



# Fish Catch Rate and Fish Composition of Commercially Operated by Multi-Day Trawling off Sindhudurg Coast of Maharashtra, India

B. R. Kharatmol<sup>1</sup> , V. B. Sutar<sup>2</sup>, A. S. Kulkarni<sup>3</sup>, A. T. Markad<sup>4</sup> and A. T. Landage<sup>5</sup>


<sup>1</sup>Dept. of Fisheries Resource Management, <sup>2</sup>Dept. of Aquatic Environment Management, <sup>3</sup>Dept. of Fisheries Extension Economics & Statistics, <sup>4</sup>Dept. of Fisheries Engineering, College of Fishery Science, Udgir, Latur, Maharashtra (413 517), India

<sup>5</sup>ICAR- Central Institute of Fisheries Education, Off Yari Road, Versova, Mumbai, Maharashtra (400 061), India



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Corresponding  [kharatmolrtn@gmail.com](mailto:kharatmolrtn@gmail.com)

 0000-0001-8720-2200

## ABSTRACT

The commercial-operated multi-day trawlers from Sindhudurg coast carried out fishing operations at Malvan landing center, South Konkan region, Maharashtra, India in the mean depth range of 18–31 m in September, 2016 to May, 2018 to assess the changing trends in the fish catch composition, catch and discards rate by multi-day trawlers operating along the Sindhudurg coast of Maharashtra state. The average catch rate was observed 25.03 kg h<sup>-1</sup> and 31.72 kg h<sup>-1</sup> with average discards 5.07 kg h<sup>-1</sup> and 7.81 kg h<sup>-1</sup> by multi-day trawler during 2016–17 and 2017–18 respectively. During two fishing seasons, the average catch rate was 28.37 kg h<sup>-1</sup>, with average discards of 6.44 kg h<sup>-1</sup> by multi-day trawlers. Major catch composition of multiday trawlers comprised *Arius maculatus*, *Parastromateus niger*, *Lactarius lactarius*, *Otolithes curvieri*, *Lepturacanthus savala*, *Rastrelliger kanagurta*, *Scomberomorus guttatus*, *Cynoglossus macrostomus*, *Uroteuthis duvaucelii*, and Penaeid prawns. Discards comprised juveniles of commercial species and adults of low market value fishes. Cod end mesh size of trawl net varied from 15–35 mm depending on the fishery resources harvested. Duration of fishing trips by multi-day trawlers varied from 2–4 days, peak fishing activities were observed during October to December followed by February in terms landing. The study clearly indicated an increase in the average catch rate h<sup>-1</sup> trawler<sup>-1</sup> during the year 2017–18 compared to the previous year 2016–17 along the Sindhudurg coast. The t-Test performed on fish catch and discard of multi-day trawlers showed a statistically significant difference ( $p < 0.05$ ) in a fish catch (kg h<sup>-1</sup>) and fish discards between two fishing seasons, i.e., 2016–17 and 2017–18.

**KEYWORDS:** Discards, fish catch, multi-day trawlers, species composition

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**Data Availability Statement:** Legal restrictions are imposed on the public sharing of raw data. However, authors have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

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## 1. INTRODUCTION

India, a tropical country, has a multispecies fishery, exploiting species that differ in their biological characteristics and habitats. The development of marine fisheries has transformed traditional fishing methods into mechanized fishing all along the coast during the last four decades (Rao, 1972). Over 90% of the marine fish catch is presently accounted for under mechanized and motorized fishing (Anonymous, 2000). Marine fisheries worldwide and in India remain seriously threatened by fishing overcapacity, overfishing, and environmental problems (Meaden and Aguilar-Manjarrez, 2013). In India, stock assessment of exploited fisheries indicated that most fish stocks were being exploited close to MSY level, some overexploited and few underexploited (Mohamed et al., 2014, Pillai, 2011).

