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Status of Fish Production in Madduvalasa Reservoir at Srikakulam, Andhra Pradesh, India

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Abstract: A thorough investigation of the fishing potential of Madduvalasa reservoir was conducted, with different parameters such as stocking density and fish landings taken into account. Fish stocking information from 2013 to 2017 were used to compare fisheries productivity across four years. The reservoir's total fish production was 18390.7 kg in 2014-15, 22289.05 kg in 2015-16, and 26432.2 kg in 2016-17, with production growing steadily from 2014 to 2017. Madduvalasa reservoir had a total fish yield of 6.19 kg/hectare in 2014-15, 8.1935 kg/hectare in 2015-16, and 9.90 kg/hectare in 2016-17. In the present research, the lowest fish capture was recorded in February 2016, while the highest was observed in July 2016. The fishery developed rapidly after 2014, with *Catla catla*, *Labeo rohita*, and *Cirrhinus mrigala* accounting for the vast bulk of carp landings in 2016-17. The test statistic F is 7.03, which is not within the 95% range of acceptability. The measured effect size is substantial (0.65) and it is comparable to the R2 in linear regression in comparison to ANOVA statistics.

Keywords: Fish capture, Fish production, Craft and gear, Season, Reservoir, Stocking density, Fish landings, ANOVA

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Introduction

Fish and fisheries are important economic activities in India. The total fish production in the country increased six fold from 0.75 million tons in 1950-51 to 4.95 in 1994-95. During the same period, inland fish production increased from 0.22 million tons to 2.09 million tons registering a near tenfold increase. Over the last four and half decades, the annual growth rate in inland fisheries was 11% and that of the marine segment was 9%. The contribution from inland fisheries to national fish production has been consistently increasing. India is one of the few countries in the world which has substantially exploited its inland fisheries potential. In India, reservoirs are considered to be the prime resource with regard to capture fisheries and extensive aquaculture. Sugunan (1995) estimated the combined surface area of all reservoirs, irrespective of size, as 3135366 ha. In Andhra Pradesh, the tanks and small reservoirs are segregated either arbitrarily

Fig. 1: Study area.

or based on yardsticks that have no limnological relevance. For instance, all the small reservoirs in the State, created before independence and those without a masonry structure and spillway shutters are called tanks. Tanks in Andhra Pradesh are classified as perennial and long seasonal (Sugunan, 2000, 2001; Sreenivasan, 2001; Bandyopadhyay *et al*., 2003; Sakhre and Joshi, 2003). Madduvalasa reservoir is the major man made wetland, constructed on the rivers Vegavati and Swarnamukhi, in the hilly area of the district and surrounded by green hills and agriculture lands. The Madduvalasa reservoir is very good example for a natural ecosystem, offering the primary, secondary producers and consumers. In the present study an attempt was made to evaluate the details of various tropical levels, primarily to work out the fishery support offered by the Madduvalasa reservoir to the mankind. Such a study was not done earlier due to the difficulty in approaching the reservoir as it is geographically located in a hilly area. Attempts were also made to evaluate the potential of Madduvalasa reservoir to develop as a centre for reservoir fishery.

Materials and Methods

Madduvalasa reservoir (Fig. 1) is located 18.586746 N, 83.618625 E in the Vangara mandal, which has 24 villages and 8 landing stations (Magguru, Vangara, Seetharampuram, Kottisa, Balijipeta, Gudivada Agraharam, Pattuvardhanam, and Sangam). The length is 8 km, and Ayacut is 9990 ha. It is constructed on the Vegavathi and Suvarnamukhi Rivers, which are subsidiaries of the Nagavali River. Water discharge: 1660 cm^3, left main canal: Ayucut, 1000 ha. Length: 1400, earthen bund: 2.32 km. The seven villages (Patuvardhanam, Devikiwada, Chinna Devikiwada, CBR Peta, Nukalavada, Narendrapuram, and Gitanapalli) comprising about 2,240 families, were adjacent to the Full Reservoir Level (FRL), and the water spread area was 2750 ha.

