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Design of a Mini-trawl and its Operational Performance in Thirumoorthy Reservoir, India

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Abstract

Catch efficiency of mini-pair trawling was evaluated in Thirumoorthy reservoir of Tamil Nadu. The mini-pair trawl with 38 m head rope length was operated from 5 m OAL FRP boat powered by 25 hp OBM. The trawlable waypoints in the reservoir were found out through a topographic survey using Echo Sounder and GPS. The total catch was found to be 95 kg in 10 operations and had an average CPUE of 30 kg h^{-1}, of which the catch was dominated by *Labeo rohita* (47%), *Catla catla* (23%), *Cirrhinus mrigala* (19%) and *Cyprinus carpio* (10%). Higher catch efficiency (CPUE of 30 kg h^{-1}) was obtained in mini-trawling as compared to existing economic harvesting techniques (CPUE of gillnet 8.82 kg/boat/day). However, the study indicated the need of detailed research before recommending the mini-pair trawl for commercial use.

Keywords: CPUE, float design, topographic survey, trawl design

Introduction

Reservoirs have an essential role in freshwater fisheries contributing to fisheries production through capture as well as culture activities. The estimated fish production from the Indian reservoirs was 0.937 lakh tonnes against its potential output of 9.86 lakh tonnes from 3.15 million ha water spread area (Sugunan, 2011). Reservoir is classified based on the area whereas the smaller reservoir has greater production 49.90 kg ha^{-1} as compared to the medium (12.3 kg ha^{-1}) and larger reservoir (11.43 kg ha^{-1}) due to easy management, better primary productivity. A maximum number of smaller reservoirs are located in Tamil Nadu (Sugunan, 1995), which includes Thirumoorthy reservoir. This reservoir has a water spread area of 454 ha; is situated in Tirupur District (Lat 10° 47'26.09" and Long 77° 15'71.44") of Tamil Nadu in the Western Ghats of India. This reservoir receives water from the Thoonakadavu reservoir, which in turn receives water from Parambikularn and Peruvaripallam reservoirs. This reservoir has been contributing remarkably to the livelihood of the fishers who are living around this reservoir. An estimated average production was of 36 kg ha^{-1} against its small reservoir potential production 100 kg ha^{-1} (Sugunan 1995) or 132 kg ha^{-1} Castro (personal communication). This poor catch rate has been recorded in this reservoir (Velmurugan et al., 2016) even though seed (Indian Major and minor carps) ranching is done by every year by Department of Fisheries (Tamil Nadu). However, the bigger size fish, adverse weather conditions and uneven bottoms of the reservoirs are the major factors resulting in poor catch rate by existing fishing methods (Sulochanan et al., 1968).

Furthermore, harvesting fish in the deeper parts of the reservoirs remains a challenge due to lack of suitable fishing methods and gears whereas trawl net is a commonly used as an active fishing gear in marine fishery, which can be extended to freshwater bodies without affecting the environment. Trawls had used to harvest the fishery resources in lake and reservoirs – Bull Shoals reservoir (Houser & Dunn, 1967), Lakes of Northern Germany (Steinberg, 1975), Lake Chilwa, Malawi (Ratcliffe, 1974), Billings Reservoir Brazil (Minte Vera & Petrere, 2000) and Czech reservoirs (Riha et al., 2012). The trawl net was used to capture big carps, catfish and perches

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in Dojran Lake in Yugoslavia (Meschkat, 1956) and the catch was dominated by carps where trawling was done in Saginaw bay area lake (Ellis & Pickering 1973). Attempts have been made to harvest the fishery resources in freshwater bodies with the use of trawl net around the world (Dahm, 1980; Minte-Vera & Petrere, 2000; Riha et al., 2012). In India, it has been tried in very few reservoirs including Hirakud Reservoir (George et al., 1982) and Gandhisagar Reservoir (Rao et al., 1988) but the documented information was inadequate. Furthermore, it is believed that inland fisheries will provide the food security especially through management of small reservoir/ water bodies. When the production reaches maximum, there is a need of advanced technology to harvest those resources at an optimum economic level. Therefore, this study is aimed to design a mini pair trawl and their catch performance in Thirumoorthy reservoir.

