14.3 | **16.2** | 17.6 | **15.2** | 20.1 | **20.4** | 16 | **17.2** | 28.4 | **35** | 19.5 | **21** |
| 20 | 14 | **16** | 17 | **15** | 19.8 | **19.6** | 15.2 | **16.4** | 27.3 | **31** | 21 | **20.5** |
| 21 | 15.5 | **15.2** | 16.5 | **14.2** | 19 | **18.6** | 15 | **15.6** | 26.4 | **29.6** | 20.5 | **20** |
| 22 | 16 | **15** | 16 | **14.5** | 20.5 | **18** | 14.8 | **15.2** | 25.1 | **29** | 23 | **22.5** |
| 23 | 14 | **14.3** | 15.4 | **14** | 20 | **19.5** | 14.2 | **14.3** | 24 | **28.6** | 22 | **21** |
| 24 | 13.2 | **14** | 15 | **13.5** | 18.6 | **17.6** | 13.2 | **14** | 23.2 | **27** | 20 | **19.6** |
| 25 | 13 | **13.5** | 14.3 | **13** | 18.4 | **17** | 13 | **13.6** | 21.8 | **25.5** | 19 | **19** |
| 26 | 12.6 | **13** | 14 | **12.5** | 18 | **16.2** | 12.6 | **13** | 20.6 | **24.1** | 18.5 | **18.6** |
| 27 | 12 | **12.5** | 13.5 | **12** | 19 | **16** | 12 | **12.6** | 19.5 | **23.1** | 18 | **18.3** |
| 28 | 13 | **11.3** | 14 | **12.5** | 20.1 | **18** | 12.5 | **13.2** | 18 | **21** | 20 | **19.2** |
| 29 | 14.5 | **14.5** | 15 | **14** | 21.5 | **19.5** | 14 | **14.6** | 16 | **23** | 21.5 | **20.6** |
| 30 | 15 | **15.2** | 16.5 | **15.2** | 22.4 | **21.5** | 15.5 | **15** | 22.5 | **25** | 23 | **22.3** |
| 31 | 16 | **16.7** | 18 | **16** | 23.6 | **23** | 16 | **17.3** | 24.5 | **27** | 24.6 | **23** |
| 32 | 18 | **18** | 18.5 | **18** | 24 | **23.5** | 17.5 | **19** | 26 | **29.3** | 25 | **24.6** |
| 33 | 14.5 | **16.4** | 16.2 | **14.3** | 22.1 | **21** | 15.2 | **15.2** | 24.6 | **26.3** | 23 | **22.5** |
| 34 | 12.5 | **14.2** | 14 | **12** | 20 | **19** | 14.3 | **13** | 22.7 | **24** | 21 | **20** |
| 35 | 11.5 | **12** | 12 | **11.8** | 18 | **16.2** | 12 | **12.6** | 19 | **21.5** | 19.5 | **18** |
| 36 | 11 | **11.5** | 11.5 | **11.2** | 17.6 | **15.4** | 11.5 | **12** | 17.6 | **20** | 18 | **17.6** |
| 37 | 10.4 | **11** | 11 | **10.4** | 17.2 | **15** | 10.4 | **11** | 16.3 | **19.5** | 17.2 | **17** |
| 38 | 10 | **10.4** | 10.4 | **10** | 17 | **14.3** | 10 | **10.6** | 15 | **18** | 16.5 | **16.5** |
| 39 | 9.8 | **10** | 10.2 | **9.4** | 16.5 | **14** | 9.8 | **10** | 14.8 | **17.5** | 15.3 | **15** |
| 40 | 9 | **9.5** | 9.6 | **9** | 16 | **13.6** | 9.2 | **9.7** | 14 | **15.5** | 14.5 | **14** |
| 41 | 8.7 | **9** | 9 | **8.4** | 15.4 | **13** | 8.6 | **9.4** | 13.5 | **14** | 13.6 | **13.2** |
| 42 | 8 | **8.6** | 8.6 | **8.2** | 15 | **12.6** | 8 | **8.5** | 12.3 | **12** | 12 | **13** |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 43 | 7.6 | **8** | 8 | **7.6** | 13.2 | **12** | 7.6 | **8** | 11.5 | **11.5** | 11.2 | **11.2** |
| 44 | 7 | **7.5** | 7.6 | **7.1** | 13 | **11.5** | 7 | **7.4** | 10.3 | **10.5** | 10.4 | **10.5** |
| 45 | 6.4 | **7** | 7 | **6.5** | 12 | **10.4** | 6.8 | **7** | 9 | **9.1** | 9 | **8.5** |
| 46 | 6 | **6.4** | 6.4 | **5.4** | 10 | **9.6** | 6.4 | **6.5** | 8.4 | **8** | 8.5 | **6** |
| 47 | 5 | **6** | 5 | 4.3 | 9.5 | 8.7 | 6 | 6 | 7 | 6.5 | 8 | 5.5 |
| 48 | 4 | **5.5** | 4.1 | 4 | 8 | 7.5 | 5 | 5 | 5.3 | 4 | 7 | 5 |

*** Negligible population All values are in kg--- Not Available Effort = 4**

**Table 4:** List of fish species population density from Marathwada region

| Name of Fish | Site I | | Site II | | Site III | | Site IV | | Site V | | Site VI | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2006-2007 | 2007-2008 | 2006-2007 | 2007-2008 | 2006-2007 | 2007-2008 | 2006-2007 | 2007-2008 | 2006-2007 | 2007-2008 | 2006-2007 | 2007-2008 |
| *Labeo rohita* | 5.7 | **6.0** | 6.0 | **6.1** | 4.6 | **4.4** | 3.2 | **3.2** | 3.4 | **3.3** | 2.8 | **3.2** |
| *Catla catla* | 6.0 | **6.3** | 6.3 | **6.5** | 5.7 | **5.7** | 3.4 | **3.4** | 3.0 | **3.3** | 3.8 | **4.2** |
| *Cirrhinus mrigala* | 5.5 | **5.7** | 6.3 | **6.4** | 5.1 | **5.2** | 3.3 | **3.5** | 3.2 | **3.3** | 3.4 | **3.6** |