Fishermen use mainly following varieties of fishing crafts:

1) A wooden boat
2) A fiber boat
3) A round rubber air tube
4) A 5 feet long thermocol sheet
5) The wooden boat is made up of mango or other wood and can accommodate 2 to 4 fishermen.
6) The fiber boat is made up of fiber and resin and can accommodate 2 to 3 fishermen.
7) A round rubber tube can accommodate only 1 fisherman.
8) The thermocol craft can accommodate 1 fisherman.

Fig. 2: Craft and Gear used at Madduvalasa Reservoir.

The primary fishing gear is a cast net, a hanging lift net, a conical trap, a cover pot, a box trap, a long push net, a drag net (Konti vala), a gill net (1 cm to 20 cm eye size), and metallic hooks (Fig. 2). Typically, fishermen install traps and nets in the evenings and retrieve the captured fish and shellfish the next morning. A metallic hook is used to catch carnivorous fish like *Channa*, *Heteropneustous*, *Glassogobius,* and eels. The results highlight the numerous actions associated with gear-wise fishing. The fishing data was obtained from various landing sites every three days, and biomass was computed by multiplying the number of days in each month. (Mc Cann, 1960; Miyamoto, 1962; Hanson and Leggett, 1982, 2011; Jhingran, 1988; Hilborn and Walters, 1992; Sugunan, 1995; Frederick and Peterman, 1995; CIFRI, 2006).

Results and Discussion

A detailed analysis of the Madduvalasa reservoir's fishing potential was carried out, taking into consideration several characteristics such as stocking density and fish landings. Fish stocking data from 2013 to 2016 were used to compare fishery production across three years. The Madduvalasa reservoir fishery is divided into two categories: the native fishery, which is totally fed by the reservoir, and the exotic fishery, which is supplemented with fish fingerlings deposited in the reservoir throughout time. Table 1 shows the fish fingerling stocking statistics from 2014 to 2016. The reservoir was stocked immediately with 240000 *Catla catla* and 160000 *Labeo rohita* fish fingerlings. When total fish landings were compared to native species landings, native species regularly performed well, despite the fact that the majority of them were lower in size, with the exception of *Channa striata*. When monthly fish landings were compared, the peak landings occurred between June and July, coinciding with the rainy season. This circumstance remained during the duration of our research time. Table 2

Table 1: Fish fingerling stocking details of the Madduvalasa reservoir during the years 2014-2017

Date of stocking	Source from where stock is obtained	Size stocked			Total
		Catla catla	*Labeo rohita*	*Cirrahnus mrigala*	
2014-15 (October)	Kikaluru, West Godavari private fish farms	240000	160000	-	400000
2015-16 (December)	Kikaluru, West Godavari private fish farms	3.3 Lak	4.2 lak	0.84,370	654370
2016-17	-	-	-	-	-

Table 2: Fish catch/ fish landings of Madduvalasa reservoir in 2014-17

Month	Fish production 2014	Prod./ hat./month (kg) 2014-15	Fish production 2015-16	Prod./ hat./month (kg) 2015-16	Fish production 2016-17	Prod./ hat./month (kg) 2016-17
February	1288.3	0.48	1476	0.55	1482.7	0.56
March	1526.8	0.57	1988.3	0.74	1736.8	0.65
April	1435	0.54	2037.7	0.76	1888.5	0.71
May	1609	0.6	1920.2	0.72	2109.5	0.79
June	2007.5	0.75	2549.8	0.96	3109.4	1.16
July	2080.7	0.78	2427.5	0.91	3230.4	1.21
August	1772.2	0.66	1988.9	0.75	2863.2	1.07
September	1519.7	0.57	1815	0.68	2516.0	0.98
October	1398.5	0.52	1684.8	0.63	2213.5	0.86
November	1248.25	0.47	1611.55	0.60	1977.4	0.74
December	1284.25	0.47	1517	0.57	1744.0	0.65
January	1220.5	0.46	1357.3	0.51	1560.8	0.58
Total	18390.7	6.89	22289.05	8.35	26432.2	9.90

shows comprehensive monthly fish landings from 2014 to 2017.