Materials and Methods

As pair-trawling technique paves the way for the more extensive operational area of the net in the reservoir, a two-seam mini trawl with the headrope length of 38 m was designed and fabricated. This net was designed to operate from two identical FRP boats measuring 5 m OAL (Over All Length) each powered with a 25 hp Out Board Motor (OBM). The experimental gear design was arrived at by scaling up of a prototype fresh water pair trawl designed by Thamson (1978) for trawling from two boats each powered by 15 to 20 hp engine. Many of the dimensions of the prototype were scaled up approximately three times to arrive at the proportion of the experimental gear.

The webbings required for various segments of the experimental gear were shaped using either rectangular or square machine-made webbing by adopting suitable cutting ratio. The technical specifications such as the number of meshes in height, number of meshes in breadth, mesh size and twine thickness in various sections of the experimental gear is given in Fig. 1. Regarding the fishing trials, preliminary testing of the performance of the gear was carried out in Thoothukudi coastal waters.

The twine surface area was calculated by using a formula developed and used by Prado (1990),

$$S = \frac{M+N}{2} \times H \times 2 \times a \times d \times 10^{-2}$$

Where,

S - Twine surface area (m^2)

M - Number of meshes at the bottom of the section

N - Number of meshes at the top of the section

H - Number of meshes along the height of the section

a - Stretched mesh size in mm

d - Diameter of the twine (mm)

The twine surface area of the experimental gear was calculated for each section. The cod-end twine surface area per section was about 1.92 and twine surface area around 3.84 m^2 along with a section. The total surface area of the experimental was 12.2 m^2.

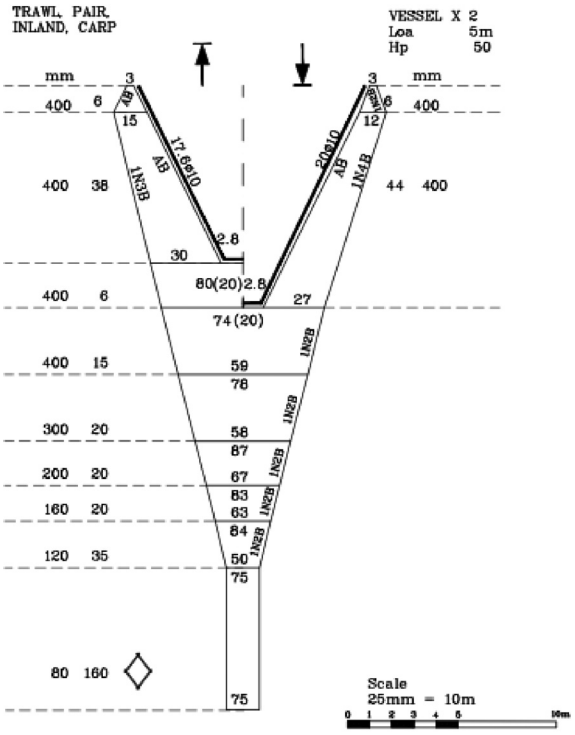

Fig. 1. Design details of experimental trawl

Selection of floats was a challenging task because of the bigger mesh size used in the wing and fore panel of the experimental gear, which caused entangling of floats with the net panels during both handling and operation of the gear. As the use of larger floats would lead to excess buoyant force, Aluminium, HDPE and Cork floats were selected and provided

with a ring. Ringed Aluminium float was developed from regular aluminium float with 160 mm Ø by attaching with an aluminium ring by welding. An aluminium ring was attained by bending 4 ft long aluminium pipe with 10 mm Ø. As the diameter was increased from 150 mm to 400 mm due to the provision of the ring, the entangling of float with the bigger meshes could be avoided (Fig. 2a). The external ring of the ringed HDPE float was similar to that of aluminium float. However, instead of welding, the ring was inserted through a rigging clamp. The entire ring with float was tightly covered with a 30 mm webbing to avoid slippage of the ring from the float (Fig. 2b). The rigged cork float was found to be cheaper compared to Aluminium and HDPE floats and hence a combination cork floats were developed. The buoyancy of 10 cork floats (each about 65 mm Ø and 55 mm length) was found to be equivalent to an aluminium float of 160 mm Ø (Fig. 2c).

To decide the vertical mouth opening of the trawl net, careful attention was given in the selection of sinkers. Iron chains weighing 13 kg was fitted in foot rope after repeated towing trials during pre-testing of the gear.

Before trawling, the topography of the reservoir was studied with the hand-operated echo sounder and GPS. The portable transducer of echo sounder was fitted with a pole and was dipped 1 feet below the water surface. The GPS was used to fix the latitude and longitude of the various points tested in the reservoir to locate the fishing ground while carting out an experiment. Finally, 20 waypoints were recorded in each of 10 along dyke side and 10 along the hillside of the reservoir to identify the trawlable grounds for the experimental gear.

