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BYCATCH ASSOCIATED WITH GILLNET FISHERY IN MADAMSILLI RESERVOIR, DHAMTARI DISTRICT, CHHATTISGARH (INDIA)

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ABSTRACT
A comparative study of bycatch was conducted on different types of gillnet operated in a medium type Madamsilli reservoir along the Sakri river in Dhamtari district, Chhattisgarh, India. The result showed the decreasing trend in bycatch from 11.960 % (180 kg), 10.778 % (90 kg), 8.867 % (101 kg), 7.014 % (43 kg) and 0.645 % (5 kg) for G5, G3, G4, G2 and G1 respectively for different mesh size of gillnets. The *Wallago attu* was found as common bycatch in all the gillnets. The species *Labeo rohita, Labeo gonius, Catla catla and Mystus singhala* were contributed as bycatch from gillnets G2, G3, G4, and G5. One-way ANOVA was carried out, and significant difference in bycatch $4.2^{a} \pm 0.81$ (G1), $42.33^{b} \pm 3.05$ (G2), $89.34^{c} \pm 4.04$ (G3), 1.0033^{d}E2 ± 5.03 (G4) and 1.7967^{e}E2 ± 2.51 (G5) was found at $P < 0.05$. The statistical analysis of data obtained in this study indicate the significant difference among the main catch and bycatch from all the gillnets.

INTRODUCTION

Fish production from an inland water body in Chhattisgarh is 2.56 lakh tones (2014) and nearly 56% fish is produced from reservoirs. The total fish production from *Dhamtari* district alone is nearly 1.3 lakh tones where this reservoir contribute of 0.8 lakh tones (CGSIRD, 2010). In Chhattisgarh, gillnet is the only gear get operated to harvest fish from reservoir. Due to smaller mesh size of the net smaller fish also get caught along with target fish. Bycatch is the incidental capture of non-targeted organisms in commercial fisheries, is a growing concern and an important conservation issue (Alverson *et al.,* 1994; Hall and Mainprize, 2005; Harrington *et al.,* 2005; Kelleher, 2005). It is also referred to an incidental catch causing mortality and injuries to the non-target species, is an issue affecting the ecosystem and survival of marine population (Read, 2013). The awareness of bycatch issue attracted a global interest as it is urged to develop an international guideline on bycatch management and reduction of discards (FAO, 2014).In general, there are three types of bycatch; normal, cryptic and ghost fishing. Normal bycatch is a non-target species trapped in nets, alive or dead, during the hauling process. Cryptic bycatch constitutes of organisms entangled in fishing gears and develops injury and die after trying to escape from the gears (Leland *et al.,* 2013).

Off late fisheries are now not only concerned with the sustainability of targeted organisms but also beginning to consider the sustainability of catches of non-targeted fauna (Hall *et al.,* 2000). The number of studies examining bycatch issues has increased exponentially in recent decades (Soykan *et al.,* 2008). At present, bycatch is a prominent international issue raising ecological concerns as some of the bycatch species of marine mammals, sea birds, sea turtles, elasmobranches and fin fishes are vulnerable to over exploitation and slow to recover from large population declines (Pawar Prabhakar, R. 2011).However these studies focus primarily on marine systems, leaving freshwater bycatch issues relatively unstudied (Raby *et al.,* 2011). This is disconcerting given that biodiversity in highly diverse freshwater ecosystems which is declining with overexploitation identified as one of the leading causes (Dudgeon *et al.,* 2006). Gillnets are commonly used in reservoirs and commercially operated in almost all lakes and reservoir systems of India. Gillnet is a passive fishing gear with species selectivity and is set for long durations (Hubert, 1996).

The vast and varied inland water resources contribute immensely to the fisheries in the State of Chhattisgarh. This state has mainly three types of water resource viz. pond/tank (74,300 ha), reservoirs (88,700 ha) and river (3,570 km). Bycatch has contributed to the degradation of marine ecosystems (Crowder and Murawski, 1998), (Hall *et al.,* and 2000), (Lewiston *et al.,* 2004) and very likely have a similar impact on freshwater ecosystems. Therefore, there is a need to determine the extent and consequences of bycatch in freshwater commercial fisheries. The main objectives of this

study were to document and comparing the total catch, main catch and bycatch among different mesh sizes of gillnets.

