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Structural changes in the mechanised fishing fleet of Kerala, South India

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ABSTRACT

Kerala State situated in the south-west coast of India, has traditionally been the foremost fishery area of the Indian sub-continent. With increasing fishing pressure in the coastal waters, fishermen operating in mechanised sector were forced to venture in to deeper waters in search of newer fishing grounds in order to maintain their catches. Marine fisheries have undergone significant changes since the 1950s and the changes in number and capacities of fishing vessels have been more significant in the last decade. In this paper, an attempt has been made to compare the structural changes in terms of length overall (L_{OA}) and installed engine horsepower among three commercially important fishing practices *viz*., trawling, purse seining and gillnetting in Kerala, over the last decade. The results have shown large scale changes in the structure of the fishing fleet in terms of size and installed engine horsepower among trawlers, purse seiners and gillnetters operating off Kerala. The study indicated an exponential growth in engine horsepower among trawlers above 18 m in L_{OA}, in recent years. This paper also points out the need for regulating capacities of the fishing vessel in order to conserve fuel and reduce greenhouse gas (GHG) emissions.

Keywords: Engine horsepower, Gillnetter, Kerala, Length overall, Purse seiner, Trawler

Introduction

In India, fisheries is an important sector which plays a significant role in creating job opportunities, enhancing income as well as foreign exchange earnings and availability of protein rich food. India was ranked fifth in the world capture fishery production, during 2011 (FAO, 2013). The annual potential yield from the Exclusive Economic Zone (EEZ) of India has been re-validated at 4.42 million t, of which 3.84 million t is from the zone up to 100 m depth and 0.58 million t is from deeper waters (GOI, 2011). The present catch of 3.82 million t (2011) (CMFRI, 2013) forms 86.45% of the re-validated fishery potential and is largely derived from the intensively fished coastal zone.

Kerala State, situated in the south-west coast of India, has traditionally been the foremost fishery area of the Indian sub-continent (CMFRI, 2013). It has a coastline of 590 km and a continental shelf area of 39,139 sq km. Kerala ranked first in marine fish production among the maritime states of India, contributing about 19% of the total marine landings (0.74 million t) during 2011 (CMFRI, 2013). Marine fishing fleet in Kerala consists of 4,722 (21.7%) mechanised, 11,175 (51.3%) motorised and 5,884 (27.0%) non-motorised fishing vessels (CMFRI, 2012). The marine landings are mainly contributed by the mechanised (56%) and motorised (42%) sectors (Mohamed *et al*., 2013). With increasing fishing pressure in the coastal waters, fishermen operating in the mechanised sector are forced to go to deeper waters in search for newer fishing grounds in order to maintain their catches. Marine capture fisheries in Kerala, have gone through significant changes since 1950s and the changes in number and capacities of fishing vessels have been more pronounced in the last decade. Excess fleet capacity and increased fuel consumption by the mechanised fisheries have been worsening over the years. In this paper, an attempt has been made to compare the structural changes in terms of length overall (L_{OA}) and installed engine horsepower among three commercially important fishing practices, *viz*., trawling, purse seining and gillnetting in the marine fisheries sector of Kerala, over the last decade.

Materials and methods

Data on length overall and engine horsepower of mechanised fishing vessels, *viz.,* trawlers, purse seiners and gillnetters operating in Kerala were sourced from Fishing Vessel Registration Database of the Marine Products Export Development Authority (MPEDA). Data pertaining to 637 trawlers forming 17% of the total trawlers, 27 purse seiners forming 45% of the total purse seiners and 18 gillnetters comprising 4% of the total gillnetters in the state, registered during 2008-2012, were taken for the present analysis. Additional information regarding mechanised fishing vessels and engines were collected from fishermen, dealers of marine engines, and boatyard operators using structured questionnaires. Details of vessel characteristics and horsepower in vogue during the last decade were obtained from Boopendranath (2000). The data were analysed using standard statistical procedures (*viz.,* frequency analysis and exponential modelling) using SAS 9.3, in order to ascertain the decadal changes that have taken place in terms of vessel size and horsepower, in the mechanised fisheries sector of Kerala.

Results and discussion

The growth pattern of mechanised fishing fleet in Kerala, during 1980-2010 period, is given in Fig. 1. The number of mechanised vessels increased from 983 in 1980, to 5088 in 1998, 5504 in 2005 and decreased to 4722 in 2010 (Anon 1981; CMFRI, 2006; DOF 2007; CMFRI, 2012). Trawlers constituted 76% of the mechanised fleet of Kerala in 1980, 88% in 1998 and 72% in 2005. In 2010, trawlers constituted about 77.9% of the total mechanised fleet of Kerala, followed by purse seiners and mechanised ring seiners (11.8%), gillnetters (9.7%) and liners (0.6%) (CMFRI, 2012). There were about 8 mechanised vessels per kilometre of coastline in Kerala during 2010.