The lowest water level was recorded at 5.03 m during June 2007 and the maximum water level was recorded at 17.82 m, which was observed during December 2010 (Fig. 3). The analysis of overall water level fluctuation of the reservoir revealed that the mean depth of the reservoir was maintained almost constant every year from August to February with the water depth ranging from 9.67 to 17.28 m, which is more suitable for trawling.

Results and Discussion

The experimental pair trawl was operated using a couple of 5 m OAL boat each powered by 25 hp OBM. The towing speed was 1.5 to 3 kn at the depth range of 9.5 to 15.5 m (Table 1). Four individuals were engaged in each boat to assist in shooting and hauling of the net besides carrying out the topographic survey. The shooting was done from one side of the boat to avoid the entangling of the net with a propeller at the same time engine was put in forward to facilitate the shooting. The towing speed fluctuations were recorded with the help of GPS. The recordings of the echo sounder were monitored continuously and whenever there was notable variation in the depth the spot has been registered as a new waypoint. Then, one towing warp was handed over to another boat, and the towing warp was released from two boats at a constant rate. The warps were connected to the iron ring of the boat before starting the tow. The net was towed for 20 min by maintaining a straight course with towing speed between 1.5 to 3 kn. In two-boat operation, the wider apertures of the gear ranged 30-40 m and the distance between the boats and speed maintained identically. During hauling, towing warps were hauled simultaneously from both of the boats; the warp and sweep lines were appropriately stacked to facilitate subsequent operation. After hauling up-to bridles, the head ropes were given to one boat to facilitate hauling of the net. A total of 10 operations were made in the same fishing

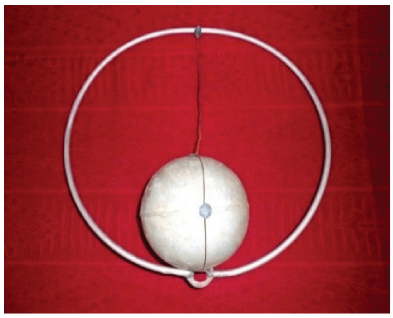

Fig. 2a. Ringed Aluminium Float

Fig. 2b. Ringed HDPE Float

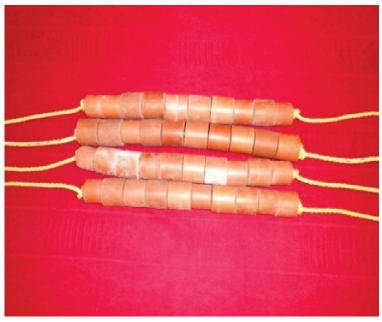

Fig. 2c. Rigged Cork Float

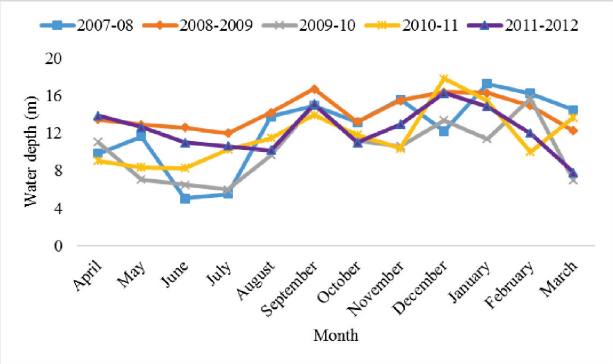

Fig. 3. Month-wise water level in Thirumoorthy Reservoir (source: PWD, Thirumoorthy Reservoir)

ground and way point's image is depicted in Fig. 4. The depth of trawlable grounds varied from 9.5 to 12 m. Apart from this marked site, the remaining areas of this reservoir were found unsuitable for trawling as there were rocks, trees and trenches in such places. Similar kind of report was presented by Rao et al. (1988), who studied the trawling operation in Gandhisagar Reservoir. The center basin of this reservoir has more suitable for trawling due to even bottom of the reservoir which as is in accordance with the findings of George et al. (1982) reported for Hirakud Reservoir. This may be attributed to the regular water movement through the sluice of the reservoir, which leads to erosion at the centre basin to make it have a flat bottom. The overall topographic study revealed that trawling in reservoirs is relatively complicated and knowledge on the bottom contour is necessary to carry out commercial operations.