Trawlers are a significant mechanized fishing fleet that contributes significantly to fisheries production, especially along the west coast of India. Analysis of Indian marine fisheries production trend showed that 80% of the marine fish catch was contributed by trawlers (Srinath, 2013). Maharashtra state has six coastal districts, namely Greater Mumbai, Palghar, Thane, Raigad, (Northern Konkan) Ratnagiri and Sindhudurg (Southern Konkan), with a total coastline of 720 km and continental shelf area of 1,11,512 km<sup>2</sup>. There are 13002 mechanized marine fishing boats in the state (Anonymous, 2017). The number of total marine fishing boats increased 3.4% over the previous year (Anonymous, 2012). Every year mechanized boats show an increasing trend and more fishing efforts, mainly in inshore waters, resulting in excessive fishing pressure on commercially important fishery resources. Studies on fish catch composition of trawl were attempted by several researchers in the country. Sathiadhas et al. (1992) evaluated the changing pattern of craft and gear combination, their catch composition, and comparative economics of operations at Nagapattinam center of Tamil Nadu coast during 1987-88. Pravin and Manohardas (1996) reported 87 species belonging to 42 families in the low-value bycatch from small and medium trawlers along the coast of Veraval, Gujarat. Rama Krishnan et al. (2012) attempted to quantify species of prawns, commercial fishes and non-commercial fishes based on landings of trawlers from the Palk Bay region during January to December 2008. In single-day fleet off Karwar and Tadri (Karnataka) the major proportion of the total catch was non-targeted bycatch (45%) when compared to the targeted shellfishes (14%), finfishes (38%) and others (3%) (Kurup, 2004, Thomas and Kurup, 2005b, Menon et al., 2006). Zynudheen et al. (2004) reported along the Gujrat coast the major species in trawl by-catches were sciaenids, engraulids, ribbon fish, penaeid and non-penaeid prawns, squids and cuttle fish. Mahesh et al. (2017) assessed

highlighted the landings of low-value bycatch (LVB) and catch composition of trawlers at Mangaluru fisheries harbor. Studies on trawl bycatch and discards were attempted by several researchers in India. Bycatch and discards are serious problems that lead to the depletion of resources and negatively impact biodiversity (Harrington et al., 2005, Alverson & Hughes, 1996). George et al. (1981) estimated bycatch in Indian shrimp trawl fisheries at 3,15,902 t annum<sup>-1</sup>, which formed 79.18% of total shrimp landings of the country. Gordon (1991) estimated that juvenile discards from trawling operations, off Vishakhapatnam were 25–30% of total landings. Juvenile fish comprised the bulk of marine landings in all the maritime states (Luther and Sastry, 1993). Pillai (1998) reported that among the bycatch, about 40% consisted of juveniles. Bhendekar (2016) reported maximum catch per hour during October for multi-day trawlers (73.27 kg) and maximum discards 15.6 kg h<sup>-1</sup> by multi-day trawlers was during September, from Mumbai coast. Singh et al. (2017) reported an average catch rate of 49.90 kg h<sup>-1</sup> and fish discards of 7.7 kg h<sup>-1</sup> for commercially operated multi-day trawlers from Ratnagiri coast of Maharashtra. Samanta et al. (2018) multi day trawlers along the Ratnagiri coast. Samanta et al. (2018) reported mean monthly bycatch generated by experimental shrimp trawling along Mumbai coast ranged from 11.82–20.65 kg h<sup>-1</sup>, in different months with an overall average of 16.82 kg h<sup>-1</sup>. The study was undertaken to assess the changing trends in the fish catch composition, catch and discards rate by multi-day trawlers operating along the Sindhudurg coast of Maharashtra state.

## 2. MATERIALS AND METHODS

### 2.1. Study area

The study area of (Malvan landing center) Sindhudurg is located in the South Konkan region of Maharashtra (Figure 1). Trawlers used for sampling in this area operated between 15°50'00" N to 16°20'00" N latitude and 72°55'00" E to 73°34'00" E longitude. About 526 commercial trawlers operated along the Sindhudurg coast, and most landed their catches at the Malvan landing center.