MATERIALS AND METHODS

Study Area

The present study was carried out at Madamsilli reservoir, Dhamtari, Chhattisgarh, India. It is the first dam in Asia to have Siphon Spillways located at 20°322 173 , N 81°, 392 423 E and constructed in the year 1923. This reservoir has 16, 19,000 m3 volume of water (Fig 1). The gillnetting is a year-round activity in Madamsilli reservoir. Gillnet operated in this reservoir have different mesh sizes such as 250 mm (G1), 140 mm (G2), 100 mm (G3), 90 mm (G4) and 80 mm (G5). Gillnets of different mesh size were randomly selected for the collection of catches. Technical details and design features of different gillnets being operated in the Madamsilli reservoir were documented. The design features includes total length, depth (M), the color of twine, the size of twine (mm), mesh size (mm), the diameter of rope (mm), types and sizes of floats and sinkers, inter-distance between two consecutive floats and sinkers (cm). Sampling and identification of species were done during a present investigation for quantitative assessment of bycatch. Main catch and bycatch for gillnets were segregated, and species identification was done using FAO identification sheets (Fischer and Bianchi, 1981, De Bruin *et al.*, 1994).

Catch Effort

Catch per unit effort (CPUE) was generated for a main catch, bycatch and total catch for the landing centers of Madamsilli reservoir. The CPUE was calculated by using the formula: Catch = CPUE x Effort (Banarjee, 1980). Catch efforts data were collected from the landing centers of Madamsilli reservoir for gillnets. The catch per unit effort (CPUE) was taken as catches from the net of 100 m long, for a soaking duration of 10 hours and the catch was expressed as weight in kg. Estimation of Bycatch, Mean quantity of bycatch and proportion of bycatch to main catch were estimated for different gillnets. Mean of bycatch was also calculated (Biradar, R. S. 2002). The proportion of bycatch to the main catch was expressed as a percentage regarding weight.

Data analysis

Analysis of Variance (ANOVA) was carried out for bycatch and main catch for selected gillnets operated in Madamsilli reservoir to test for variability at 5% level of significance. Duncan Multiple Range Test was used to separate means. Statistical Package for Social Science (Version 16.0) was used.

RESULTS AND DISCUSSION

Gillnet was found to be a major gear used for harvesting of fishes from Madamsilli reservoir. A wide variation in design features of gillnets was found (Table. 1) (Fig. 2-6). The gillnets operated in Madamsilli reservoir varied in length from 100 m to 250 m head rope. The hanging co-efficient was 0.7, and this was almost uniform for all the nets operated in Madamsilli reservoir. However, there was a wide variation in gap between two consecutive sinkers but this variation was not found in between two consecutive floats (Table 1). The largest mesh size of net was 250 mm, and the smallest was 80 mm with operational depth ranging from 4-6 m.

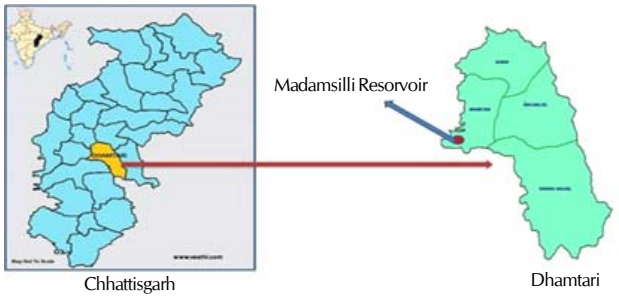

Figure 1: Study Area (Madamsilli Reservoir, Dhamtari, Chhattisgarh)

Table 1: Design and operational parameters of Gillnets used in Madamsilli Reservoir, Dhamatari