Trawlers

About 4,722 trawlers are operating from Kerala (CMFRI, 2012) and the fleet consists of small, medium and large trawlers (Kurup *et al.,* 2009). Trawling is the most demanding fishing method in terms of energy consumption when compared to gillnetting, longlining, ring seining and purse seining (Gulbrandsen, 1986; Aegisson and Endal, 1993; Boopendranath, 2009).

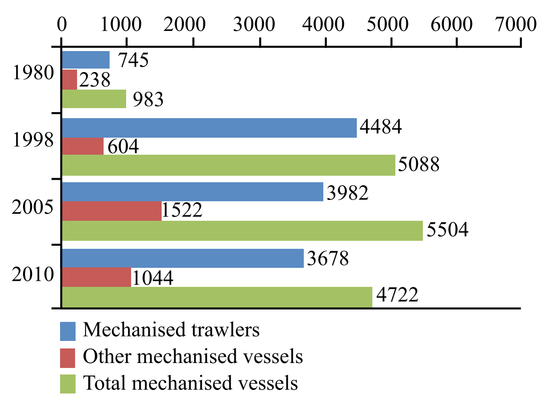

Fig. 1. Increase in number of mechanised trawlers, other mechanised vessels and total marine fishing fleet in Kerala during 1980-2010 (Source: Anon 1981; CMFRI, 2006; DOF 2007; CMFRI, 2012)

Frequency distribution of length class of trawlers

A comparison of frequency distribution of length classes of trawlers operating from Kerala is shown in Fig. 2. During the year 2000, almost 56% of trawlers were of length class 13-14 m L_{OA}, followed by 12-13 m (12.3%), 11-12 m (9.1%), 14-15 m (8.4%), 10-11 m (5.8%), 15-16 m (4.6%) and 9-10 m (3.9%). During 2012, the most dominant length class (40.6%) was 19-20 m L_{OA}, followed by 20-21 m (15.9%), 18-19 m (10.7%), 17-18 m (6.1%), 21-22 m (5.2%) and representation by other length classes were below 4%. During 2012, length classes ranged from 9-10 m to 22-23 m L_{OA}, whereas during 2000, the range extended from 9-10 m to 15-16 m L_{OA}, showing a significant shift in the preferred size of trawlers.

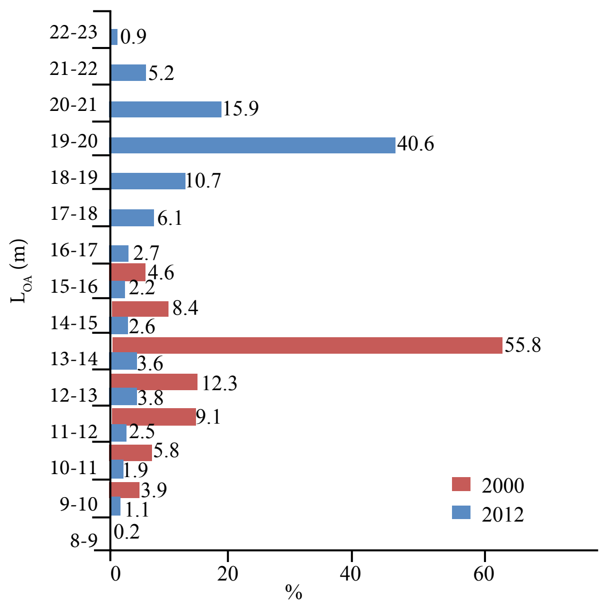

Fig. 2. Frequency distribution of length classes of trawlers in Kerala

Frequency distribution of installed engine horsepower of trawlers

Frequency distribution of engine horsepower (hp) of trawlers, during 2000 and 2012 are represented in Fig. 3. The engine horsepower in trawlers, during the year 2000, ranged between 50 and 150 hp, whereas in 2012, engine horsepower extended up to 495 hp. Engines with 100-150 hp were widely used (62.3%) during 2000, followed by engines with 50-100 hp (37.5%). During 2012, 24.7% of the trawlers were using engines with 100-150 hp, 18% with 150-200 hp, 16.8% with 300-350 hp and 16.2% with 250-300 hp. Trawlers with engines higher than 350 hp were 13.7% and those using less than 100 hp were 5.3%. Use of high horsepower engines in trawlers coincided with the adoption of high speed trawling using fish trawls with large trawl mouth and having large meshes in the front trawl panel sections, for harvesting fast moving fishes.

