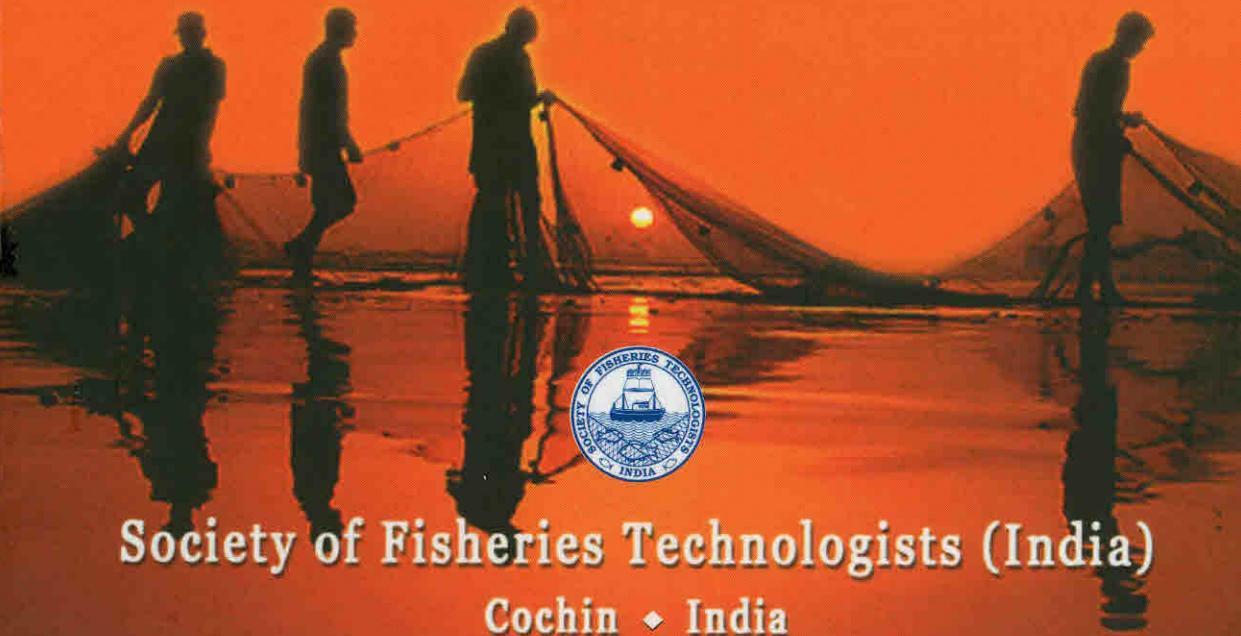


Coastal Fishery Resources of India

• Conservation and Sustainable Utilisation



Society of Fisheries Technologists (India)

Cochin ♦ India

Coastal Fishery Resources of India: Conservation and Sustainable Utilisation

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Gillnet Fishing in India

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Gillnets are of special interest to small-scale fishermen, due to the simple design, low investment, high energy efficiency and the requirement of only simple non-specialised small craft for their operation. Being a low energy fishing method, gillnet fishing is favoured in recent years in the context of escalating fuel costs. It is a highly selective gear, as the fish of a particular size in relation to the selected mesh size only is caught while smaller fishes are able to escape. With appropriate selection of mesh size, overexploitation and capture of juveniles can be avoided and bycatch can be reduced to a minimum, as not many species other than the targeted fishes will be caught. It is a low energy fishing method using relatively low powered vessels expending fuel only for propulsion and not for actual fishing operation.

The introduction of synthetic fibres and mechanization of fishing operations helped gillnet fishing to become a popular fishing system in the world, in both small-scale and large-scale sectors. As the scale of operation increases, the advantages of the gear decrease and the method becomes labour and capital intensive. Drift gillnets made of polyamide monofilament or multifilament netting measuring up to 8-12 m deep and extending up to 60 km were called by environmentalists as 'walls of death' (Anon, 1992). Over the years, there has been a tendency to use nets of increasingly larger dimensions. Gibson (2009) reported an illegal drift gillnet of 130 km long with Antarctic toothfish from the Antarctic waters. Bycatch in drift gillnets may include sea birds, cetaceans and sea turtles.