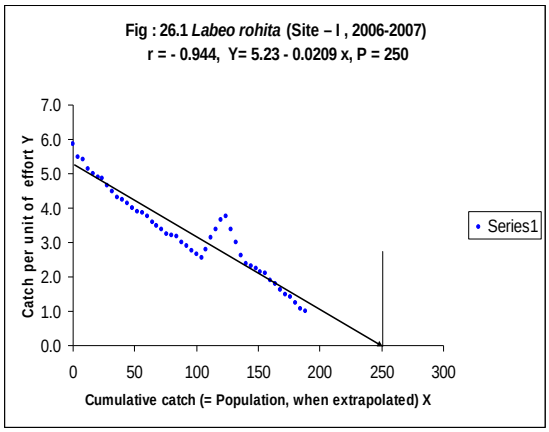
**1) Values are in %* Indicates negligible population density--- Not available**

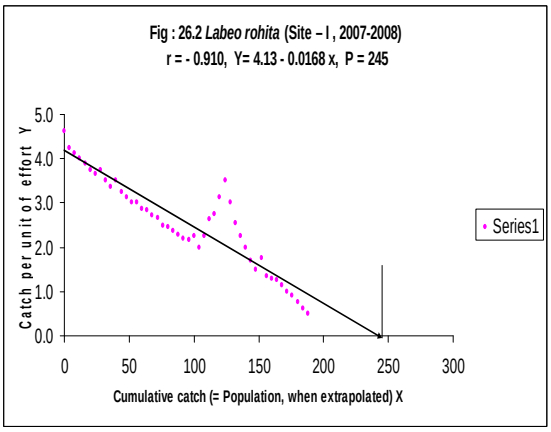
**Table 5:** Population Status of Major Carps from Marathwada Region

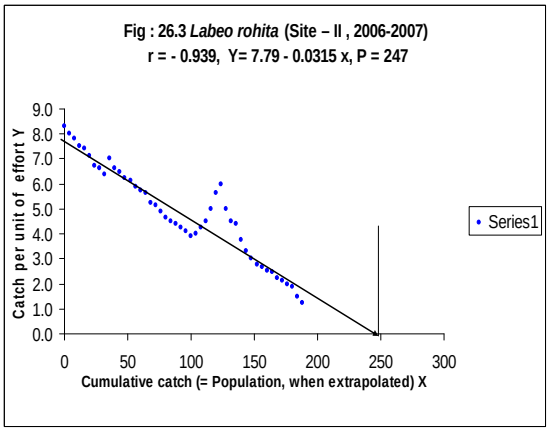
| | Labeo rohita | | Cirrhinus mrigala | | Catla catla | |
|---|---|---|---|---|---|---|
| **Site** | **2006-2007** | **2007-2008** | **2006-2007** | **2007-2008** | **2006-2007** | **2007-2008** |
| I | 250 | 245 | 243 | 234 | 264 | 257 |
| II | 247 | 233 | 260 | 243 | 261 | 246 |
| III | 264 | 230 | 295 | 270 | 329 | 296 |
| IV | 247 | 217 | 243 | 237 | 248 | 228 |
| V | 257 | 221 | 242 | 226 | 229 | 225 |
| VI | 216 | 212 | 255 | 238 | 287 | 278 |

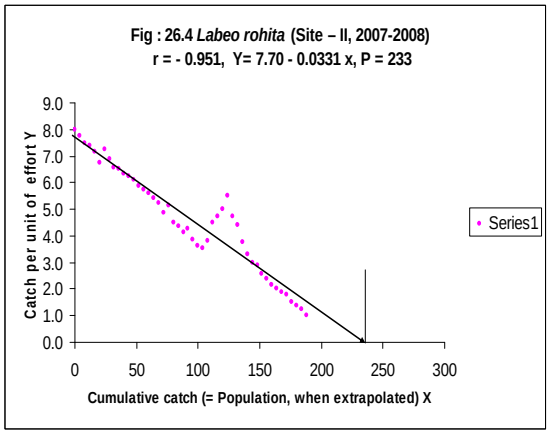
***All the Values are in Numbers**

**Graphical representation of population of fish from Marathwada Region**



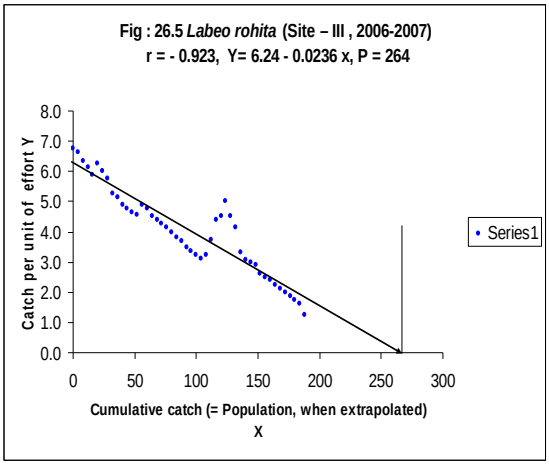


Fig : 26.5 Labeo rohita (Site – III , 2006-2007)
r = - 0.923, Y= 6.24 - 0.0236 x, P = 264
Catch per unit of effort Y
Cumulative catch (= Population, when extrapolated) X
Series1

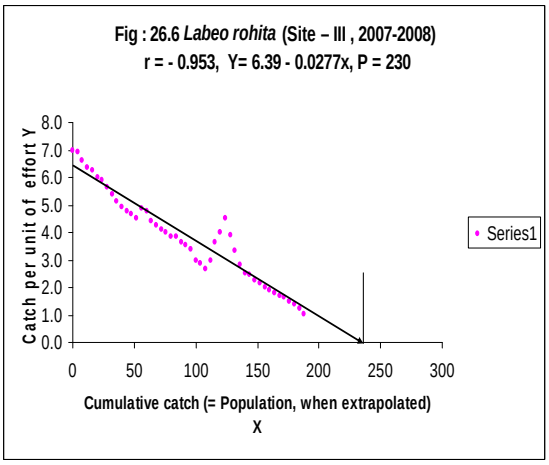


Fig : 26.6 Labeo rohita (Site – III , 2007-2008)
r = - 0.953, Y= 6.39 - 0.0277x, P = 230
Catch per unit of effort Y
Cumulative catch (= Population, when extrapolated) X
Series1