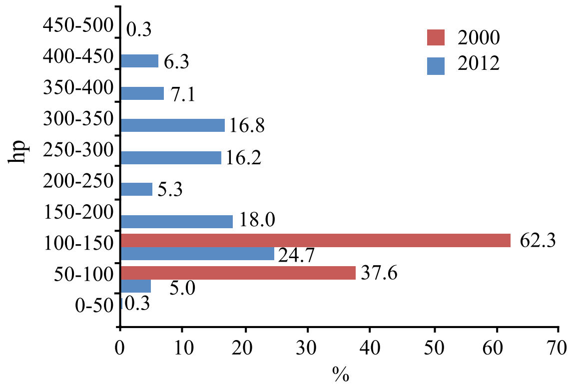

Fig. 3. Frequency distribution of installed horsepower of trawlers in Kerala

Relationship between length and engine horsepower of trawlers

The relationship between length and engine horsepower of trawlers during the year 2012 is shown in fig. 4. The scatter plot of overall length vs. engine horsepower of trawlers exhibited an exponential relation. The simple exponential function of the form Engine horsepower = a*exp (b*length) was fitted by Levenberg marquardt algorithm using SAS 9.3. The resultant model is given by the equation:

Engine horsepower $=14.625^{*}\exp^{0.147*LOA}$; $R^2 = 0.602$

Fig. 4. explains the relationship between engine horsepower and length overall, with moderate R^2 value in terms of observed and predicted value. The rate of change of engine horsepower (hp) was 0.147 with respect to change in the L_{OA}. The exponential growth of engine horsepower was evident in trawlers with L_{OA} greater than 18 m.

Frequency distribution of makes of engines installed in trawlers

Fig. 5 depicts the frequency distribution of different makes of engines installed in trawlers operating from Kerala, during 2012. Marine diesel engines from 13 different manufacturers were prevalent. Ashok Leyland (India) marine diesel engines were most popular (57.3%), followed by Sinotruk (China) (15.9%), Weichai Power (China) (14.8%), Cummins (USA) (3.5%), Yuchai (China) (2.8%) and Caterpillar (USA) (1.4%). Representation of Ruston (England), Greaves (India), Wandi (China), MWM (Brazil), Hino (Japan) and Tata Cummins (India-USA) were 0.5% or less. Ashok Leyland (India) collaborates with Weichai Power (China) in marketing marine diesel engines in India.

Purse seiners

Purse seining is an active fishing method for harvesting of shoaling fishes and propulsion is required for reaching and returning from fishing ground and for operation of the gear. About 60 purse seiners operated from Kerala (CMFRI, 2012).

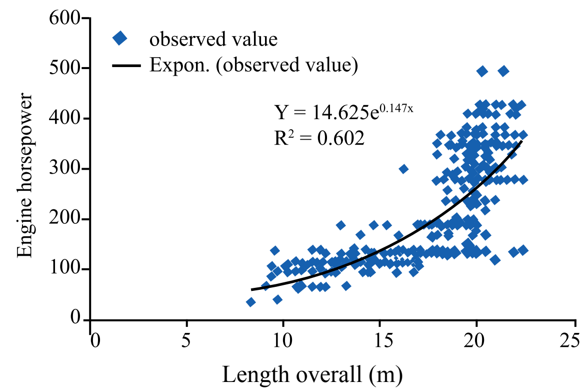

Fig. 4. Relationship between length and engine horsepower of trawlers during 2012

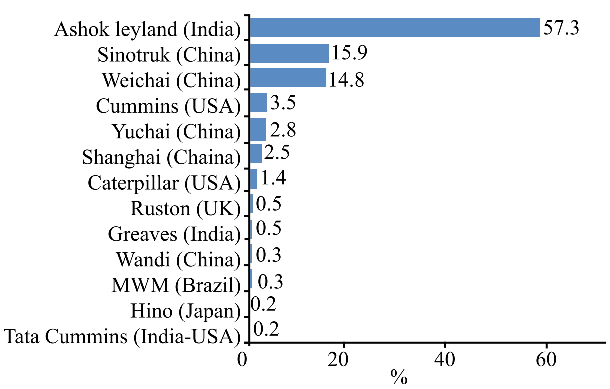

Fig. 5. Frequency distribution of different makes of engines installed in trawlers operating from Kerala, during 2012