The Madduvalasa reservoir fishery is dominated by major carp, which are replenished at regular intervals. The native species were divided into four categories: catfish, eels, predatory fish, and miscellaneous. *Glossogobius giuris* represents predatory fish, whereas murrels include *Channa marulius*, *Channa orientalis*, *Channa punctata, and Channa striata*. *Mastacembelus armatus* and *Mastacembelus pancalus* are both species of spiny eels. Catfish species include *Mystus bleekari*, *M. cavasius*, *M. gulio*, *Mystus tengara*, *M. vittatus*, *Ompok bimaculatus*, *Wallago attu*, *Clarias batrachus*, *Clarias gariepinus*, *Heteropneustes fossilis,* and *Pangasius pangasius*. The eels are represented by *Anguilla bengalensis*, while the rest of the species were classified as miscellaneous, which are smaller and dominated by *Puntius spp*. Throughout the research period, carp consistently led the overall capture, followed by catfish and murrels. In 2016, predatory fish capture was comparable to that of big carps, indicating a potential resource and breeding environment for predatory fish that prey on other miscellaneous species. The reservoir was stocked at 413 numbers per hectare. During the research period, fish output in Dhaura Reservoir was 106.6 kg ha1, compared to 32 kg ha1 before to adoption (Utpal *et al*., 2009).

Fish production in the Madduvalasa reservoir is an important aspect of the investigation. The reservoir's total fish production was 18390.7 kg in 2014-15, 22289.05 kg in 2015-16, and 26432.2 kg in 2016-17, with production growing steadily from 2014 to 2017. A similar tendency continued throughout the study's subsequent years. It is important to mention that in 2014-15, during a period of heavy rainfall and flash floods at Madduvalasa reservoir, all excess gates were lifted to release water. A large number of fish escaped via the main drain canal and were caught in the main drain canal downstream. Madduvalasa reservoir had a total fish yield of 6.19 kg/hectare in 2014-15, 8.1935 kg/hectare in 2015-16, and 9.90 kg/hectare in 2016-17 (Fig. 3) (Ramachandra Rao, 2018). Similar research was conducted by Rama Rao (2015), who stated that the highest fish capture recorded in December was 4910.7 kg, with the second largest harvest reported in November at 4141.8 kg in Lowe Manair Dam. Wojciech *et al*. (2010) found that cyanids dominated the biomass of the Malta Reservoir until 1992, with proportions ranging from 37 to 82%. Since 1996, the fish assemblage biomass has decreased from 14.2% to 6.4% by 2008. In 2000, biomass density grew by 13.8%, reaching 85.5 kg ha1.

In 2014-15, the total fish capture was 18390.7 kg, yielding 6.89 kg per acre. The highest fish capture was reported in July 2014, while the lowest catch was reported in January 2015. In 2015-16, the total fish capture was 22289.05 kg, yielding 8.35 kg per acre. The highest fish harvest was reported in June 2015, with the smallest catch occurring in January 2016 (Table 2). In 2016-17, the total fish capture was 26432.2 kg, yielding 9.90 kg/hectare (Figs. 4, 5, 6). Similar results were observed for the number of reservoirs; the average fish output from Indian reservoirs is estimated to be 6.7 kg/ha. David et al. (1969) estimate that typical fish output from Indian reservoirs is just 6.7 kg/ha. An estimated average fish yield from Indian reservoirs is just 6.7 kg/ha (Jhingran and Tripathi 1976). Tungabhadra and Mettur have estimated yields of 6.2 kg/ha and 39.0 kg/ha, respectively (Jhingran 1988). Deepak and Ningwal (2014) found that the average annual fish production at Mod Sagar, which has 82.50 ha of water accessible for fish culture, was 40.31 kg/hectare, which is much higher than that of comparable Indian reservoirs. According to Sugunan (2000), yearly output, biomass, and P/B ratios in India ranged from 2.4 to 11.3 kg ha^{-1} $year^{-1}$, 9.1-49.4 kg ha^{-1} $year^{-1}$, and 0.15-0.30 ha^{-1} $year^{-1}$, respectively. Fish output potential was assessed at 290 kg ha^{-1} $year^{-1}$. The reservoir was stocked at 413 numbers per hectare. During the research period, fish output in Dhaura Reservoir was 106.6 kg ha1, compared to 32 kg ha1 before to adoption (Utpal *et al*., 2009).

