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Pair Trawling vs. Otter Trawling: An evaluation of efficiency along the Southwest Coast of India

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Abstract

In Karnataka, the trawling industry contributes significantly to fish landings. Though conventional otter trawlers account for the majority of trawl landings in the state, pair/bull trawling, which is prohibited, also during the post-monsoon season. There are no published reports on the specifications of the gear used or the changes operation, in the region over the last few years. A comparison of pair/bull trawls and mid-water finfish otter trawls operating off the coast of Karnataka was conducted. The specifications for the gears were gathered from the gear fabrication units in Mangalore and Malpe. The pair trawl's head rope (HR) measured 183–293 m in length, while the finfish otter trawl's HR measured 99–110 m. The pair trawls had a mouth opening that was between 2.9–4.06 times that of the mid-water finfish otter trawls. Trawlers operating along the Karnataka coast conducted both pair and otter trawling during the same cruise, depending on the circumstances. The study indicates that the catch rate was significantly higher in pair trawls than in otter trawls. The average drag produced by pair trawls was calculated to be 6.74 tonnes at a speed of 3.0 kn, while the drag produced by otter trawls was only 2.28 tonnes at the same speed. The result of the study indicates that while the high fuel consumption of a pair trawling unit may negate some of the profits, the overall profit margin of the unit remains high during pair trawling, enticing fishermen to engage in clandestine pair trawling. Capping engine power, regulating gear size and operation and enforcing legal mesh sizes through stringent "monitoring, control and surveillance" mechanisms mitigate the negative impacts of pair trawling.

Keywords: Pair trawling, juveniles, otter trawls, fuel consumption

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Introduction

Trawling, which accounts for more than 50% of total fish landings in India (CMFRI, 2018), is the most important fishing method. Since the introduction of trawl net in Indian seas, considerable modifications have been made in the design and operation of trawls to maximize the capture of specific resources. Over the years, the size and engine power of trawlers have also increased significantly (Renju et al., 2014). About 35,228 trawlers ranging in size from 12 to 22 m operate along the Indian coast (Edwin et al., 2014).

Karnataka has a 300 km long coastline and a shelf area of approximately 27,000 square kilometers. During 2005 to 2015 (CMFRI, 2005; 2015), the State contributed between 8 and 18% of total marine fish landings in the country, sustaining the livelihoods of around 0.17 million people, 0.04 million of whom are directly dependent on fisheries (Rohit et al., 2016). Along the coast, a variety of gear types are operated, with trawlnets and purse seines accounting for the majority of the catch. Karnataka has a total of 3,209 registered trawlers and 274 registered purse seiners and have historically contributed inversely to the state's total catch. Purse seine catch contribution has decreased from 57% in 1990 to approximately 16% in 2015, while catches from

trawlers has increased from 29% in 1990 to 73% in the same period, owing to the lateral (depth-wise) and horizontal (along the shore) expansion of trawlers' operational area.

Trawls were used in Karnataka for the first time on an experimental basis in 1957, primarily to exploit shrimp, which then became a characteristic of the state's mechanized fisheries since the early 1970s (Rohit et al., 2016). As has been documented elsewhere in the country, fishermen in Karnataka have incorporated several changes to the design, shape and operational parameters of their gear in order to increase fishing efficiency, expand the area of operation and enable the capture of a variety of species at different depths. These changes have been complemented by an increase in the size of craft engine capacity and endurance of the fishing craft along with increase in the size of nets used. Pair/bull trawling, in the state has also undergone changes over the period.