Gillnetting though considered as a highly selective and responsible fishing method, of late, this gear has invited criticism due to the problem of ghost fishing associated with the lost gear, unwanted bycatch and low quality of fish caught in set nets. These allegations caused a world wide ban on large-scale driftnet fishing in the high seas by the United Nations in 1991 (UN Resolution 46/215). Apart from ghost fishing, the lost fishing gear adds to marine debris. The derelict fishing gear entangled in coral reefs are difficult to recover without damaging the corals (Matsuoka *et al.*, 2005).

In this paper, an overview of gillnet fishing in India, in terms of material, fleet size, selectivity, net configuration, energy efficiency and incidence of bycatch including juveniles is given and an attempt is made to find out how responsibly this gear is operated in Indian waters.

Gillnet fisheries of India

Marine capture fisheries sector provides livelihood security for about 3 million fishermen residing in over 3600 fishing villages in India (Anon, 2005). The country's fishing fleet includes about 0.24 million crafts and 5.1 million fishing gears (Anon, 2005). Out of the 5.1 million units of fishing gears operated, 83% are gillnets. The gillnet fisheries of India are considered to be the mainstay of the artisanal sector, comprising of small-scale localised operations. Oceanic gillnetting as a commercial enterprise in which modern technologies and large-scale capital expenditure are applied to catch, store and process the fish onboard the fishing vessel has not come to Indian waters, so far (Northridge, 1991).

Gillnet fisheries of India is classified into non-motorised, motorised and mechanised sectors, based on the size of the craft and method of propulsion. Luther *et al.* (1997) classified gillnets into small mesh and large mesh gillnets taking 45 mm as the cut off mesh size. Under the small mesh nets, the mesh size ranges between 14 and 45 mm, while large mesh gillnets have mesh size above 45 mm and up to 400 mm with mesh size up to 160 mm being common. CMFRI re-classified gillnets into three categories, *viz.*, small, medium and large, based on mesh sizes. Gillnets having mesh size below 45 mm were categorised as small, those between 45 and 70 mm as medium and those above 70 mm as large (Anon, 2005). The non-motorised sector operate small and medium mesh gillnets from kattamarams, dugout and plank built canoes (3.03-7.6 m L_{OA}) targeting at sardines, mackerel, prawns, mullets, anchovies and other miscellaneous fishes. The motorised sector operate small, medium and large mesh gillnets. Gillnets of small and medium fleet size weighing 10 to 30 kg are operated from plank built canoes, dugout canoes and kattamaram (7.6 -9.1 m L_{OA}) fitted with outboard engines (OBM) up to 15 hp targeting mackerel, sardines, anchovies, and pomfrets while the large mesh gillnets weighing up to 300 to 400 kg are operated from dugout, plywood and plank built canoes (7.6-12.1 m L_{OA}) fitted with 15-25 hp outboard engines targeting seerfishes, tunas and sharks. The mechanized fishing vessels (9.1 -13.6 m L_{OA}) fitted with 60-90 hp inboard diesel engines employ large mesh gillnets weighing 300-800 kg and target seerfishes, tunas and sharks.

Netting material

The small, medium and large mesh gillnets are almost exclusively made of polyamide (PA) while large mesh nets operated in Gujarat area and to a lesser extent in Andhra Pradesh and Tamil Nadu are made of high density polyethylene (HDPE). The common gillnet materials and their specifications are given in Table 1.

Table 1: Netting specifications of commercial gillnets operated in India

	Non-motorised sector		Motorised sector	Mechanised sector
	Small mesh gillnets	Small mesh gillnets	Large mesh gillnets	Large mesh gillnets
Mesh size	14-70 mm	14-70 mm	70-400 mm	70-400 mm
Material	<ul style="list-style-type: none"> ▪ PA monofilament (0.16 - 0.23 mm dia) ▪ PA multifilament (210dx1x2 - 210dx1x3) 		<ul style="list-style-type: none"> ▪ PA monofilament (0.6 - 0.8 mm dia) ▪ PA multifilament (210dx5x3 - 210dx24x3) ▪ HDPE twisted monofilament (2-2.5 mm dia) 	
Hanging coefficient	0.49 - 0.70		0.44 - 0.65	