Frequency distribution of length classes of purse seiners

A comparison of frequency distribution of length classes of purse seiners of Kerala is given in Fig. 6. During the year 2000, the dominant length class of purse seiners was 15-16 m L_{OA} (21.2%), followed by 14-15 m and 13-14 m (19.7% each), 12-13 m and 16-17 m (13.6% each), 17-18 m (10.6%) and 18-19 m (1.5%). Significant increase in the sizes of purse seiners were observed during 2012. Dominant length class during 2012 was 19-20 m L_{OA} (37%), followed by 18-19 m (25.9%), 17-18 m (14.8%) and 20-21 m (7.4%). Representation of length classes exceeding 21 m and less than 17 m were 3.7% each. During 2012, length classes of purse seiners ranged up to 21-22 m, while, during 2000, the range was only up to 18-19 m L_{OA}.

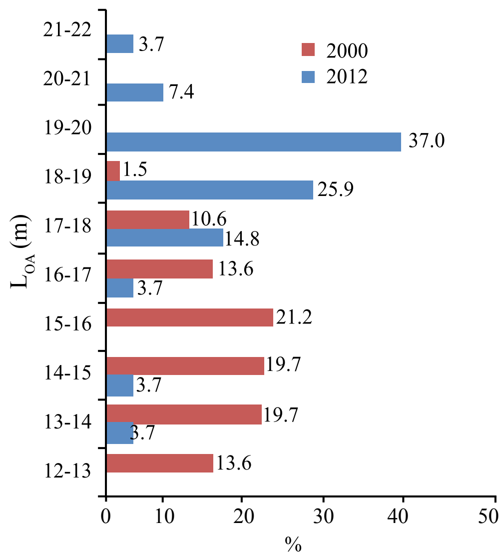

Fig. 6. Frequency distribution of length classes of purse seiners in Kerala

Frequency distribution of installed engine horsepower of purse seiners

Comparison of frequency distribution of installed engine horsepower among purse seiners of Kerala is shown in Fig. 7. During 2000, majority of the purse seiners (55.3%) had engines with 100-150 hp (55.3%), followed by 150-200 hp (44.7%). In 2012, engines with horsepower in the range of 150-200 gained dominance (37.0%), followed 100-150 hp (25.9%), 250-300 hp (22.2%), 300-350 hp (7.4%), 200-250 hp and 350-400 hp (3.7% each). The upward trend in the engine horsepower, coincided with increase in size of the purse seines deployed.

Gillnetters

Gillnetting is a passive method and propulsion is used for reaching the fishing ground, deployment of the gear and return to the base. About 460 gillnetters are operating from Kerala (CMFRI, 2012).

Frequency distribution of length classes of gillnetters

Frequency distribution of length classes of gillnetters in Kerala (Fig. 8) shows that, during the year 2000, gillnetters of length class 9-10 m L_{OA} (53%) dominated in the fleet, followed by 10-11 m (31.3%), 7-8 m (7.5%), 8-9 m and 12-13 m (3.8% each), 11-12 and 13-14 m (1.3% each). During 2012, the length classes 10-11 m, 14-15 m, 16-17 m and 17-18 m were the dominant classes (16.7% each), followed by 12-13 m (11.1%); 18-19 m and 19-20 m (5.5% each). During this period there was a conspicuous increase in the size of the gillnetters compared to the previous years.

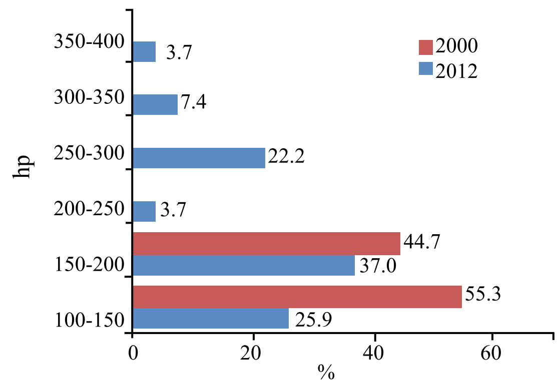

Fig. 7. Frequency distribution of installed horsepower of purse seiners in Kerala