Karnataka is a major coastal State where pair trawling is practiced in the post-monsoon period. In the early 1990s, short voyage trawlers of single day fleet (SDF) with an overall length (LOA) of 9 to 11.2 m and engine power ranging from 37 to 88 hp operated pair trawl nets with a 40 m head-rope length in the 10-18 m depth zone (Rohit et al., 1993). Pair trawling became more popular in 2013 and was conducted from larger multi-day voyage trawlers with an LOA of 20 m, primarily targeting ribbonfish and squids (including juveniles) along the entire depth zones. The pair trawlers' indiscriminate capture of juveniles sparked unrest among motorized and non-motorized traditional fishermen, as well as purse seine fishermen, resulting in intersectoral conflicts. Due to the increased conflicts and protests from fishers, the Department of Fisheries, Government of Karnataka issued an order in November 2016 declaring pair/bull trawling an offence under the Karnataka Marine Fisheries (Regulation) Act, 1986 (Viswambharan et al., 2016). Additionally, in November 2017, the Union Government also issued a new order prohibiting pair trawling in India's exclusive economic zone. Despite the ban orders, pair/bull trawling continues clandestinely along Karnataka from August/September to November, immediately following the annual ban on mechanised fishing (https://bangaloremirror.indiatimes.com/news/state/karnataka-22-bull-trawlers-seized-in-karwar/articleshow/60929542.cms).

Trawlers operating along the Karnataka carry different types of trawl nets and either undertake pair or otter trawling, depending on the fishing conditions during a multi-day trip. As a result, separate reports on the specifications of the trawl gear used and the catch composition in pair trawling are unavailable. Therefore, this study intends to conduct a comparative analysis of the gear characteristics and relative catch rates of pair trawling and mid-water otter trawling off the coast of Karnataka.

Materials and Methods

A structured questionnaire was designed to collect details regarding the different parts of the trawl net and the operational parameters of the gear. The data regarding the gear designs were collected from the gear manufacturing units located at Malpe and Mangalore. For comparison, the opening of the trawl mouth was calculated as per (Reid, 1977) and the twine surface area and the total drag of each trawl net were calculated (Vijayan & Baiju, 2006). The total drag including the floats and other accessories was estimated by assuming that the net drag contributes approximately 75% of the total drag experienced underwater by the trawl.

Catch data from the pair trawls and otter trawls undertaking multi-day operations were collected through a multi-stage stratified random sampling technique as detailed by Srinath et al. (2005). Though the two fishing crafts performed mostly pair trawling during the entire cruise (multi-day pair trawl-MDPTN) as a single unit occasionally they operated their respective otter trawls (multi-day trawl-MDTN operation) and this portion of the catch thus landed were accounted separately. Considering this, the analysis of the trawl catch was carried out during September to October, 2013 and August to September, 2014, when majority of the units collaborated for pair trawling.

Additionally, comparative studies were conducted by analyzing landing data from randomly selected trawls that were engaged in otter trawling (12 units of MDTN) and pair trawling (35 units of MDPTN) and landed at Mangalore Fisheries Harbour (18 September 2013 and 26 September 2014) and at Malpe Fisheries Harbour (18 October 2013 and 26 September 2014).

Monthly catch rates were calculated in terms of catch per trawling hour (CPH) and expressed in kg h^{-1}. Single-factor analysis of variance (ANOVA)

was used to compare the catch rates of multi-day trawl (MDTN) and multi-day pair trawl (MDPTN). The catch rates of target species (kg h^{-1}) from pair trawling and otter trawling operations along the coast were also estimated during September-October 2013 and August-September 2014.

Seerfish, *Scomberomorus commerson*, being one of the most valued fish targeted in multiple gears, including hook and line, purse seine, pair trawl, otter trawl and gillnets, the size classes caught by these gears, in October, was also compared.

Results and Discussion

The length overall (LOA) of the multi-day trawlers operating in the region ranged between 16 and 21 m and the same craft was used for pair and otter trawling operations. The notification dated 01.08.2013 by the Department of Fisheries, Government of Karnataka, limited the engine power of trawlers to 350 hp, but it was observed that engine power had exceeded 350 hp. The engine power of the vessels engaged in pair and otter trawling operations was comparable and the same vessels were involved in both operations.

The length of the head rope on a trawl used for pair trawling ranged from 183 to 293 m (Fig. 1), while the length of the head rope of the most commonly used net for otter trawling was 99 to 110 m (Fig. 2). When compared to otter trawls operating in the region, the length of the head rope was 1.6 to 2.96 times longer and the area of the mouth opening was 2.01 to 4.06 times larger for pair trawls. Table 1 compares the gear characteristics of the pair trawl and the mid-water otter trawl. Diamond meshes of 20 mm mesh size were mostly used in the codend.