Early 1990s witnessed the rapid introduction of nylon monofilament gillnets and by early 2000 monofilament almost completely replaced nylon multifilament in the small mesh gillnet sector as well as large mesh nets targeted at pomfrets, mackerel and small tuna in many states of India (Vijayan *et al.*, 1993; Rao *et al.*, 1994; Pravin *et al.*, 1998; Pravin and Ramesan, 2000; Thomas, 2001; Thomas *et al.*, 2005). However, monofilament gillnets could be a considerable threat to marine species (Ayaz *et al.*, 2006). The tendency is towards using increasingly thinner netting twines. Until 2005, the lowest diameter of PA monofilament yarn used for fabrication of gillnets was 0.16 mm (Thomas *et al.*, 2005). By 2008, PA monofilament yarn as thin as 0.12 mm was available in the field (Thomas *et al.*, 2008). Now-a-days, fishermen prefer for monofilament gillnets made of 0.12 and 0.14 mm dia, which they call as 'superfine nets' (Sambasivan, pers. comm.). The widespread use of nylon monofilament of very thin diameter has to be monitored cautiously as this material lasts hardly for one fishing season spanning 3-6 months. Unlike nylon multifilament, it is difficult to mend monofilament netting of very thin twine

diameter and hence fishermen discard the derelict nets in the beach or in the coastal waters raising issues of marine debris and ghost fishing. If not strictly regulated, derelict and discarded gillnets made of monofilament netting with very small twine diameter may become a major problem, increasing plastic debris and incidence of ghost fishing in the coastal environment, in the coming years.

Fleet size

The use of synthetic netting, introduction of OBMs and mechanisation of propulsion in fishing vessels revolutionized the industry by a rapid increase in the quantity of nets used. Besides, the urge to catch more by using larger nets also resulted in increase in the fleet size. There has been a significant increase in the quantum of nets taken for operation over the last five decades indicating a significant increase in the fishing effort (Table 2).

Table 2: Changes in dimensions of gillnet units used in marine fisheries of India

Period	Gillnet dimensions (Length x Depth, m)	
	Small mesh gillnets	Large mesh gillnets
1950s	150 x 2	150 x 3
1990s	500 x 5	450 x 5
Early 2000s	800 x 6	2,500 x 12
Late 2000s	800 x 7	10,000 x 18

The drift gillnets of India which was small-scale in nature, till early 2000s, showed a clear shift to the large scale operations, at least in certain pockets of the country. The fishermen from Tamil Nadu operating from Kerala, uses large mesh gillnets targeting sharks, tunas, sailfish and other large pelagics, with fleet lengths up to 10,000 m and hung depth up to 18 m (Sebastian, pers. comm.). This is a clear indication of the shift in the scale of operations taking place in the Indian gillnet fisheries sector.

Selectivity

Selectivity in gillnets mainly depends on the mesh size and mesh configuration, which in turn, is influenced by the hanging coefficient. Table 3 shows optimum mesh size worked out for some of the

commercially important fishes. However, a wider spectrum of mesh sizes is used in the commercial fisheries, which may differ from the optimum. The fleet of gillnets operated in commercial fisheries often consists of units of more than one mesh size attached end to end. This results in different species and different size groups of same species in the landings. Thus, in spite of the known selectivity of gillnet for a particular narrow size range of fishes, the use of different mesh sizes results in the landing of a wide size range of the species and size groups.

The hanging coefficient of the small mesh gillnets is typically 0.5, ranging between 0.49 and 0.70. For large mesh gillnets targeting species such as pomfrets and mackerel, it is around 0.5 while that for seerfishes, tunas and sharks, the hanging coefficient is around 0.45 ranging between 0.41 and 0.65 (Thomas *et al.*, 2005). Sainsbury (1996) suggested that for gilling the fish, hanging coefficient is usually between 0.5 and 0.66 with 0.6 being common. As the hanging coefficient decreases below 0.5, there are chances of entangling resulting in non-uniformity in the size class of fishes caught. Due to the multi-species nature of the Indian fishery, it is a common practice among fishermen to rig nets at hanging coefficient of 0.5 and just above so that both gilling and entangling are effective covering fish species of different body shapes.