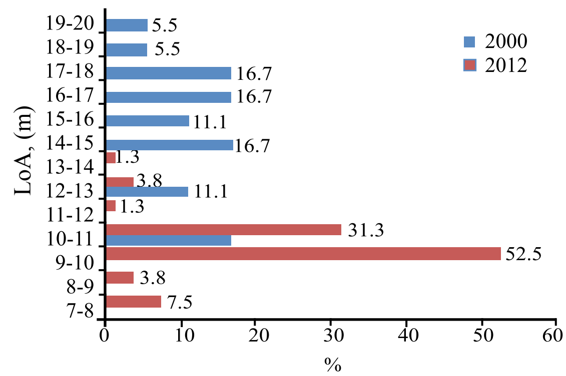

Fig. 8. Frequency distribution of length classes of gillnetters in Kerala

Frequency distribution of installed engine horsepower of gillnetters

Comparison of distribution of installed engine horsepower among gillnetters of Kerala, during 2000 and 2012 (Fig. 9) indicates that marine diesel engines with horsepower of 60-80 hp (52.3%) dominated the fleet during 2000, followed by engines with less than 60 hp (36.4%) and 80-100 hp (11.4%). There was a significant increase in the engine horsepower during 2012 with lower representation of 60-80 hp (5.6%) and 80-100 hp (16.7%) and higher representation of 100-120 hp (33.3%) and 120-140 hp engines (44.4%) in the fleet.

A decade ago, fishing vessels in Kerala were largely dependent on marine diesel engines of Indian origin with horsepower rating up to 193 hp, for powering the mechanised vessels (Boopendranath, 2000). During the last 4-5 years, there is an increasing tendency among the operators of trawlers, purse seiners and mechanised ring seiners to install high horsepower engines (Baiju *et al.*, 2012; Mohamed *et al.*, 2013). Majority of high horsepower engines used in mechanised vessels of Kerala include Chinese makes such as Sinotruk, Weichai Power,

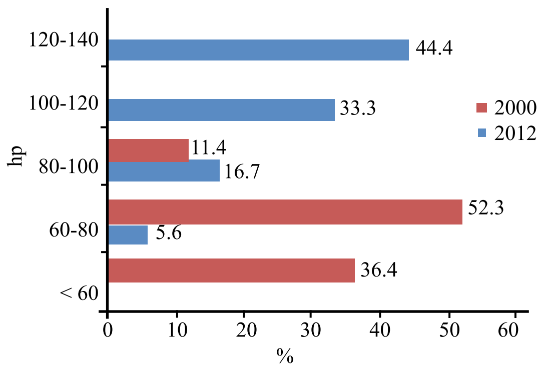

Fig. 9. Frequency distribution of installed engine horsepower of gillnetters in Kerala

Yuchai and Shanghai and high horsepower engines from Ashok Leyland in collaboration with Weichai Power.

Optimum fleet size of mechanised vessels for marine fishing off Kerala were estimated at 3030 and 3143, respectively by Kurup and Devaraj (2000) and Sathianandan *et al.* (2008). According to these estimates, the existing number of mechanised vessels in Kerala (CMFRI, 2012) are in excess by 50-55% than optimum fleet size. A recent estimate based on revalidated potential yield of fishery resources in the Indian Exclusive Economic Zone has given optimum mechanised fleet size as 4032 for Kerala, consisting of 3610 trawlers, 316 purse seiners and mechanised ring seiners and 72 gillnetters (Mohamed *et al*., 2013). According to this estimate, the existing number of mechanised vessels in Kerala (CMFRI, 2012) are in excess by about 17% than required fleet size.

Though the number of mechanised fishing vessels in Kerala has shown a decrease by 14% between 2005 and 2010 census periods (CMFRI, 2006; 2012), fishing power of a considerable percentage of individual fishing units has significantly increased due to increase in installed engine horsepower, vessel capacities, improved navigation, fish detection capabilities and improved efficiency of fishing gear systems, in recent years, as evident from the present study as well as other studies (Boopendranath, 2009; Kurup *et al*., 2009; Pillai *et al*., 2009; Baiju *et al*., 2012; Mohamed *et al*., 2013). The results of the present study points to the need for optimising and regulating capacities of the fishing vessels based on their area/ depth of operation, in order to mitigate negative impacts on resources, conserve fuel and reduce greenhouse gas (GHG) emissions, which has been highlighted in several studies (Bhathal and Pauly, 2008; Boopendranath, 2009; 2012; Kurup *et al*.,2009; Baiju *et al*., 2012; Mohamed *et al*., 2013).

The results have demonstrated large scale changes in the structure of the mechanised fishing fleet of Kerala, both in terms of size and installed engine horsepower among trawlers, purse seiners and gillnetters, during the last decade. The study indicated an exponential increase in engine horsepower, in recent years, among trawlers above 18 m in L_{OA}. With increasing fishing pressure in coastal waters and diminishing returns, the area of operation of mechanised fleet has further extended to deeper waters and vessels with larger size, power and capacities equipped for multiday fishing have become popular. The study also suggests the need to account for the increase in the fishing capacity of the vessels while planning for fishing fleet restrictions.

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