Pair trawling is practised along the Karnataka coast beginning in the post-monsoon months of August/ September. The operating depth of multi-day trawlers using a pair-trawl was generally greater than 27 m (15 fathoms), ranging from 36 to 130 m, with a towing speed of 3.3 to 4.5 kn during the study. The duration of each haul varied between 2 to 2.5 h in case of pair trawling depending on the abundance of fish, while the duration extended upto three hours in case of otter trawling. When a pair trawl was operated from crafts with varying engine power, it was noted that the larger craft reduced its speed appropriately in response to the smaller craft's engine power limitations.

The towing warps in the midwater pair trawls were rigged so as to tow the trawl net very close to the surface, thereby reducing the length of the wire rope and also increasing the towing speed. At the end of each pair trawling operation, the codend was alternately hauled to one of the two boats, where the catch was emptied, sorted, quantified, iced and stored in the fish-hold.

The preliminary survey has indicated that the fishers in the region have significantly expanded their operating area, which now stretches from Ratnagiri in Maharashtra to Ponnani in Kerala. The horizontal and offshore spread of vessels operating off the coast of Karnataka has been previously reported (Rohit et al., 2016).

The analysis of catch rates by gear revealed that MDPTN had significantly higher catch rates (ANOVA, $F=14.7$, $p<0.01$), with a mean CPH±SD of 157±29 kg h^{-1}, compared to MDTN, which had a catch rate of 81±28 kg h^{-1} (Fig. 3).

Table 1. Comparison of the gear characteristics of pair trawl and mid-water otter trawl

Specification		Pair trawl	Mid-water otter trawl
Mesh size (wing)		6000 mm	6000 mm
Engine power		425-550 HP – (850-1100 hp for 2 vessels)	425-550 HP
Head rope length (m)		183-293	99-110
Vertical spread (m)		65-85	53-60
Horizontal spread (m)		110-176	66-59
Area covered per haul ($m^{2)}$		7,132-14,045	3,456-3,555
Ratios	Area	2.01:1 to 4.06:1	
Pair trawl: Midwater trawl	HR	1.6:1 to 2.96:1	