In the present research, the lowest was observed in February 2016 while the highest fish capture was reported in July 2016. The fishery developed rapidly after 2014, with *Catla catla*, *Labeo rohita*, and *Cirrhinus mrigala* accounting for the vast bulk of carp landings in 2016-17. From June to August 2016-17, *Labeo rohita* dominated the landscape. *Catla catla* and *Labeo rohita* were the most often seen species in 2014, 2015, and 2016, followed by *Cirrhinus mrigala*. The season-wise fish capture was compared between the three succeeding years, and the maximum catch was found during the monsoon, followed by the pre-monsoon and post-monsoon periods (Table 3).

Economic support offered by Madduvalasa reservoir:

The A.P. Fishery Society has around 574 members; with each family of four depend on the Madduvalasa reservoir for their livelihood. Their primary occupation is fishing, and the reservoir fish are classified into nine groups: the first group includes the major carps, *Catla catla, Labeo rohita, Cirrhinus mrigala*, and *Ciprinus carpio*; the second group includes murrel fishes, including *Ophiocephalus sp*.; the third group includes catfishes, including *Wallago attu*, *Clarias*

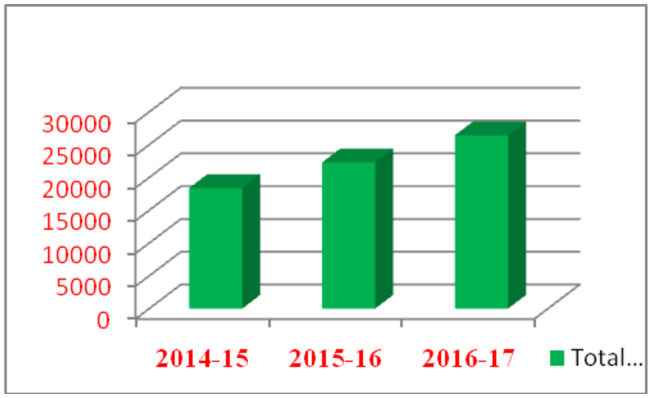

Fig. 3: Fish production from 2014-2017.

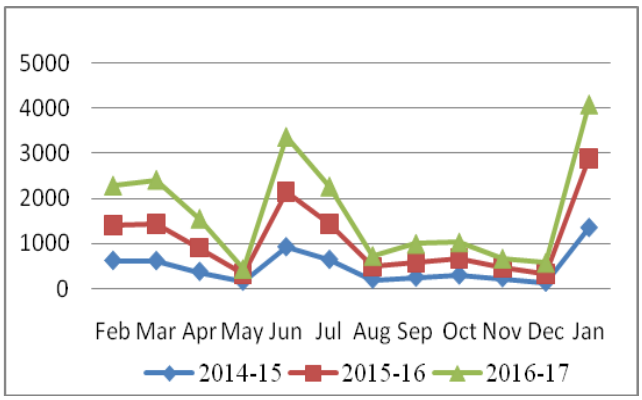

Fig. 4: Pre-monsoon 2014-17.

