Fishery Technology 59 (2022) : 56 - 59

Research Note

Effect of Trap Funnel angle on Fish Capture Efficiency

K. K. Prajith* and V. R. Madhu
ICAR- Central Institute of Fisheries Technology, P. O. Matsyapuri, Cochin - 682 029, India

The efficiency of a fishing system is determined by its structural and operational characteristics, as well as the biological characteristics of the targeted species. Traps are extensively used, both in the marine and inland waters and is widely regarded as low energy and low impact fishing system (Chen et al., 2012; Kopp et al., 2020). The catch composition and retention efficacy of a trap is determined by many parameters, including the physical characteristics of the trap, the type of fishing methods applied and also the behavioural characteristics of the species being targeted (Furevik & Lokkeborg, 1994; Li et al., 2006; Vadziutsina & Riera, 2020). There has been a gradual decline in both the targeted and non-targeted species that were traditionally caught in the trap fisheries worldwide and new candidate species are being tried as alternatives in trap fisheries (Hawkins & Roberts, 2004; Bacheler & Smart, 2016).

Trap fisheries in India, is mostly concentrated in the traditional sector and the designs being used now have evolved over a period, based on the understanding of the behaviour of fishes and other operational parameters. With significant reduction in the traditionally caught species and new species being targeted, the process of developing or evolving a suitable design takes extended periods, with concurrent high costs for field trials. Hence an alternative is to setup in-situ experiments, in which the efficiencies can be evaluated in relatively short time and with reduced cost (Miller & Addison, 1995; Gristina & Gagliano, 2004; Dupuch et al., 2011). Studies have shown that the angle and position of the entrance funnel is one of the most important factors that affects the ingress and egress of fish from the trap (Yamane, 1995; Sugimoto et al., 1996).

Received 25 October 2021; Revised 06 December 2021; Accepted 13 January 2022

**E-mail: prajithkk@gmail.com*

Tilapia was introduced in India in 1952, to fill the unoccupied niches of the freshwater ecosystems. However, due to its prolific breeding nature, the species spread all across the country and now available in all the natural waterbodies including estuaries. This species makes up between 3% and 7% of the overall fish population in many of the major Indian rivers (NFDB, 2015).

Taking the above factors into consideration, this experiment was intended to find an angle of elevation of the trap funnel, required to increase the trapping efficacy for wild Tilapia (*Oreochromis mossambicus)*. Experiment was setup in the fish behaviour laboratory of Veraval Research Centre of ICAR-Central Institute of Fisheries Technology, Veraval, Gujarat, India. Glass tanks with dimensions of 120 x 30 x 45 cm (l x b x h) were used for the experiments. All tanks were filled with freshwater and aeration was provided throughout the experiment. Tilapia (*Oreochromis mossambicus*) was collected using cast net from the estuarine region of rivers, Hiran and Kapila, Somnath District, Gujarat, India, where freshwater influx was more. From the mixed catch, Tilapia fishes were sorted and transferred to aerated plastic barrels and transported to the experimental station within 30 min. The fishes were acclimatised, quarantined and transferred to the respective tanks. Five fishes were stocked in a tank (Average fish length and weight: 13.4 cm and 50 g). Six replicates were maintained for each treatment. Rectangular shaped GI frames (Fig. 1) with a dimension of 42 x 26 cm were fabricated and a circle shaped opening (13 cm Ø) was provided in the middle of the frame for the attachment of funnel. Flexible aluminium webbing panels were used for the fabrication of funnel and were attached using polyethylene twines at three different angles of elevation to the vertical, *viz.*, 40°, 60° and 90° to study the fish response to different elevation angles.

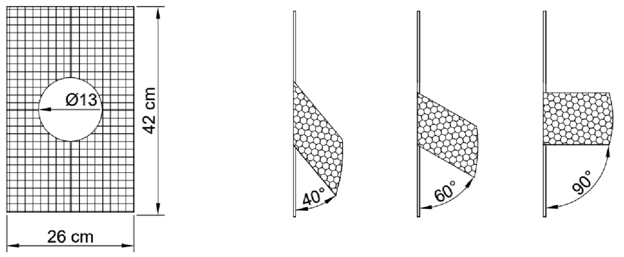

Fig. 1. Design details of trap entrance panel

The frame with the funnel attached was placed such that it separated the tank into two unequal parts, ¾ of the aquarium was used for keeping the fish, termed as active area (AA) and remaining ¼ of the tank was set as the area for bait, baited area (BA). The setup was used based on the assumption that, baited area (feeding area) is the interior of the trap and the remaining area is the open water where the fishes swim freely (Fig. 2). A nutritionally balanced feed was formulated as per the guidelines of ICAR-CIBA (ICAR-CIBA, 2020) with readily available ingredients, which contained approximately 20-25% and 3-5% g of protein and lipids respectively.