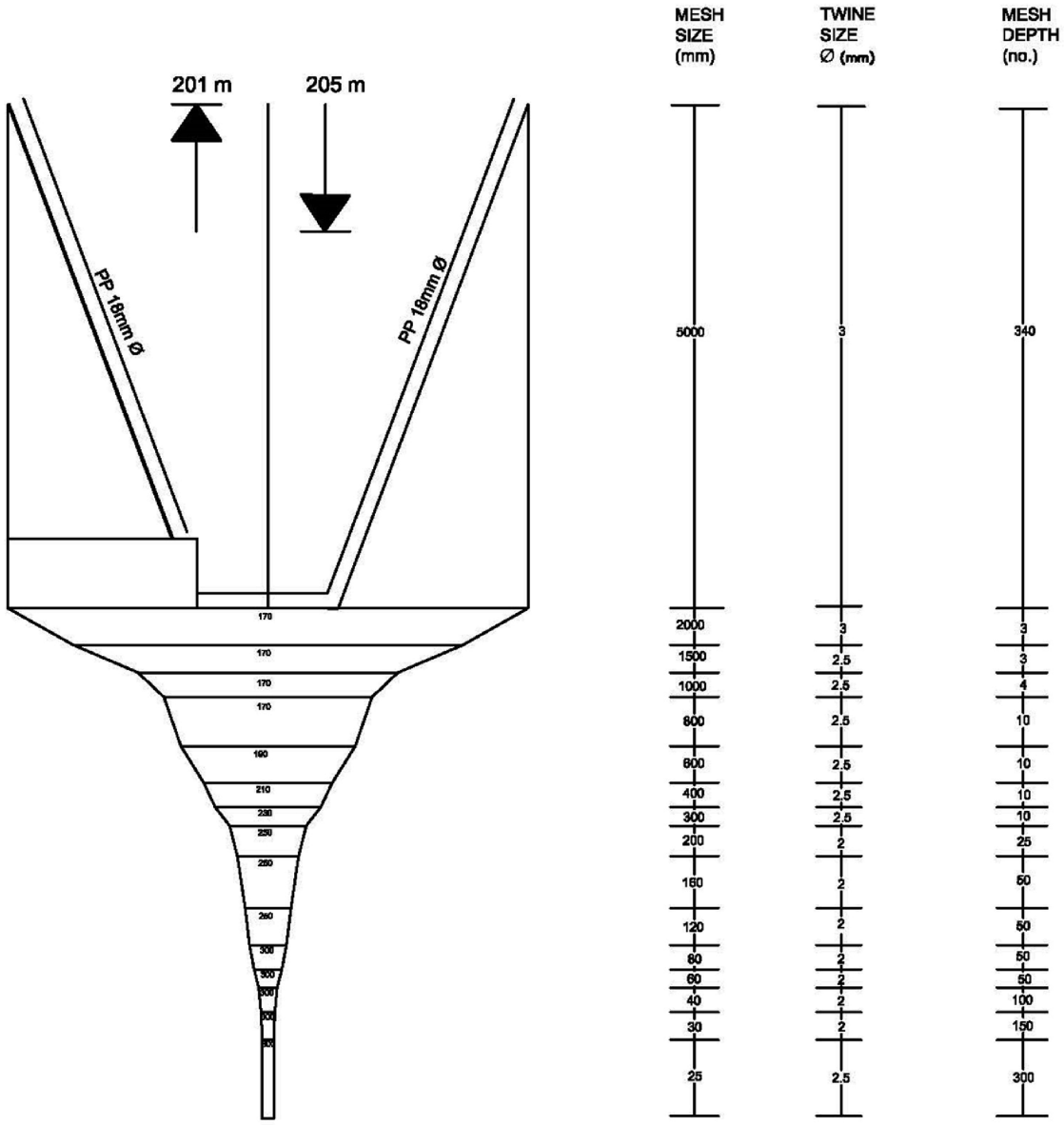

Fig. 1. Most prevalent design of pair-trawl net

Comparative studies conducted using data from randomly selected trawlers that were engaged in otter trawling and pair trawling at Mangalore Fisheries Harbour on 18 September 2013 and 26 September 2014 and at Malpe on 18 October 2013 and 26 September 2014, revealed that pair trawlers landed 9 to 28 t of catch in a trip lasting an average of 6 days. On the other hand, otter trawlers landed approximately 4 to 13 t of the catch over the course of a 6 to 8 day trip. The average CPH for pair trawlers is therefore high, even if the catch is divided among two trawlers.

The resources targeted by pair trawlers mostly included ribbonfish *Trichiurus lepturus*, squids *Uroteuthis* spp., seerfish *Scomberomorus commerson* and Indian mackerel *Rastrelliger kanagurta*. Other resources landed occasionally included oil sardines *Sardinella longiceps* and pomfrets. Besides, many shoaling carangids (scads) were caught during the operation. The comparison of catch rates by MDPTN and MDTN (Fig. 4) showed that pair trawls are very effective, considering the larger nets used. The catch rate of targeted species in pair trawling was found to be higher as compared to otter trawling operations (Fig. 4).