Design Features	Gillnets G1	G2	G3	G4	G5
Mesh size (mm)	250	140	100	90	80
No. of meshes in length	800	1025	1645	975	2000
No of meshes in depth	25	60	55	32	46
Twine diameter (mm)	1.0	1.0	1.0	1.0	1.0
Hanging co-efficient(inner)	0.7	0.7	0.7	0.7	0.7
Netting material	PA	PA	PA	PA	PA
Colour of webbing	white	white	white	Light green	white
Head rope and foot rope length (m)	100	150	200	150	250
Diameter of head rope (mm)	5.0	5.0	5.0	5.0	5.0
Diameter of foot rope (mm)	5.0	5.0	5.0	5.0	5.0
Rope material	PE	PE	PE	PE	PE
Type of float	Thermocol & Plastic	Thermocol	Plastic	Thermocol & Plastic	Plastic
Gap between two consecutive floats(m)	1.0	1.0	1.0	1.0	1.0
Type of sinker (Weight)	Lead (20 g)	Stone	Stone	Lead (20 g)	Stone
Gap between two consecutive sinkers (m)	0.5	1.5	1.5	1.0	2.0
Depth of operation (m)	4 - 6	4 - 6	4 - 6	4 - 6	4 - 6
Time of fishing	7 am – 5 pm	7 am – 5 pm	7 am – 5 pm	7 am – 5 pm	7 am – 5 pm
Duration of fishing (Hours)	10	10	10	10	10

Table 2: Mean quantity and proportion of catch and bycatch from Gill nets operated in Madamsilli Reservoir, Dhamatari

Species	Mean Length(cm)	Main catch (kg) and Contribution (%) from Gillnets G1	G2	G3	G4	G5
Main Catch						
Labeo rohita	35	20 kg(2.597%)	200 kg(35.087%)	250 kg(33.557%)	350 kg(33.718%)	500kg(37.735%)
Labeo gonius	30	-	15 kg(2.631%)	24 kg(3.221%)	25 kg(2.408 %)	25 kg(1.886%)
Catla catla	54	100 kg(12.987 %)	150kg(26.315%)	200 kg(26.845%)	320 kg(30.828%)	400 kg(30.188%)
Cirrhinus mrigala	40	50 kg(6.493%)	80 kg(14.035%)	65 kg(8.724%)	80 kg(7.707%)	80 kg(6.037%)
Mystus singhala	48	150 kg(19.480%)	35 kg(6.140%)	75 kg(10.067%)	80 kg(7.707%)	95 kg(7.169%)
Ompok pabda	25	-	15 kg(2.631%)	23 kg(3.087%)	25 kg(2.408%)	35 kg(2.641%)
Puntius sarana	15	-	5 kg(0.877%)	8 kg(1.073%)	8 kg(0.770%)	10 kg(0.754%)
Wallago attu	60	450 kg(58.441%)	70 kg(1.228%)	100 kg(13.422%)	150 kg(14.450%)	180 kg(13.584%)
Total Main Catch	770 kg(99.354%)	570 kg(92.985%)	745 kg(89.221%)	1038 kg(91.132%)	1325 kg(88.039%)	
Bycatch						
Labeo rohita	20	-	18 kg(41.860%)	20 kg(22.222%)	25 kg(24.752%)	50 kg(27.777%)
Labeo gonius	18	-	3 kg(6.976%)	10 kg(11.111%)	5 kg(4.950%)	35 kg(19.444%)
Catla catla	25	-	15 kg(34.883%)	25 kg(27.777%)	30 kg(29.702%)	50 kg(27.777%)
Cirrhinus mrigala	22	-	-	8 kg(8.888%)	10 kg(9.900%)	12 kg(6.666%)
Mystus singhala	28	-	2 kg(4.651%)	2 kg(2.222%)	3 kg(2.970%)	5 kg(2.777%)
Ompok pabda	15	-	-	12 kg(13.333%)	15 kg(14.851%)	13 kg(7.222%)
Puntius sarana	9	-	-	3 kg(3.333%)	3 kg(2.970%)	3 kg(1.666%)
Wallago attu	30	5 kg(100.00%)	5 kg(11.627%)	10 kg(11.111%)	10 kg(9.900%)	12 kg(6.666%)
Total Bycatch		5 kg(0.645%)	43 kg(7.014%)	90 kg(10.778%)	101 kg(8.867%)	180 kg(11.960%)
Total Catch		775 kg	613 kg	835 kg	1139 kg	1505 kg

Table 3: Catch per Unit Effort (CPUE) of Gillnets of Madamsilli Reservoir, Dhamatari

Gill Net	Main Catch (Kg)	Effort (Hrs.)	CPUEFor Main catch	Bycatch (Kg)	Effort (Hrs.)	CPUEfor Bycatch	Total Catch(kg)	Effort (Hrs.)	CPUEfortotal catch
G1	770	10	77.0	5	10	0.5	775	10	77.5
G2	570	10	57.0	43	10	4.3	613	10	61.3
G3	745	10	74.5	90	10	9.0	835	10	83.5
G4	1038	10	103.8	101	10	10.1	1139	10	113.9
G5	1325	10	132.5	180	10	18.0	1505	10	150.5