The quantity of feed was determined based on the body weight of the fishes in the tank and the feed was dispersed in five equal parts. Once the feed was added to the respective feeding area, number of fishes getting inside and escaping back to the active area was noted. After 60 min of observations, the entire experimental setup was brought back to initial form and the experiments were repeated four times in a day. All the experimental setup was maintained for 11 days and a total of 44 observations were recorded.

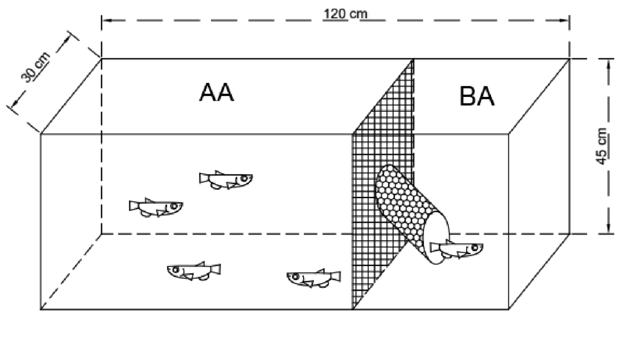

Fig. 2. Pictorial representation of experimental deign

This experimental set up with trap entrance facilitated free and easy movement of the fishes and helped in observing the behavioural and swimming response. In the case of 90^0 angled mouth, the funnel was exactly parallel to the base of the trap, and it was observed that fish could easily move inward and backwards in the two areas, which reduced retention rate. Fishes entered the trap with 60^0degree angled funnels showed similar behaviour as in traps with 90^0 elevation. The trap with an angle of elevation of 40^0 angle reduced the backward movement of fishes and hence had the highest retention ratio. The results are in line with reports of other similar studies (Munro, 1974; Luckhurst & Ward, 1987). The observation that attractiveness of feed decreasing with time as reported by Whitelaw et al. (1991), was also noticed during the experiments. The fish in traps with straight funnels found escapement easier and thus their numbers decreased over time. Arunjenish et al. (2017) also reported similar observations from a field trail conducted along coastal fishing ground off Mandapam in Tamil Nadu, South-West coast of India.

The differences in the retention efficiency of the three traps were statistically tested using one way ANOVA and the results showed that there was no significant difference in the proportion of retention, between the angles 40 (retention: 0.62) and 60° (retention: 0.61) funnels, however the retention probability (0.51) for the 90° angled trap was significantly lower ($p<0.01$) than the retention/capture probabilities for the other two funnel angles (40 and 60). The lower retention probability of the 90° angled trap, can be due to the easy visibility of the escape opening, both from outside and inside, unlike the case of 40° and 60° angled trap designs. For an effective trap mouth design, the opening of the mouth is very critical, and influences retention. The funnel angles with 90° and 60° facilitated the free movement of fish. Whereas the lower angled funnel provided a capturing area which made the fishes to stay in a confined position. Which supports the sheltering behaviour of prey fishes like Tilapia (Dupuch et al., 2011).

In the experimental tanks, the fishes showed schooling, free-swimming as well as fighting behaviour. As fishes were acclimatized from the wild, during the initial days of experiment they responded to the feed with hunger as stimuli. Later on, the fishes got acclimatized to the experimental condition and moved throughout the experimental tanks (free movement). After feeding, some fishes moved inside the trap through the funnel and swam back to the open area. This reveals that fishes entered inside the trap not only for feeding, but also as a foraging or for a comfortable hiding place. High & Ellis, (1973) opined that in natural environment, fishes enter to the trap because of various reasons, like for curiosity, following the action of fellow individuals and for feeding (Predatory fishes). Tilapia fishes show schooling behaviour in natural environment and serves as a prey for several species in wild (Fagbenro, 1989; Fagbenro & Sydenham, 1990). There is evidence that prey fishes show more affinity to traps as it provides a physical structure in the natural environment (Layman & Smith, 2001).

There are many behavioural changes in domesticated and natural behaviour of animals. Domestication gives new environmental conditions to animals. In in- situ experiments one of the major drawbacks observed was the classic conditioning behaviour of fishes. After few days of experiment, fishes actively respond to the feed (first stimuli), and they also respond to the sound, movement or any other external physical stimulus. So, periodic changes in the surrounding or experimental setup is required to minimize bias in the results.

Li et al. (2006) studied the effect of various angles of elevation *viz.,* 46, 37, 27 and zero degree, but the higher angles were not evaluated. Sheaves (1995) observed higher catch from the trap with straight funnel deployed for short duration compared to the trap with bend angle (horse head shape). The correlation between size of the fishes and the angle of trap opening could be an important factor, but this was not considered in this study.

In general, confined experimental condition are simple and less complex when compared to the natural ecosystems. The behavioural response of fishes in the wild and experimental conditions differ slightly and acclimatization to the surroundings is an issue (Pasquet, 2018). This in-situ trial was to optimise the angle of elevation over a wide angle and therefore further trials and refinement with smaller angle of elevations between 30 – 40 degrees and less than 30-degree angle is required before an actual prototype can be developed and employed for field trials.