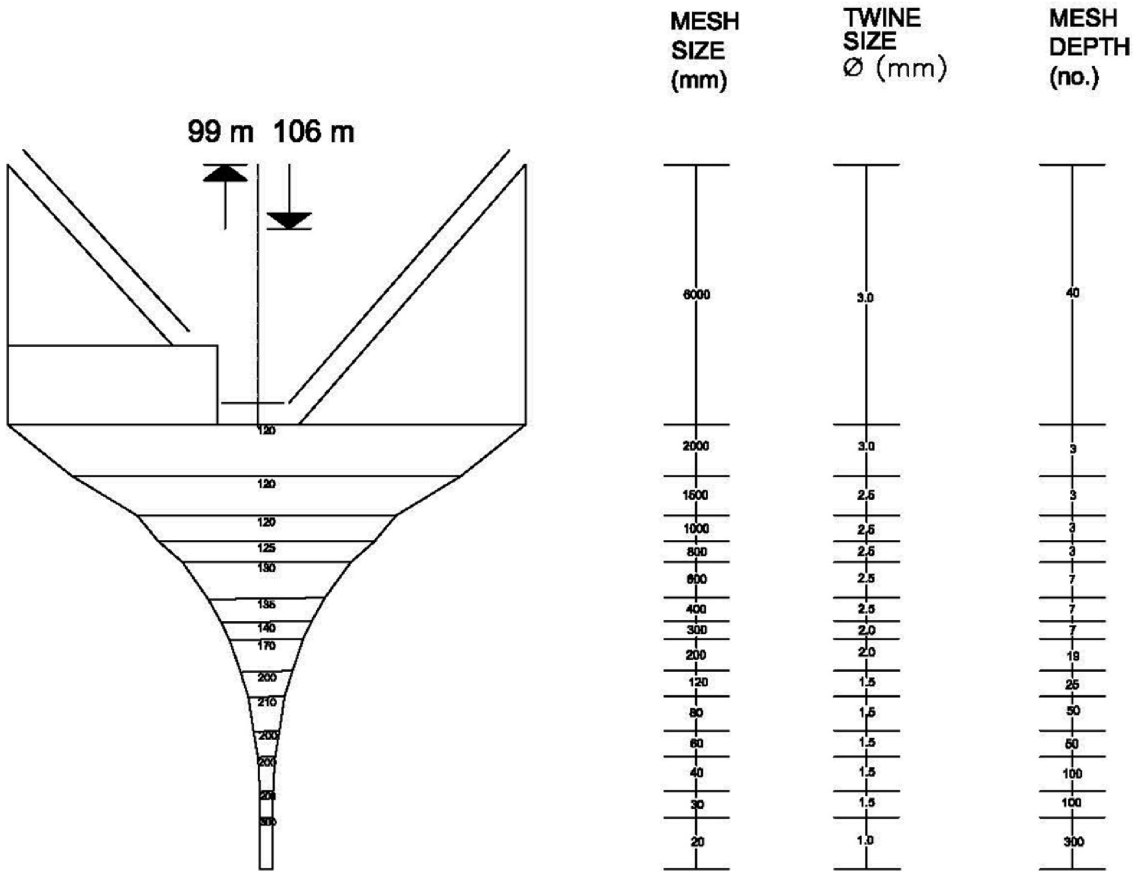

Fig. 2. Most common design of otter trawl net used along Karnataka

The average drag estimated as per Reid (1977), for the pair trawls was 6.74 t at a speed of 3.0 kn, while it was only 2.28 t for finfish otter trawls assuming the same speed.

The engines used in trawlers consumed between 35 and 45 l of fuel per hour of operation. The high rates of diesel consumption, combined with the drag of the large trawl net being towed, would negate some of the benefits associated with the high catch rates. The pair trawling operations achieved higher overall catch rates. It was estimated that a trawler would catch 1.2–1.5 times as many fish when engaged in pair trawling as when engaged in otter trawling. The benefits are higher in the former operation, which encourages fishermen to conduct pair trawling operations clandestinely. Additionally, depending on the season, pair trawling enables targeting of fish schools aggregated in the upper water column efficiently when compared to otter trawling.

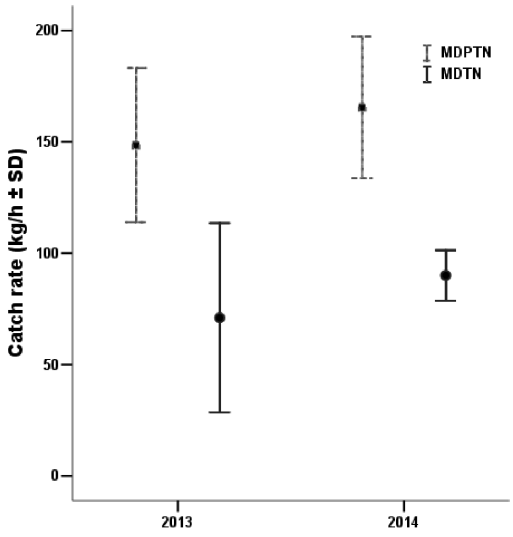

Fig. 3. Error plot showing the catch rates (CPH-kg h^{-1}) from multi-day pair trawl (MDPTN) and multi-day trawl (MDTN) in Karnataka