Table 4: Result of one way ANOVA for main catch, by-catch and total catch for all five types of gillnets

Gillnets	Main catchMean ± SD	BycatchMean ± SD	Total catchMean ± SD
G1	7.7667^{b} E2 ± 30.55	4.2^{a} ± 0.81	7.7667^{b}E2 ± 12.58
G2	6.0333^{a}E2 ± 30.56	42.33^{b} ± 3.05	6.04400^{a} E2 ± 7.81
G3	7.4833^{b}E2 ± 40.10	89.34^{c} ± 4.04	8.3100^{c}E2 ± 16.37
G4	1.0260^{c}E3 ± 31.74	1.0033^{d}E2 ± 5.03	1.1380^{d}E3 ± 7.54
G5	1.3550^{d}E3 ± 32.78	1.7967^{e}E2 ± 2.51	1.5050^{e}E3 ± 15.00

All values were mean standard deviation (SD) of triplicate analysis. Differ superscripts in the same row indicate significant differences ($P < 0.05$).

Table 5: Results of one way analysis of variance (ANOVA) comparing the main catch, bycatch and total catch from different five gillnets operated in Madamsilli reservoir

		Sum of Squares	df	Mean Square	F	Sig.
Main Catch	Between Groups	1047325.733	4	261831.433	235.545	.000
	Within Groups	11116.000	10	1111.600		
	Total	1058441.733	14			
By Catch	Between Groups	52644.203	4	13161.051	1.135E3	.000
	Within Groups	116.007	10	11.601		
	Total	52760.209	14			
Total catch	Between Groups	1515298.267	4	378824.567	2.462E3	.000
	Within Groups	1538.667	10	153.867		
	Total	1516836.933	14			

Significance level of the factors (Source of variation): *p* d"0.05

In Madamsilli reservoir maximum total catch was contributed by Gillnet G5 (1505 kg) whereas least total catch was contributed by gillnet G2 (613 kg). The total catch contributed by gillnet G1 was 775 kg where main catch was 770 kg (99.354 %) and bycatch 05 kg (0.645 %) . *Wollago attu* (mean length 30 cm) was the only species contributed as bycatch in gillnet G1 and this same species (lean length 60 cm) have highest contribution (58.441 %) as main catch in the same gillnet. Gillnet G2 contributed least main catch among all the gillnets operated in Madamsilli reservoir. In gillnet G2, *Labeo rohita*

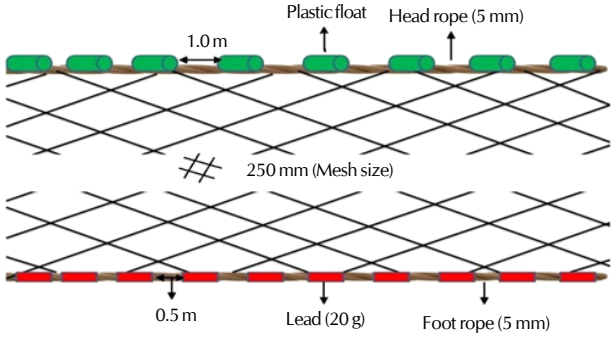

Figure 2: Gillnet (G1)

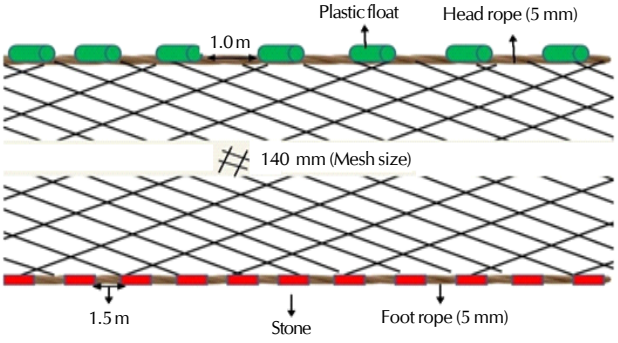

Figure 3: Gillnet (G2)