Estimating the total monthly fish catch and discard rate with fish composition and CPUE from multi-day trawlers was done using stratified multi-stage random sampling (Alagaraja, 1984). Data for the study on catch rate, species composition, and discards of fish and shellfish of commercial trawlers operated along the Sindhudurg coast were collected fortnightly regularly for two years. The study was undertaken for two consecutive fishing seasons from September, 2016 to May, 2017 and September, 2017 to May, 2018. Seven multi-day commercial trawlers were selected for data collection per statistical design (Snedecor and Cochran, 1967). Details of fishing operations were

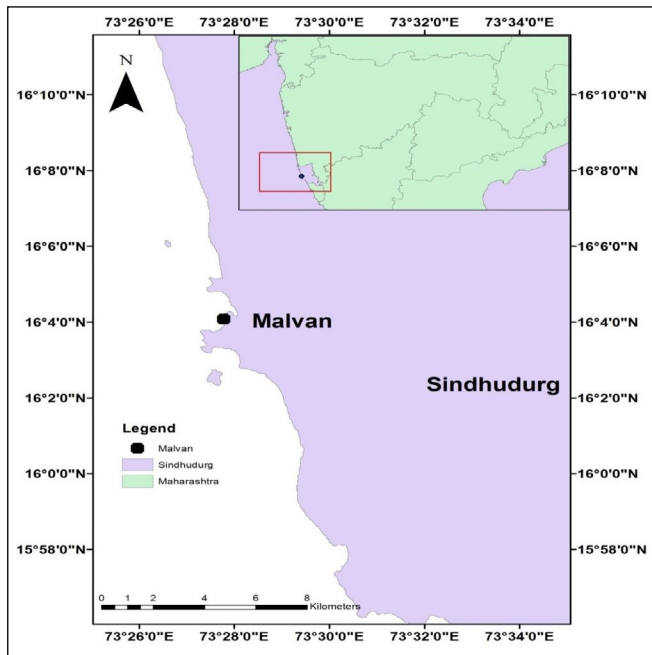


Figure 1: Map showing study sites

gathered partly from boat owners and crew of the trawlers directly involved in fishing and vessel information from vessel registration certificates. Onboard information collected includes the date, depth of shooting and hauling of the net, time of shooting and hauling of the net, type of net, mesh size (Cod end), total catch boat<sup>-1</sup> trip<sup>-1</sup> and haul<sup>-1</sup>, total discards (kg) and several hauls day<sup>-1</sup> was collected. The species composition and size of the catch was obtained through a sampling of trawlers during unloading on the fishing harbor.

Along with fishing information, an unsorted portion of the discarded catch was collected as a sample representing the haul. The catch was identified up to species level using Fischer and Bianchi (1984) and Froese and Pauly (2011). Data were analyzed using Microsoft Excel, 2013. At-Test (Paired Two Sample for Means) was used to determine whether the data is statistically significant or not.

### 3. RESULTS AND DISCUSSION

#### 3.1. Fishing craft and gear

It was observed that the overall length ( $L_{OA}$ ) of commercial-operated multi-day trawlers in the Sindhudurg district varied from 13.20–15.80 m. Most trawlers were constructed of mango wood (*Mangifera indica*) and fitted with 80 to 145-hp marine diesel engines. Cod end mesh size varied from 10–30 mm.

#### 3.2. Fishing operations

The fishing season generally starts by mid-August along the Maharashtra coast after the end of the monsoon ban period. The majority of trawlers use GPS for navigation.