Acknowledgements

The authors are thankful to Director, ICAR-Central Institute of Fisheries Technology, Kochi, India for permission to submit this paper. Thanks are due to Dr. Muhamed Ashraf, P., Principal Scientist, ICAR-CIFT, Kochi for the suggestions and input provided for this study.

References

Pasquet, A. (2018) Effects of domestication on fish behaviour http://dx.doi.org/10.5772/intechopen.78752

Arunjenish, D., Neethiselvan, N., Sundaramoorthy, B., Jawahar P. and Ravikumar T. (2017) Comparative efficiency of fish trap with different funnel designs Indian j. Fish. 64(4): 116-119

Bacheler, N. M. and Smart, T. I. (2016) Multi-decadal decline in reef fish abundance and species richness in the southeast USA assessed by standardized trap catches. Mar. Biol. 163(2):26

Chen, W., Al-Baz, A., Bishop, J. M., and Al-Husaini, M. (2012) Field experiments to improve the efficacy of gargoor (fish trap) fishery in Kuwait's waters. Chin. J. Oceanol. Limnol. 30(4): 535-546

Dupuch, A., Paradis, Y. and Magnan, P. (2011) Behavioural responses of prey fishes to habitat complexity and predation risk induce bias in minnow trap catches. J. Fish Biol. 79(2): 533-538

Fagbenro, O. A. (1989) Recruitment control and production of Tilapia guineensis (Dumeril) with the predator, Channa obscura (Gunther). Aquat. Sci. 4: 7-10

Fagbenro, O.A. and Sydenham, D.H.J. (1990) Studies on the use of Clarias isheriensis Sydenham (Clariidae) as a predator in Tilapia guineensis Dumeril (Cichlidae) ponds. J. Appl. Ichthyol. 6: 99-106

Furevik, D. M. and Lokkerborgl, S. (1994) Fishing trials in Norway for torsk (Brosme brosme) and cod (Gadus morhua) using baited commercial pots. Fish. Res. 19: 219-229

Gristina, M. and Gagliano, M. (2004) Performance of traditional rush and modern plastic traps on the capture of Palinurus elephas (Fabricius, 1787) in laboratory tanks. Fish. Res. 67(2): 235-239

Hawkins, J. P. and Roberts, C. M. (2004) Effects of Artisanal Fishing on Caribbean Coral Reefs. Biol. Conserv.18(1): 215-226

ICAR-CIBA (2020) Homemade formulated feed for aquarium keeping using household ingredients for use in COVID -19 lockdown period. HOMEMADE FEED_CIBA.pdf (icar.org.in)

Kopp, D., Coupeau, Y., Vincent, B., Morandeau, F., Méhault, S. and Simon, J. (2020) The low impact of fish traps on the seabed makes it an eco-friendly fishing technique. PLoS One, 15(8): e0237819-e0237819

Layman, C. A. and Smith, D. E. (2001) Sampling bias of minnow traps in shallow aquatic habitats on the Eastern Shore of Virginia. Wetlands 21: 145-154

Li, Y., Yamamoto, K., Hiraishi, T., Nashimoto, K. and Yoshino, H. (2006) Effects of entrance design on catch efficiency of arabesque greenling traps: a field experiment in Matsumae, Hokkaido. Fish. Sci. 72(6): 1147-1152

Luckhurst, B. and Ward, J. (1987) Behavioural dynamics of coral reef fishes in Antillean fish traps in Bermuda. Proc. Gulf Carib. Fish. Inst. 38: 528-546

Miller, R. J. and Addison, J. T. (1995) Trapping interactions of crabs and American lobster in laboratory tanks. Can. J. Fish. Aquat. Sci. 52(2): 315-324

Munro, J. L. (1974) The mode of operation of Antillean fish traps and the relationships between ingress, escapement, catch and soak. J. Cons. Int. Explor. Mer. 35(3): 337-350

NFDB (2015) Guidelines for Responsible Farming of Tilapia in India, Novemeber 2015. 16 p

Sheaves, M. (1995) Effect of design modifications and soak time variations on Antillean-Z fish trap performance in a tropical estuary. Bull. Mar. Sci. 56(2): 475-489

Sugimoto, Y., Fuwa, S., Ishizaki, M and Imai, T. (1996) Entrance shape of fish trap and fishing efficiency. Bulletin of the Japanese Society of Scientific Fisheries (Japan) ISSN: 0021-5392

Vadziutsina, M. and Riera, R. (2020) Review of fish trap fisheries from tropical and subtropical reefs: Main features, threats and management solutions. Fish. Res. 223: 105432

Whitelaw, A. W., K. J. Sainsbury, Dews, G. J., and Campbell, R. A. (1991) Catching characteristics of four fish-trap types on the North West Shelf of Australia. Aust. J. Mar. Fresh. Res. 42: 369-382

Yamane, T. (1995) Effect of Different Funnel Designs on the Catching Ability of Small Pots for Prawns Macrobrachium nipponense. Fish. Sci. 61(2): 187-19