The species-wise compositions in an experimental pair trawl for the ten fishing operations are given in Table 2. *L. rohita* was the dominant species, which accounted for 47% of the total landing and followed by 23% of *C. catla,* 19% of *C. mrigala* and 10% of

Table 1. Operational details of experimental gear

Sl. No.	Particulars	Results
1.	Type of gear	Pair trawl
2.	Type of craft	FRP (open deck boat)
3.	Size of craft (OAL) (m)	5
4.	Number of Craft	2
5.	Horsepower of the engine (hp)	25
6.	Depth of fishing ground (m)	9.5 to 15.5
7.	Length of warp paid out (m)	20 to 40
8.	Towing speed (kn)	1.5 to 3
9.	Number of hauls	10
10.	Duration of tow (min)	20

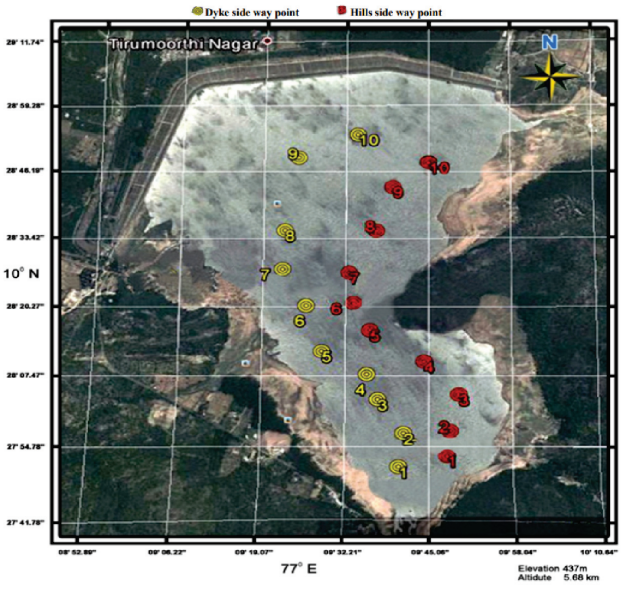

Fig. 4. Waypoints of trawlable fishing grounds in Thirumoorthy reservoir

Table 2. Species composition of fish landed in ten hauls of the experimental trawl net

Sl. No.	Name of the species	Numbers	Length range (cm)	Total weight (kg)	Percentage
1	*C. catla*	10	43-55	22	23.15
2	*L. rohita*	30	35-46	45	47.37
3	*C. mrigala*	8	50-56	18	18.95
4	*C. carpeo*	10	28-34	10	10.53
	Total	58	-	95	-

C. carpio. The total catch was found to be 95 kg in 10 hauls and had an average CPUE of 30 kg h^{-1}. The catch efficiency was higher as compared to the report of Kartha & Rao (1991); the author documented that, CPUE was of 15.85 kg in two boats mid-water trawling operation. George et al. (1982) carried the experimental trawling in Hirkud reservoir; the performance of the trawling in the reservoir was 1.94 kn of towing speed with 155 hauls and CPUE of the trawl was estimated at 19.4 kg h^{-1} and catfish dominated in the catch as much as 38.2% by weight. The authors concluded that trawling as an effective method to capture the fish in the reservoir. A virtual absence of major carps in the catch in this study revealed that this gear might not be destructive to carps. Gillnet is commonly used in Thirumoorthy reservoir to harvest the fish and calculated CPUE of this gear was 8.82 kg/boat/day (Velmurugan et al., 2016). Higher catch (CPUE of 30 kg h^{-1}) was obtained in experimental gear due to use of an efficient instrument such as the echo sounder and GPS to identify the fishing grounds (Juza et al., 2012). The catch efficiency also varies with seasons, water depth, nature of the bottom, biomass of the fish in the reservoir, and design aspects of the gear (Bobori & Salvarina, 2010). Trawl net had the higher catchment area over gillnet however, is not suitable to operate in all the area of the inland water bodies, expect which having plain bottom contour. Therefore, before performing trawling in reservoirs the size of fish, biodiversity, water level fluctuation and bottom contour has to be studied well.

This study concludes that a mini-pair trawling can be performed in Thirumoorthy reservoir during the August to February, as there would be adequate water requisite for the operation of the net. Also, all the part of reservoir not suitable for trawl net operation, though central basin of this water body elite for trawling from which the CPUE was of 30 kg h^{-1} at the towing speed of 1.5 to 3 kn. More studies are required in this reservoir with different towing speed, different coloured fishing nets and time of operation (day/night) to confirm this catch efficiency.

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