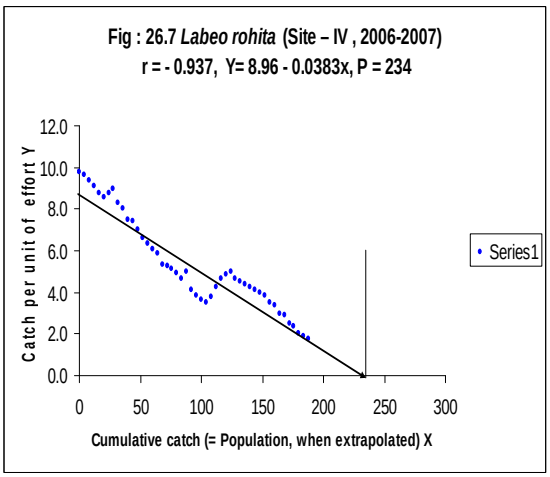


Fig : 26.7 Labeo rohita (Site – IV , 2006-2007)
r = - 0.937, Y= 8.96 - 0.0383x, P = 234
Catch per unit of effort Y
Cumulative catch (= Population, when extrapolated) X
Series1

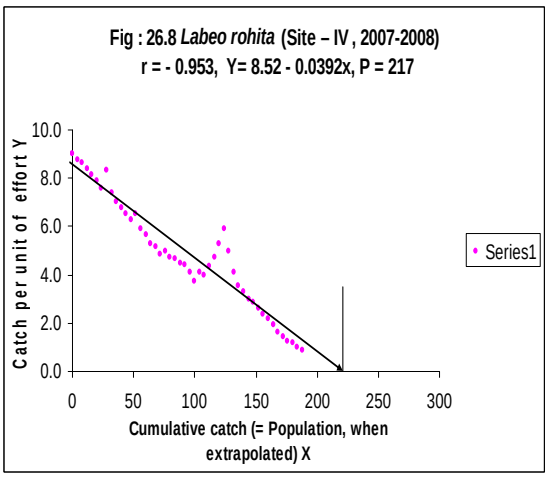


Fig : 26.8 Labeo rohita (Site – IV , 2007-2008)
r = - 0.953, Y= 8.52 - 0.0392x, P = 217
Catch per unit of effort Y
Cumulative catch (= Population, when extrapolated) X
Series1

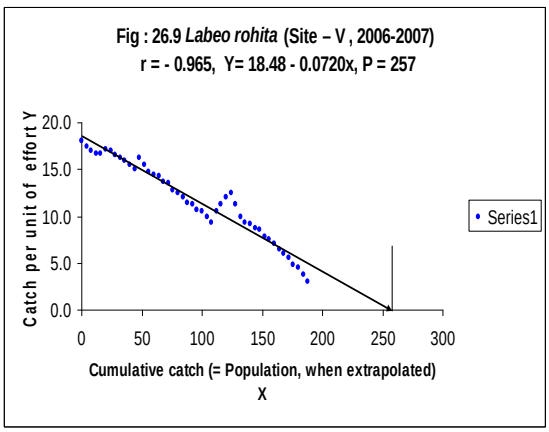


Fig : 26.9 Labeo rohita (Site – V , 2006-2007)
r = - 0.965, Y= 18.48 - 0.0720x, P = 257
Catch per unit of effort Y
Cumulative catch (= Population, when extrapolated) X
Series1

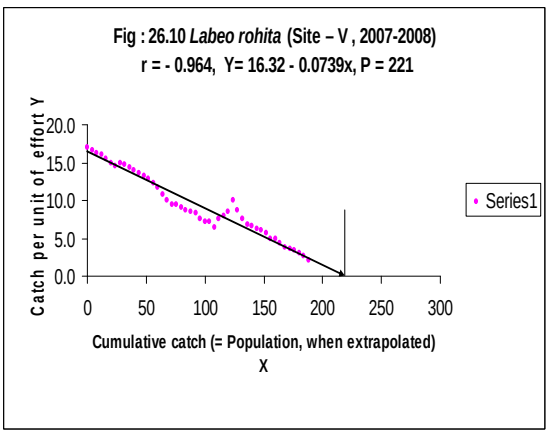


Fig : 26.10 Labeo rohita (Site – V , 2007-2008)
r = - 0.964, Y= 16.32 - 0.0739x, P = 221
Catch per unit of effort Y
Cumulative catch (= Population, when extrapolated) X
Series1

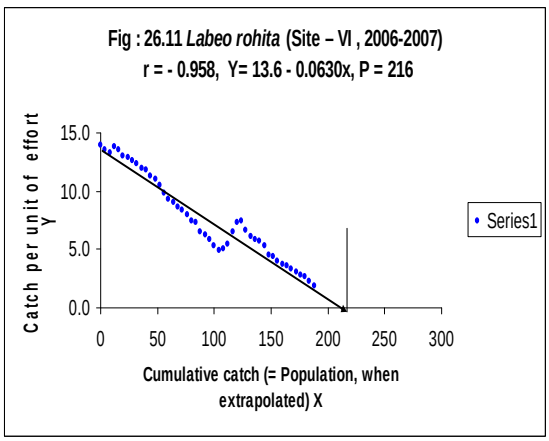


Fig : 26.11 Labeo rohita (Site – VI , 2006-2007)
r = - 0.958, Y= 13.6 - 0.0630x, P = 216
Catch per unit of effort Y
Cumulative catch (= Population, when extrapolated) X
Series1

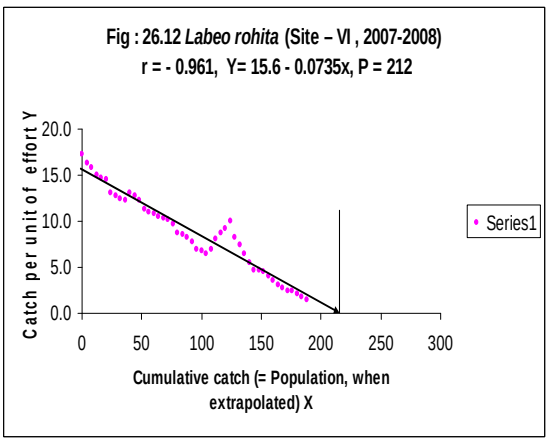


Fig : 26.12 Labeo rohita (Site – VI , 2007-2008)
r = - 0.961, Y= 15.6 - 0.0735x, P = 212
Catch per unit of effort Y
Cumulative catch (= Population, when extrapolated) X
Series1