The duration of fishing trips by multi-day trawlers varied from 2–4 days, while medium and large vessels (>13.00 m) remained at sea for more days. The commercial trawlers performed fishing operations between 15°50'00" N to 16°20'00" N latitude and 72°55'00" E to 73°34'00" E longitude. The depth of fishing operation ranged from 12–50 m for multi-day trawlers. Multi-day trawlers carried 3–8 types of trawl nets for harvesting marine fishery resources in the state. It emerged from the study that there was no uniformity in the number of nets carried by trawlers along the entire coastal belt of Maharashtra. It varied from place to place depending on the availability of resources. Depending on the target resource, the cod-end mesh changed monthly from 10–35 mm and that at the wing portion from 60–1500 mm. Trawling operations were carried out during the day between 6.00 am to 6.00 pm. On average, trawlers undertook three hauls daily, each haul of 3 h along the Sindhudurg coast.

#### 3.3. Catch and discards rate

The present study revealed that the average catch rate of the multi-day trawler was 25.03 kg h<sup>-1</sup> with average discards of 5.07 kg h<sup>-1</sup> during the first-year study period (2016–17). Peak fishing activities were observed during September–November and January in terms of landing. During the second year study period (2017–18), the average catch of multi-day trawler was 31.72 kg h<sup>-1</sup> with average discards of 7.81 kg h<sup>-1</sup> respectively. Peak fishing activities were observed from October–December, followed by February landings. Variation in catch h<sup>-1</sup> and discards h<sup>-1</sup> by multi-day trawlers is given in Figure 2 and Figure 3. Considering the data for two years (2016–17 and 2017–18), the average catch was 28.37 kg h<sup>-1</sup> with average discards of 6.44 kg h<sup>-1</sup> of multi-day trawler. The study indicated an increase in the average catch rate h<sup>-1</sup> trawler<sup>-1</sup> during 2017–18 compared to the previous year, 2016–17. The t-Test performed on fish catch and discard of multi-day trawlers revealed a statistically significant difference ( $p < 0.05$ ) in fish catch (kg h<sup>-1</sup>) and fish discards (kg h<sup>-1</sup>) between two fishing seasons, i.e., 2016–17 and 2017–18 along the Sindhudurg coast.

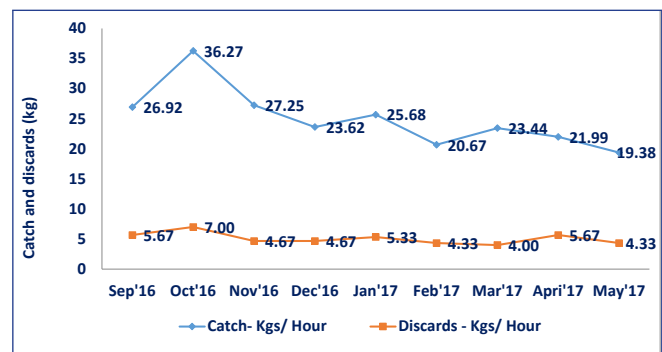


Figure 2: Monthly variation in catch and discards from multi-day trawlers during 2016–17

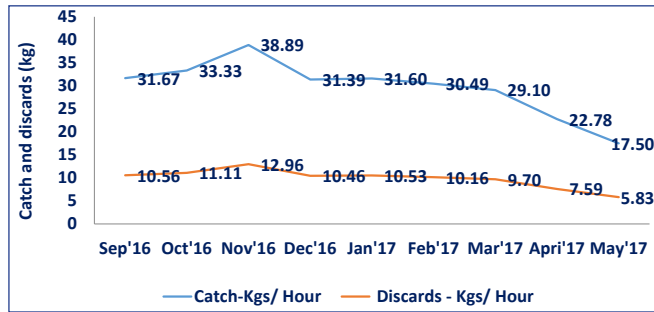


Figure 3: Monthly variation in catch and discards from multi-day trawlers during 2017–2018