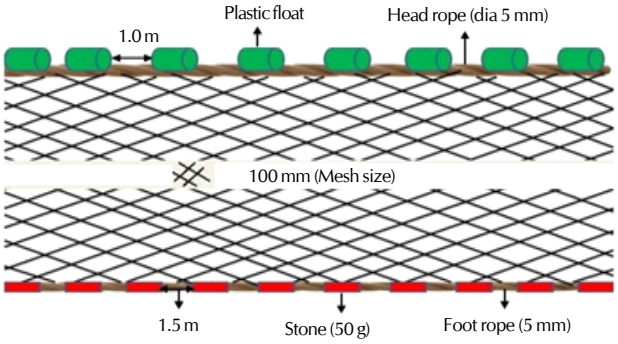

Figure 4: Gillnet (G3)

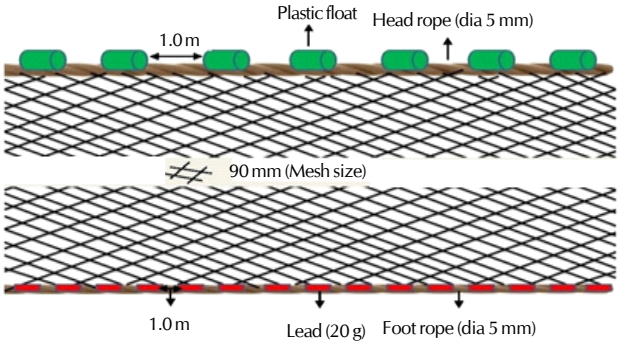

Figure 5: Gillnet (G4)

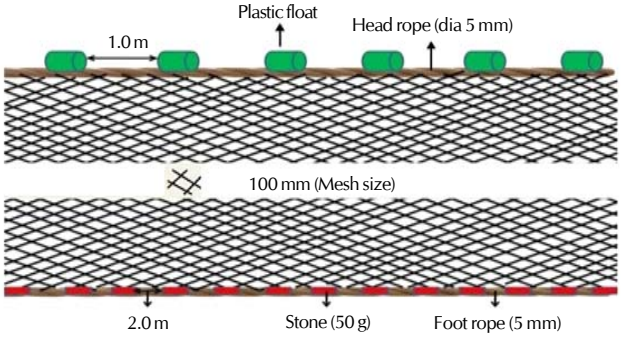

Figure 6: Gillnet (G5)

(mean length 35 cm and 20 cm) have maximum contribution in main catch and bycatch viz. 35.087 % and 41.860 % respectively. The less mesh size of gillnets results into reduced selectivity and increased bycatch. The presence of smaller size *Labeo rohita* and *Catla catla* species as bycatch in gillnet G2, G3, G4 and G5 showed the least selectivity of the gillnets. Only one fish species, *Wollago attu* was found as bycatch from the gillnet G1. The gillnet G2 have 41.860 % and 34.883 % contribution in bycatch of *Labeo rohita* and *Catla catla* respectively. *Cirrhinus mrigala*, *Puntius sarana* and *Ompok pabda* only contributed by gillnet G3, G4 and G5 as bycatch. The gillnet G5 have least mesh size followed by G4, G3 and G2 where as the gillnet G1 have highest mesh size and contributed least bycatch. (Table 2). So, the mesh size of the gill net G2, G3, G4 and G5 has to be regulated to reduce proportion of bycatch.

The details on catch per unit effort (CPUE) was estimated for each shot of 100 m long of gillnets for a soaking duration of 6 hrs are given in Table 3. The maximum CPUE of bycatch was recorded as 30.00 kg from the gillnet G5 and minimum was 0.833 kg from the gillnet G1. A catch per unit effort (CPUE) was generated for the main catch, bycatch and total catch for all the gillnets (Table 3). The statistical analysis of data obtained in this study indicate the significant differences among the main catch and bycatch from all the gillnets. (Table 4). Table 4 presents results of one-way ANOVA with Duncan test, comparing the difference in main catch and bycatch at different coasts. The effects of both factors were highly significant with the p-value < 0.05 as found in earlier studies (Anirudh *et al.*, 2014).

The statistical analysis of data obtained in this study indicate the significant differences among the main catch, bycatch and total catch from all the gillnets operated in the Madamsilli reservoir. (Table 5).

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