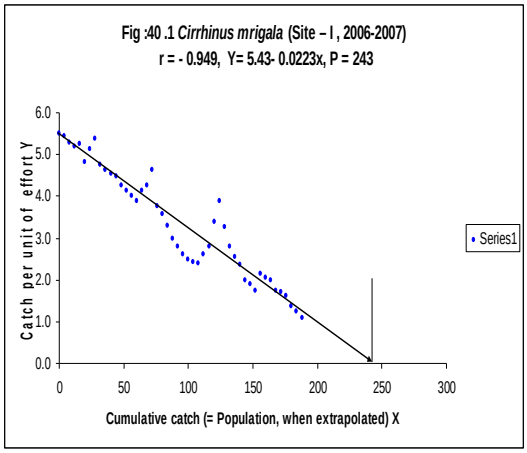


Fig :40 .1 Cirrhinus mrigala (Site – I , 2006-2007)
r = - 0.949, Y= 5.43- 0.0223x, P = 243
Catch per unit of effort Y
Cumulative catch (= Population, when extrapolated) X
Series1

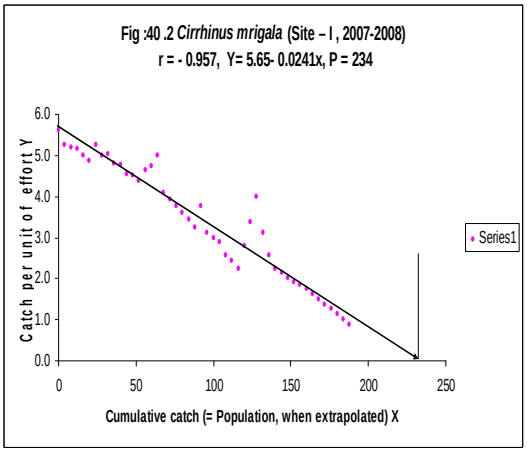


Fig :40 .2 Cirrhinus mrigala (Site – I , 2007-2008)
r = - 0.957, Y= 5.65- 0.0241x, P = 234
Catch per unit of effort Y
Cumulative catch (= Population, when extrapolated) X
Series1

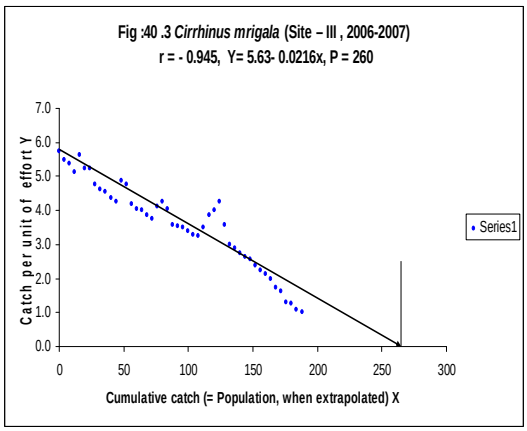


Fig :40 .3 Cirrhinus mrigala (Site – III , 2006-2007)
r = - 0.945, Y= 5.63- 0.0216x, P = 260
Catch per unit of effort Y
Cumulative catch (= Population, when extrapolated) X
Series1

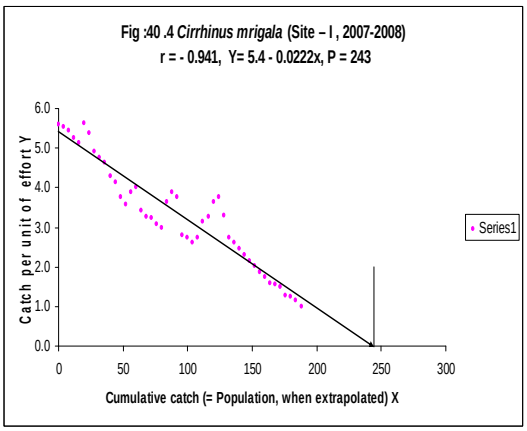


Fig :40 .4 Cirrhinus mrigala (Site – I , 2007-2008)
r = - 0.941, Y= 5.4 - 0.0222x, P = 243
Catch per unit of effort Y
Cumulative catch (= Population, when extrapolated) X
Series1

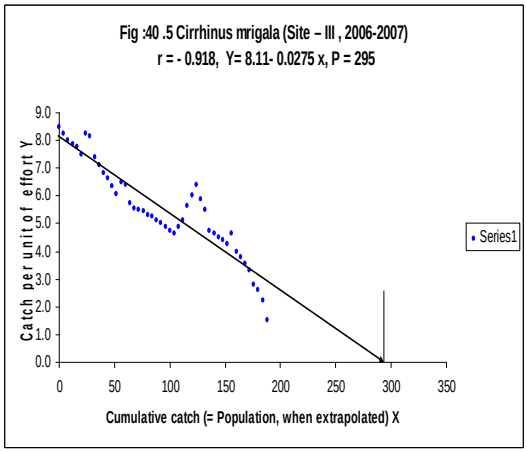


Fig :40 .5 Cirrhinus mrigala (Site – III , 2006-2007)
r = - 0.918, Y= 8.11- 0.0275 x, P = 295
Catch per unit of effort Y
Cumulative catch (= Population, when extrapolated) X
Series1

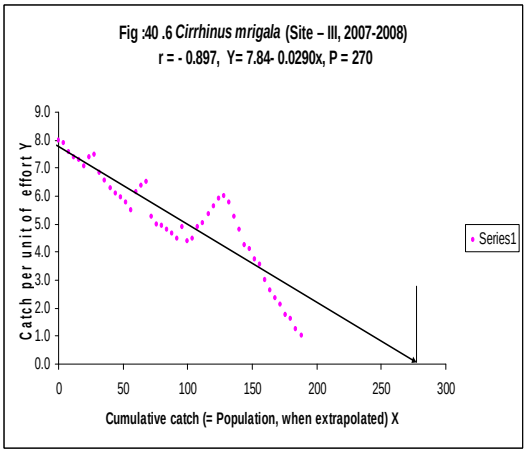


Fig :40 .6 Cirrhinus mrigala (Site – III, 2007-2008)
r = - 0.897, Y= 7.84- 0.0290x, P = 270
Catch per unit of effort Y
Cumulative catch (= Population, when extrapolated) X
Series1