Madhu et al. (2017) reported that by-catch was low during the period September (12.9±2.7 kg haul<sup>-1</sup>) to November (17.4±8.1 kg haul<sup>-1</sup>). The quantity of by-catch generated was significantly higher during December (43.5±9.3) and January (56.3±17.1) along the coast of Sindhudurg, Maharashtra. Singh et al. (2017) reported an average catch rate of 49.90 kg h<sup>-1</sup> and 28.20 kg h<sup>-1</sup> with fish discards at an average of 7.7 kg h<sup>-1</sup> and 3.84 kg h<sup>-1</sup> multi-day and single-day trawlers, respectively from Ratnagiri coast of Maharashtra. Bhendekar et al. (2016) showed that the catch% by multi-day trawlers varied from 66–92%, while it varied from 70–95% in the case of single-day trawlers. Maximum discards h<sup>-1</sup> by multi-day trawlers, i.e., 15.6 kg, was during September, while it was October for single-day trawler (4.03 kg h<sup>-1</sup>) from the Mumbai coast of Maharashtra. Dineshbabu et al. (2013) attributed the increase in catch rates to the introduction of high-speed engines in 2010. In Karnataka, during 2001–2002, the bycatch from trawlers formed 47.9–54.4%, and discards constituted 33.9–35.1% of the total catch (Zacharia et al., 2006). Gordon (1991) estimated that juvenile discards from trawling operations off Vishakhapatnam, were 25–30%. Rao et al. (1967) reported the catch h<sup>-1</sup> by otter trawling in the Arabian Sea was 198 kg h<sup>-1</sup>.

### 3.4. Catch composition

Major catch composition of multiday trawlers comprised *Rastrelliger kanagartha*, *Otolithes cuvieri*, *Lepturacanthus savala*, Penaeid prawns, *Lactarius lactarius*, *Scomberomorus guttatus*, *Pampus argenteus*, *Scoliodon laticaudus*, *Parastromateus niger* and *Uroteuthis duvaucelii* during 2016–17. Considering the catch composition of commercially operated multi-day trawlers off Sindhudurg coast, in terms of mean landings *Rastrelliger kanagartha* was the significant species followed by *Lepturacanthus savala* and *Otolithes cuvieri*. Monthly major catch composition by multi-day trawlers during 2016–17 is given in Figure 4.

Catch composition of commercially operated multi-day trawlers during 2017–18 off Sindhudurg coast, *Parastromatus niger* was the significant species, followed by *Rastrelliger kanagartha* and *Otolithes cuvieri* in terms of mean

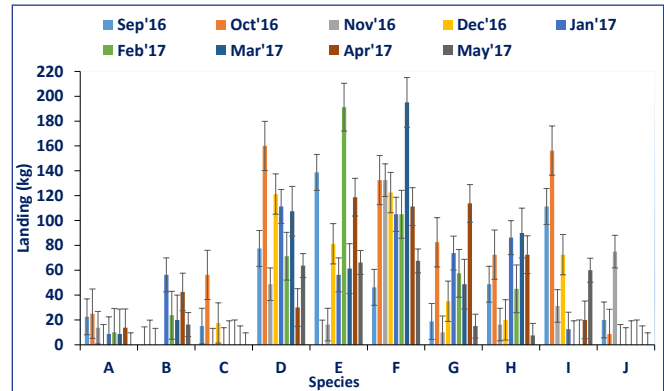


Figure 4: Monthly major catch composition of multi-day trawlers during 2016–17; A: *Scoliodon laticaudus*; B: *Pampus argenteus*; C: *Parastromateus niger*; D: *Otolithes cuvieri*; E: *Lepturacanthus savala*; F: *Rastrelliger kanagartha*; G: *Scomberomorus guttatus*; H: *Lactarius lactarius*; I: Penaeid prawns; J: *Uroteuthis duvaucelii*

landings. Peak landing of *Otolithes cuvieri* was observed during September to December. The monthly major catch composition of multi-day trawlers during 2017–18 is given in Figure 5.