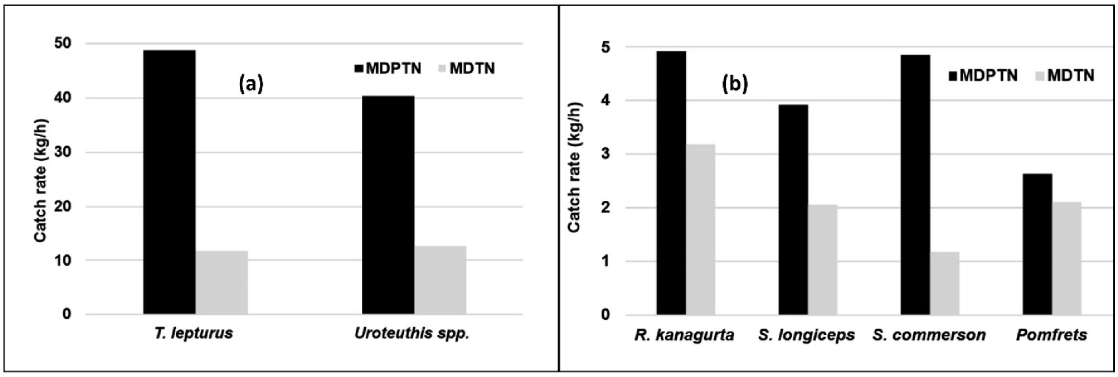

Fig. 4. Catch rates (CPH-kg/h) of major targeted species in multi-day pair trawls (MDPTN) in comparison with the catch rates in multi-day trawl (MDTN) in Karnataka.

The comparison of the size of seerfish, *S. commerson* caught in different gears in October, showed that pair trawls caught the smaller individuals, 36.2±3.21 cm (26-44 cm), when compared to the sizes from otter trawl 50±8.7 cm (35.5-63); purse seine, 70±5.11 (62-76 cm); gillnet 71±11 cm (53-94) and hooks and line, 76.43±9.56 cm (61-94 cm). Additionally, the study indicated a high prevalence of smaller seerfish, particularly when pair trawling is carried out in coastal waters (<12 nm). Due to the larger fishing capability of pair trawls compared to otter trawling and other gear types, they can capture a greater proportion of smaller sized fishes and hence have a more detrimental effect on the stocks. It was also observed that the mesh sizes used in the codend is comparatively small and often made of diamond mesh, which would affect the escapement of juveniles (Madhu, 2018). Additionally, it was observed that trawlers switch between pair and otter trawling operations at their convenience, which complicates effort estimation, when fishery-dependent data is used to assess fish stocks like being practiced in India (Alagaraja et al., 1982).

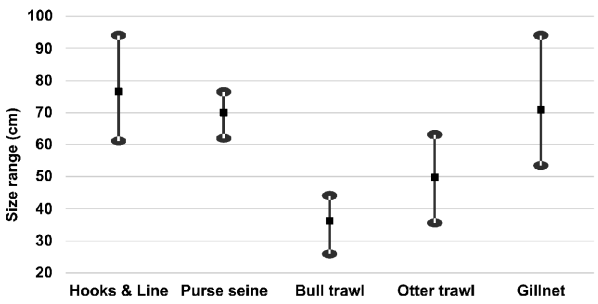

Fig. 5. Size range of *Scomberomorus commerson* commonly caught by different gears along Karnataka Coast in October

The Government of Karnataka has restricted the unbridled increase in the engine power of trawlers through regulation, however compliance with this law is equivocal, necessitating constant monitoring of adherence and compliance. Implementing minimum legal sizes (MLS) for catches, employing legal mesh sizes in trawl codends, adopting an optimal fleet size for trawlers and putting in place effective monitoring, control and surveillance would, to a larger extent, mitigate the negative repercussions of trawling and make it more sustainable in the future.

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