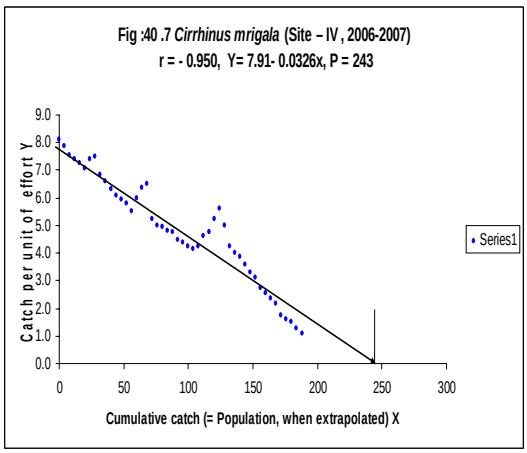


Fig :40 .7 Cirrhinus mrigala (Site – IV , 2006-2007)
r = - 0.950, Y= 7.91- 0.0326x, P = 243
Catch per unit of effort Y
Cumulative catch (= Population, when extrapolated) X
Series1

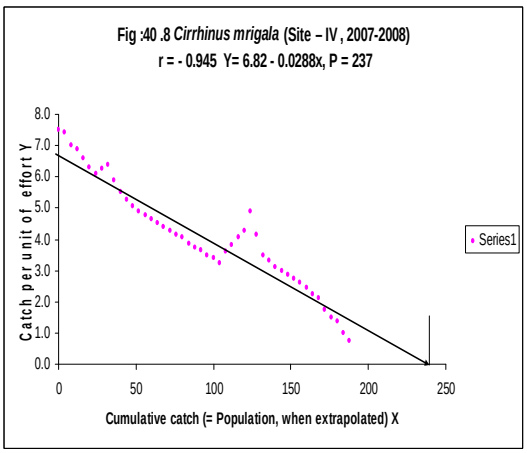


Fig :40 .8 Cirrhinus mrigala (Site – IV , 2007-2008)
r = - 0.945 Y= 6.82 - 0.0288x, P = 237
Catch per unit of effort Y
Cumulative catch (= Population, when extrapolated) X
Series1

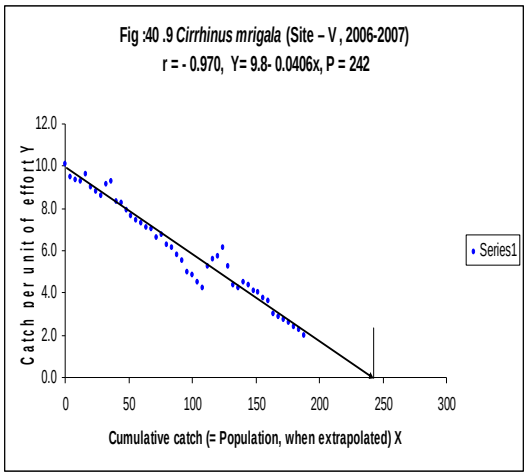


Fig :40 .9 Cirrhinus mrigala (Site – V , 2006-2007)
r = - 0.970, Y= 9.8- 0.0406x, P = 242
Catch per unit of effort Y
Cumulative catch (= Population, when extrapolated) X
Series1

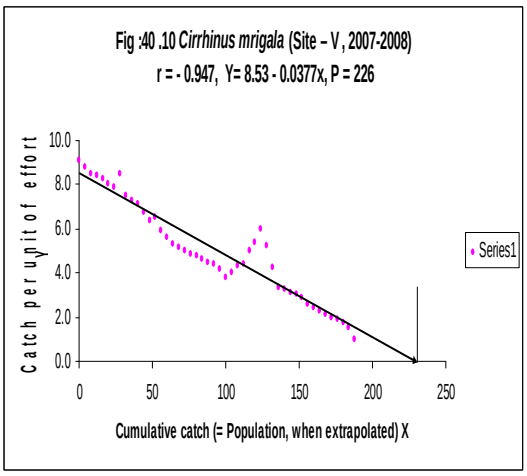


Fig :40 .10 Cirrhinus mrigala (Site – V , 2007-2008)
r = - 0.947, Y= 8.53 - 0.0377x, P = 226
Catch per unit of effort
Cumulative catch (= Population, when extrapolated) X
Series1

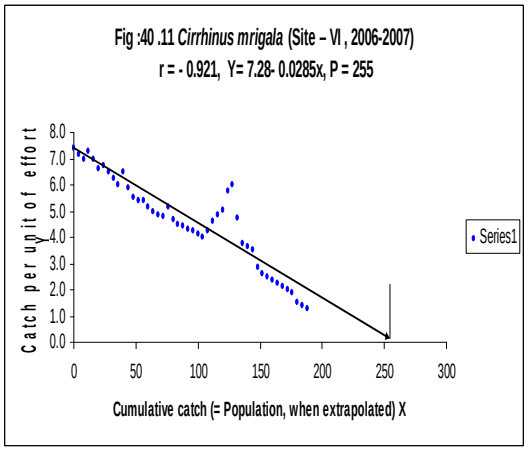


Fig :40 .11 Cirrhinus mrigala (Site – VI , 2006-2007)
r = - 0.921, Y= 7.28- 0.0285x, P = 255
Catch per unit of effort
Cumulative catch (= Population, when extrapolated) X
Series1

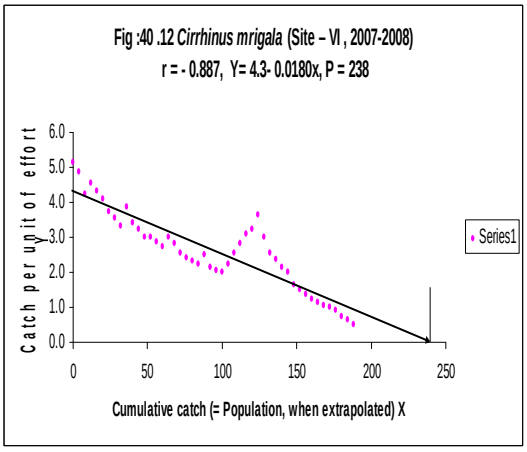


Fig :40 .12 Cirrhinus mrigala (Site – VI , 2007-2008)
r = - 0.887, Y= 4.3- 0.0180x, P = 238
Catch per unit of effort
Cumulative catch (= Population, when extrapolated) X
Series1