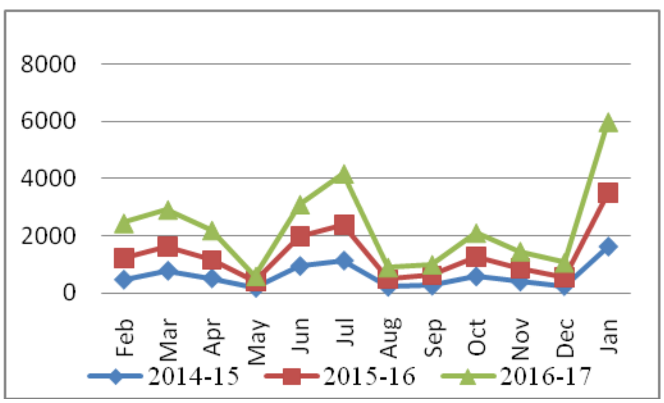

Fig. 5: Monsoon 2014-17.

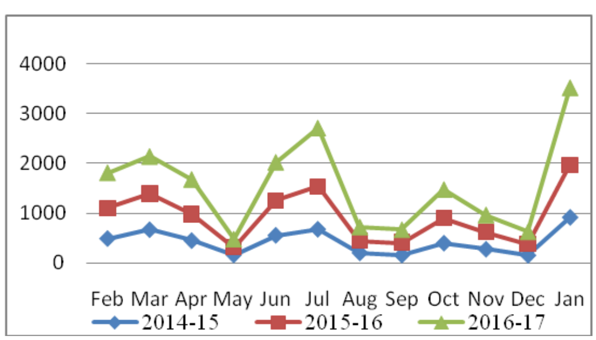

Fig. 6: Post-monsoon 2014-17.

Table 3: Fish catch/ fish landings of various seasons at Mdduvalasa reservoir in 2014-17

	Pre-monsoon			Total	Monsoon			Total	Post-monsoon			Total
	2014-15	2015-16	2016-17		2014-15	2015-16	2016-17		2014-15	2015-16	2016-17	
Feb	625.5	795	865	2285.5	472.5	750	1220	2442.5	493	612	706	1811
Mar	620	823	970	2413	781.5	855.5	1275	2912	668.5	730	740	2138.5
Apr	379.5	535	640	1554.5	519.5	650	1020	2189.5	453	525	700	1678
May	160.5	171	110	441.5	191.5	225	165	581.5	170	151	160	481
Jun	931.5	1228	1200	3359.5	942.5	1039	1116	3097.5	557	700	764	2021
Jul	647.5	792	826	2265.5	1129.4	1267	1779	4175.4	677.5	857	1172	2706.5
Aug	208	289	235	732	225	270	400	895	210	235	280	725
Sep	250	350	400	1000	265	367	360	992	165	245	260	670
Oct	298.6	378.4	352.9	1029.9	585.1	678	837.2	2100.3	401.5	505.85	568.4	1475.75
Nov	238	240	197	675	405	465	580	1450	281.5	335	350	966.5
Dec	140	202	240	582	250.5	310	495	1055.5	161	220	250	631
Jan	1360	1533.8	1181.6	4075.4	1612.6	1904.7	2471.8	5989.1	913.5	1054.8	1545.3	3513.6
	5859.1	7422.2	7217.5	20498.8	7380.1	8781.2	11719	27880.3	5151.5	6170.65	7495.7	18817.85