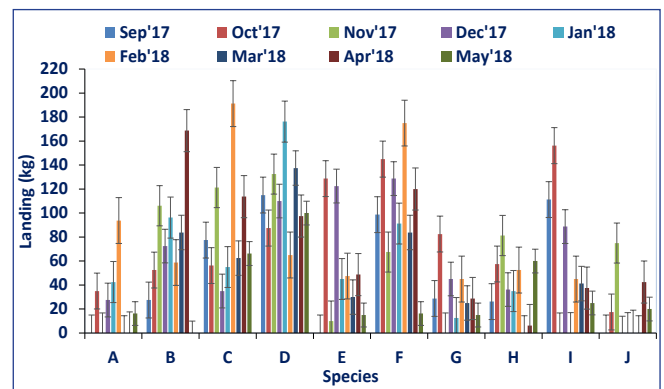


Figure 5: Monthly major catch composition of multi-day trawlers during 2017–18; A: *Magalaspis cordylla*; B: *Arius maculatus*; C: *Parastromateus niger*; D: *Otolithes cuvieri*; E: *Lepturacanthus savala*; F: *Rastrelliger kanagartha*; G: *Scomberomorus guttatus*; H: *Lactarius lactarius*; I: Penaeid prawns; J: *Uroteuthis duvaucelii*

The present study revealed that from the south Konkan region (Ratnagiri and Sindhudurg district) of Maharashtra, 116 species of diverse fishes, crustaceans, and mollusks were recorded from multi-day trawlers during the present study. Major catch composition of multiday trawlers comprised *Arius maculatus*, *Parastromateus niger*, *Lactarius lactarius*, *Otolithes cuvieri*, *Lepturacanthus savala*, *Rastrelliger kanagartha*, *Scomberomorus guttatus*, *Cynoglossus macrostomus*, *Uroteuthis duvaucelii*, and Penaeid prawns. A study by Singh et al. (2017) incorporated traditional knowledge with geographic information systems for preparing thematic

maps of marine fisheries resources along the Ratnagiri coast, Maharashtra; during 2015–16, around 134 species landed by commercial trawlers were reported. Bhendekar et al. (2016) reported 126 species from multi-day and single-day trawlers operating from the Mumbai coast. About 101 species were recorded from the marine capture fisheries bycatch and discard at Karanja and Mora landing centers from Uran (Raigad), Navi Mumbai, Maharashtra (Pawar Prabhakar, 2011).

An increasing number of trawlers coupled with excessive fishing pressure and indiscriminate fishing in the coastal waters has led to an increase in the catch of juveniles of several species over the years. Most trawlers do not venture beyond 50 m depth for fishing and concentrate on fishing within this area which ultimately exerts undue fishing pressure on the available coastal fisheries resources. The exploitation of groups like seer fishes, mackerels, pomfrets, crabs, prawns, and lobster has reached near optimum levels (Ail et al., 2017). One such typical example is Canada, where one of the world's most productive and once inexhaustible marine fisheries in the 'Grand bank' had collapsed (Bensam and Menon, 1994). To manage trawl fishery resources efficiently, caution must be exercised in using trawl nets. Selective fishing practices and mesh size regulations must be strictly adhered to for the sustainability of fishery resources. The database on fishing fleet, fishing operation, fish catch ( $\text{kg h}^{-1} \text{boat}^{-1}$ ) fish discards ( $\text{kg h}^{-1}$ ), fish catch composition, etc., would assist policymakers in preparing conservation and resource management policies.

#### 4. CONCLUSION

The average catch rate was  $25.03 \text{ kg h}^{-1}$  and  $31.72 \text{ kg h}^{-1}$  with average discards  $5.07 \text{ kg h}^{-1}$  and  $7.81 \text{ kg h}^{-1}$  by multi-day trawler during 2016–17 and 2017–18. Peak fishing activities were observed during October to December followed by February and April in terms of landings. Catch composition of commercially operated multi-day trawlers off Sindhudurg coast, in terms of mean landings *Rastrelliger kanagurta* was the major species followed by *Lepturacanthus savala* and *Otolithus cuvieri*.

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