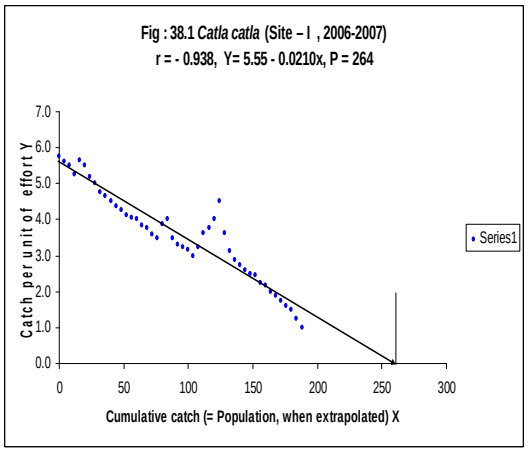


Fig : 38.1 Catla catla (Site – I , 2006-2007)
r = - 0.938, Y= 5.55 - 0.0210x, P = 264
Catch per unit of effort Y
Cumulative catch (= Population, when extrapolated) X
Series1

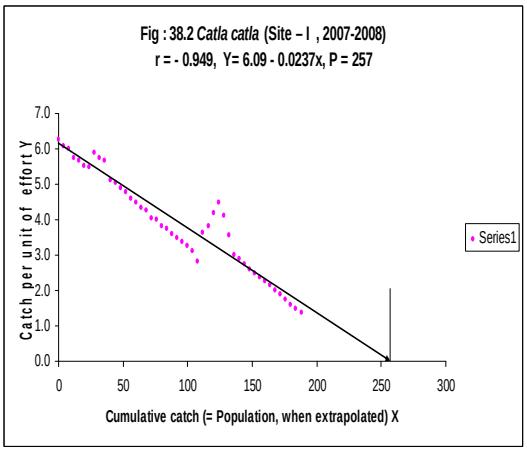


Fig : 38.2 Catla catla (Site – I , 2007-2008)
r = - 0.949, Y= 6.09 - 0.0237x, P = 257
Catch per unit of effort Y
Cumulative catch (= Population, when extrapolated) X
Series1

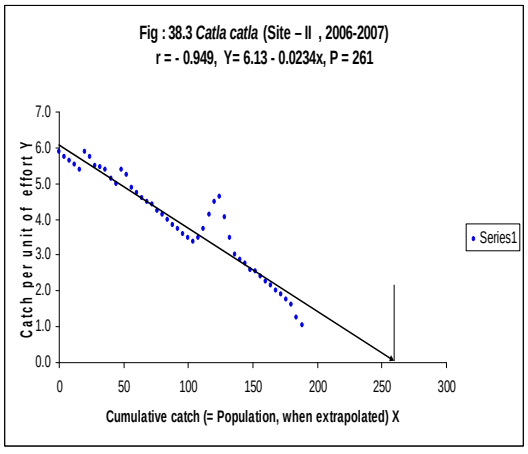


Fig : 38.3 Catla catla (Site – II , 2006-2007)
r = - 0.949, Y= 6.13 - 0.0234x, P = 261
Catch per unit of effort Y
Cumulative catch (= Population, when extrapolated) X
Series1

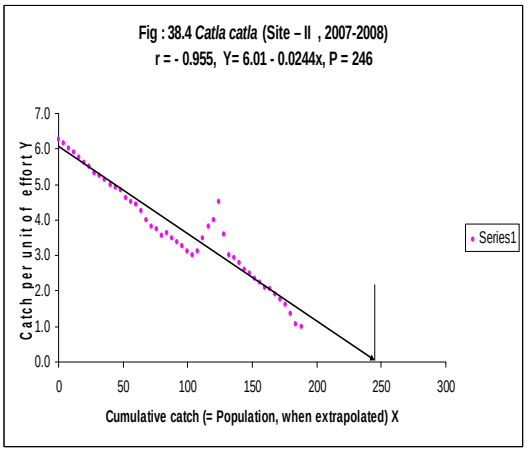


Fig : 38.4 Catla catla (Site – II , 2007-2008)
r = - 0.955, Y= 6.01 - 0.0244x, P = 246
Catch per unit of effort Y
Cumulative catch (= Population, when extrapolated) X
Series1

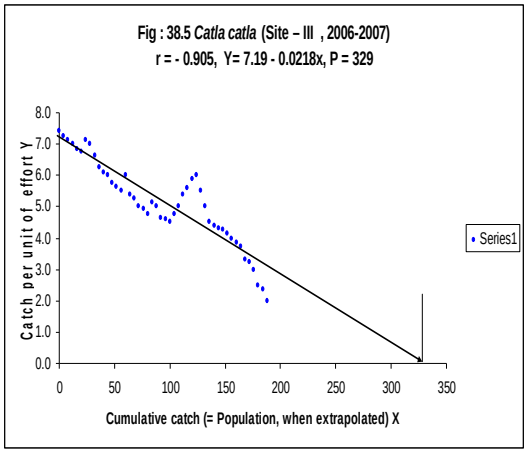


Fig : 38.5 Catla catla (Site – III , 2006-2007)
r = - 0.905, Y= 7.19 - 0.0218x, P = 329
Catch per unit of effort Y
Cumulative catch (= Population, when extrapolated) X
Series1

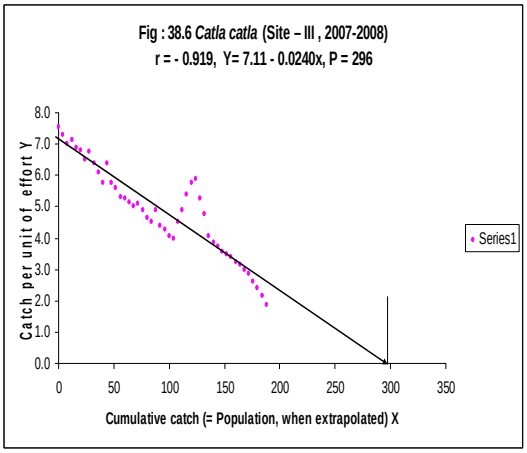


Fig : 38.6 Catla catla (Site – III , 2007-2008)
r = - 0.919, Y= 7.11 - 0.0240x, P = 296
Catch per unit of effort Y
Cumulative catch (= Population, when extrapolated) X
Series1