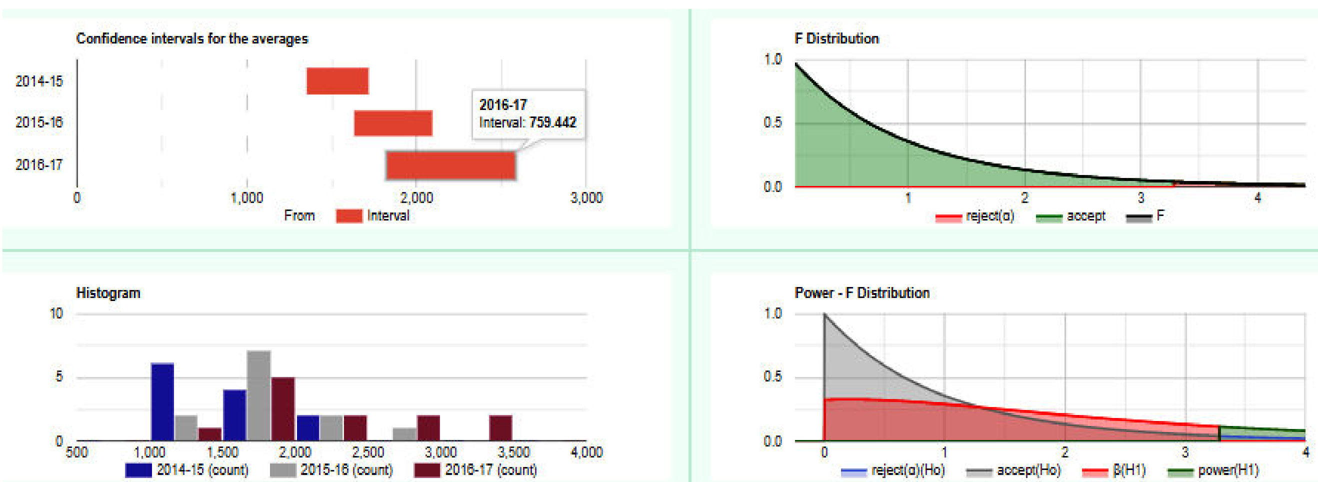

Fig. 7: ANOVA comparison of fish capture at Madduvalasa Reservoir.

batrachus, *Heteopnuestes fossilis*, and all the remaining varieties, which are mostly small in size composition. The economic data were that in 2014-15, the return was Rs. 1317843.00, and each household received Rs. 2295.89; in 2015-16, it was increased to Rs. 1666844.00, and each family gained Rs. 2903.91; and in 2016-17, it was increased to Rs. 2097083.00, and each family gained Rs. 3653.46.

The lower the p-value (0.002861), the less evidence there is for H1 when comparing the ANOVA statistic. The test statistic F is 7.03, which is not within the 95% range of acceptability. The measured effect size is substantial (0.65). This suggests that the size of the gap between the averages is significant. $\eta 2$ = 0.3. It is comparable to the R2 in linear regression (Fig. 7). Hanson and Leggett (1982) found comparable findings for the best univariate of fish yield (r2 = 0.84 and r2 = 0.48, respectively) and biomass (r2 = 0.75 and r2 = 0.83, respectively) across four data sets. Tianye Zhang *et al*. (2024), found a significant linear relationship between estimated and measured fish body weights, with a mean relative error (MRE) of 2.87%. There was no significant difference in estimated and measured weights ($p = 0.94$). The MRE of the multi-factor model was much lower than that of the single-factor model (length-weight of 8.86% and height-weight of 7.41%). The results revealed that the devised system is an extremely effective way for entirely automated biomass estimate. In the current study, fish output grew progressively from 2014 to 2017, and the findings demonstrated that fish stocking, floods, and water quality all play a part in this growth. Andrew *et al.* (2015) represented fish biomass. Understanding variability in fish productivity, biomass, production/biomass (P/B) ratios, and their link to exploitation is critical to fisheries sustainability (Vass, 2007; Andrzejewski *et al*., 2011).

Conclusion

The Madduvalasa reservoir waters support ideal fish development because the availability of sufficient nutrients causes phytoplankton blooming, which is followed by zooplankton. The dominant chlorophyceae plankton gives the Madduvalasa reservoir waters a green hue. Fish that feed on phytoplankton and zooplankton, as well as other small fish, grow to enormous sizes, and fish aged five to six years, as proven by annual rings, were found in the reservoir with body weights ranging from 10–15 kg. Gravid female fish such as catla, mrigala, and carpio are frequently available. Within three months, the major carp seedlings fed in the reservoir had reached a body weight of 240–500 g. Large size. *Channa striatus* weighed 3.3–4.1 kg, while eels weighed 2–3.5 kg. The School of *Puntius, Salmostoma,* and *Amblypharyngodon* were dominant in the miscellaneous group of fish. A smaller number of *Chanda nama* and *Ambassis ranga* were available throughout the year. The least number of *Lepidocephalichthys* was observed in the April and May in the reservoir peripheral sandy region.

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