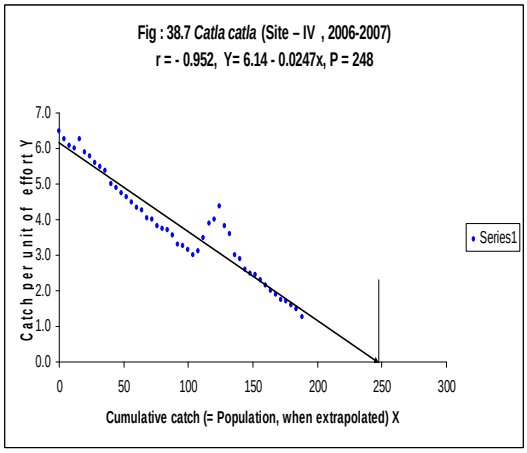


Fig : 38.7 Catla catla (Site – IV , 2006-2007)
r = - 0.952, Y= 6.14 - 0.0247x, P = 248
Catch per unit of effort Y
Cumulative catch (= Population, when extrapolated) X
Series1

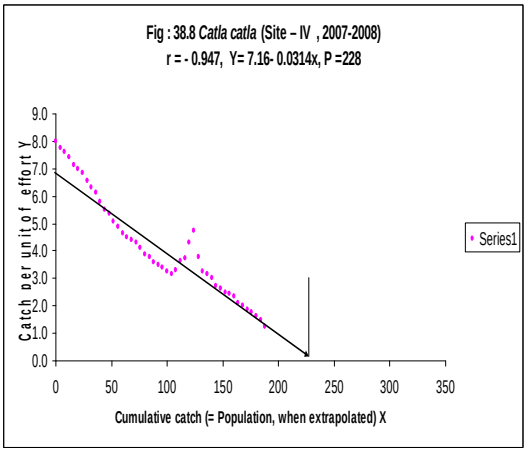


Fig : 38.8 Catla catla (Site – IV , 2007-2008)
r = - 0.947, Y= 7.16- 0.0314x, P =228
Catch per unit of effort Y
Cumulative catch (= Population, when extrapolated) X
Series1

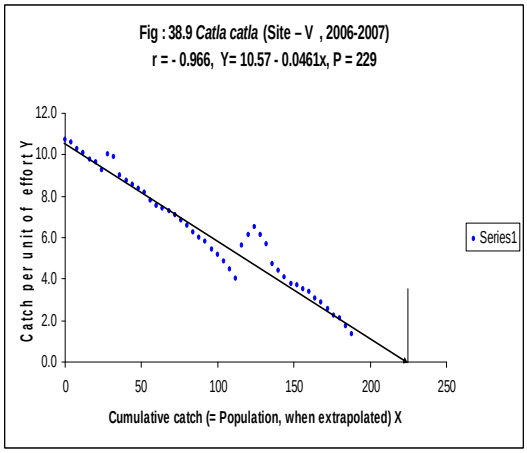


Fig : 38.9 Catla catla (Site – V , 2006-2007)
r = - 0.966, Y= 10.57 - 0.0461x, P = 229
Catch per unit of effort Y
Cumulative catch (= Population, when extrapolated) X
Series1

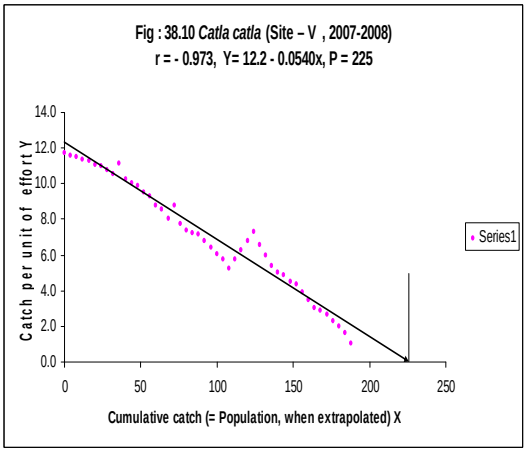


Fig : 38.10 Catla catla (Site – V , 2007-2008)
r = - 0.973, Y= 12.2 - 0.0540x, P = 225
Catch per unit of effort Y
Cumulative catch (= Population, when extrapolated) X
Series1

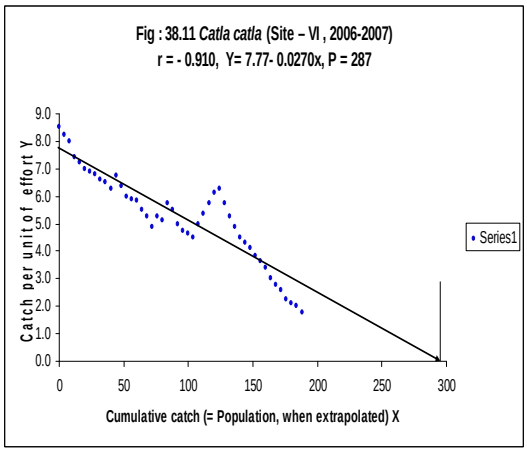


Fig : 38.11 Catla catla (Site – VI , 2006-2007)
r = - 0.910, Y= 7.77- 0.0270x, P = 287
Catch per unit of effort Y
Cumulative catch (= Population, when extrapolated) X
Series1

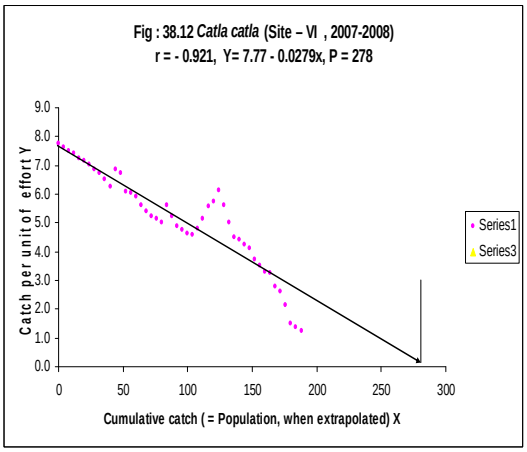


Fig : 38.12 Catla catla (Site – VI , 2007-2008)
r = - 0.921, Y= 7.77 - 0.0279x, P = 278
Catch per unit of effort Y
Cumulative catch ( = Population, when extrapolated) X
Series1
Series3

## 3. Result and Discussion

During the present investigation from October 2006 to September 2008 it was observed that the maximum population of *Labeo rohita* was 264 at site III in the year 2006 to 2007 while a minimum of 212 at site VI in the year 2007 to 2008 (Table 5).

During the present investigation from October 2006 to September 2008 it was observed that the maximum population density of *Labeo rohita* was 6.1 at site II in the year 2007-2008 and minimum was 2.8 at site VI in the year 2006-2007, (Table 4).

The maximum population of *Cirrhinus mrigala* was 295 at site III in the year 2006-2007 and minimum was 226 at site V in the year 2007-2008, (Table 5).

Maximum population density of *Cirrhinus mrigala* was 6.4 at site II in the year 2007-2008 and minimum population density was 3.2 at site V in the year 2006-2007, (Table 4).

During the present investigation maximum population of *Catla catla* was 329 at site III in the year 2006-2007 and minimum was 225 at site V in the year 2007-2008, (Table 5).

Maximum population density of *Catla catla* was 6.5 at site II in the year 2007-2008 and minimum population density was3.0 at site V in the year 2006-2007, (Table 4).

The graph showing the regression value, the value of Y and Population of fish.

During the study period it was observed that the fish population of major carp are found at all the six site throughout the year, but it is decline in 2007-2008 as compare to 2006-2007.

During the present investigation fish population at six study sites was carried out by catch- effort method described by Delury, (1947) [6] and it was observed that sustained decline in the catch per unit effort is a reliable indication of regression of population in successive catching. Similar results were observed by Delury, (1947 and 1951) [6, 7] for estimation of biological population from Canada were sustained decline in catch per unit of effort in the successive catching was observed. Cooper and Lagler, (1956) [4] measured the fish population from North Amer by using catch effort method.

Carlander, (1955) [2] estimated the population of fish in lakes were sustained decline in catch per unit of effort in the successive catching was observed. Omand, (1951) [11] estimated the population of fish based on catch effort method and process in the successive catching. Fischler, (1965) [8] estimated population of male blue crabs (*Callinectes sapidus*) by catch-effort method and with the sustained decline in the catch per unit effort in successive catching. Paloheimo, (1963) [12] estimated the population of lobster, when a sustained decline in catch per unit of effort in the successive catching was observed. Riley *et al.,* (1992) [13] estimated the trout population in small streams in North America and obtained similar result.

Schaefer, (1954) [15] studies the dynamics of marine fish population from America by using catch effort method and found sustained decline in the catch per unit of effort in the successive catching.

Schumacher and Eschmeyer, (1943) [16] estimated fish population by catch effort method from lakes with similar result. Robin Mahon, (1980) [14] estimated fish population density and biomass in streams of Canada by using catch effort method and he also found sustained decline in the catch per unit of effort in the successive catching.

Population density at river Bhadra of Western Ghats was studied by Shahnawaz *et al.,* (2009) [17] and he observed that Cyprinidae family was dominant with distribution of fish species.

Gultneh Solomon *et al.,* (1981) [9] studied fluctuation and distribution of the population density along with movement of Rose Bitter ling in Shein Tone river and concluide that Cyprinidae family was most dominant, Jatindra Nath Bhakta and Probir Kumar Bandyo Padhyay, (2007) studied the population density of exotic fishes in Churni River of West Bengal, India and shows that Cyprinidae family was dominant over the other families of fish communities.

## 4. Conclusions and Recommendations

- During present investigation, it was observed that *Labeo rohita, Catla catla, Cirrhinus mrigala,* were present in all six study sites from Marathwada region.
- Maximum catch was observed during the month of October while minimum during rainy season. Slight increase in fish catch during the summer was observed due to loss of water evaporation.
- Human activities, water diversion, changes in method of land utility and deforestation may have contributed to dramatic and rapid impact on fish population. This may be due to the challenges faced by built structures in order to control floods and increased flow of water.
- Reduction in the size of habitat, unscientific methods of fishing, and unplanned fish harvesting during breeding season might have reduced fish population.
- Use of small mesh fishing gear at all six study sites might have been responsible for reduced population of fish species.
- Deforestation might have indirectly declined fish population due to excessive siltation and soil erosion in the catchment area.
- It was observed that population of fishes showed significant variation (Mungikar, 2003) [10].
- Due to construction of the dam, the down streams water flow was reduced as a result of which the migratory fishes were unable to move, and it affected the abundance and distribution of fish population.

### 4.1 Recommendations

- In order to maintain the population of fish fauna proper studies on effect of environmental condition on fish population with modern techniques are needed.
- Different fish species breed in different seasons. Usually female fishes with great number of eggs in their ovary are caught in high number during breeding season, due to which a large quantity of egg resource is perished. The fishing activity should be therefore banned during these months. The fine meshed nets like cast net, mosquito net, catching juvenile must be banned because they reduce the survival rate of fish species.
- Due to over fishing and destructive fishing practices the fish stock and population and being declining.
- Proper care should be taken during construction of dam so that down stream should have enough water throughout the year for growth and survivial of fish fauna and migratory fishes to move from upstream to downstream in order to maintain their population constant through out the year.
- Farmers should be made aware about the losses in fish diversity to population due to excessive use of pesticides.
- The area inhabited by rare species of fishes should be

protected in the form of fish sanctuary and also to protect them to increase their population.

- Cryopreservation of fish spermatozoa, eggs and embryo of indigenous fish species is employment to increase their survival rate and population.
- An improved breeding technique using biofiltration and formulating suitable larval feed has to be employed to increase larval survival and fish species population. To enhance reproductive rate, improved breeding techniques like induced breeding by Chinese hatchery and their other hatching models be used.
- Studies on fish growth, conservation of fish population be included in graduate and post graduate studies.
- Government should effectively implement legislation, policies and strategies towards fish growth, population and conservation.

## 5. Acknowledgement

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