Though gillnets are considered as highly selective, there has been reports that in the coastal waters of India, juveniles and non-target species are landed using multi-mesh gillnets and gillnets with mesh sizes smaller than the optimum for a particular target species (Luther *et al.*, 1994; Jude *et al.*, 2002a; 2002b; Thomas and Hridayanathan, 2003; Muthiah *et al.*, 2003). In Andhra Pradesh, in trammel net, mesh size of inner panel has been reduced from 50 to 20 mm and of outer panel from 250 to 100 mm.

Energy efficiency

Gillnet fishing is a highly energy efficient fishing method which consume only 0.15-0.25 kg of fuel per kg of fish caught, compared to trawling which consumes 0.8 kg (Gulbrandsen, 1986). Thomas (2001) reported that gillnets operated in coastal waters of Kerala, consumed 0.46 kg of fuel per kg of fish caught.

Fuel cost has become a significant input in the operational costs, with the advent of motorization and mechanization. The average revenue realised per rupee spent on fuel for motorised small mesh gillnets and

Table 3: Optimum and commonly used gillnet mesh sizes in commercial fisheries

Gillnet type	Targeted fish	Commonly used mesh sizes in commercial fisheries (mm)	Optimum mesh size (mm)	Reference
Sardine net	Indian oil sardine (<i>Sardinella longiceps</i>)	30, 32, 33, 36, 38, 40	33.4	Joseph and Sebastian (1964)
Mackerel net	Indian mackerel (<i>Rastrelliger kanagurta</i>)	38, 40, 50, 52	50	Mathai <i>et al.</i> (1993)
Seer drift net	Narrow-barred Spanish mackerel (<i>Scomberomorus commerson</i>)	70, 90, 100, 110, 120, 140, 170	152	Sulochanan <i>et al.</i> (1975)
Seer drift net	Indo-Pacific king mackerel (<i>Scomberomorus guttatus</i>)	65, 70, 90, 100	104	Sreekrishna <i>et al.</i> (1972)
Pomfret net	Silver pomfret (<i>Pampus argenteus</i>)	110, 116, 120, 130	126	Panikkar <i>et al.</i> (1978)
Prawn net	Indian white shrimp (<i>Fenneropenaeus indicus</i>)	32, 34, 36, 38, 48, 50, 52	38	George (1991)
Tuna drift net	Frigate tuna (<i>Auxis thazard</i>)	60, 65, 70, 90, 100, 115	84	Jude <i>et al.</i> (2002a)
Tuna drift net	Kawakawa (<i>Euthynnus affinis</i>)	60, 65, 70, 90, 100, 115	104.2	Jude <i>et al.</i> (2002b)
Sardine net	Goldstripe sardinella (<i>Sardinella gibbosa</i>)	25, 26, 28, 30, 32	29.6	Neethiselvan <i>et al.</i> (2001)
Sardine net	Spotted sardinella (<i>Amblygaster sirm</i>)	25, 26, 28, 30, 32	30.5	Neethiselvan <i>et al.</i> (2000)

mechanized large mesh gillnets during 1989-90 were Rs. 8.60 and 9.95, respectively (Panikkar *et al.*, 1993). During 1999-2000, the corresponding figures were 4.55 and 6.08, respectively (Thomas, 2001). Increase in engine power and escalation in fuel price has caused the fall in the revenue (Thomas, 2001). A comparison of the revenue realisation related fuel expenditure for different categories of gillnet units and ring seine units, is given in Fig.1. The revenue per rupee of fuel for ring seine during 1995-96 was Rs. 3.24 (Edwin, 1997). It shows that gillnetting in the coastal waters of India is more fuel-efficient than even a bulk catching method like ring seine.

Bycatch problem

In gillnets, bycatch comprise non-targeted fish species including juveniles of target species, marine mammals, sea turtles and sea birds. Luther and Appanna (1993) reviewed the size composition of species from

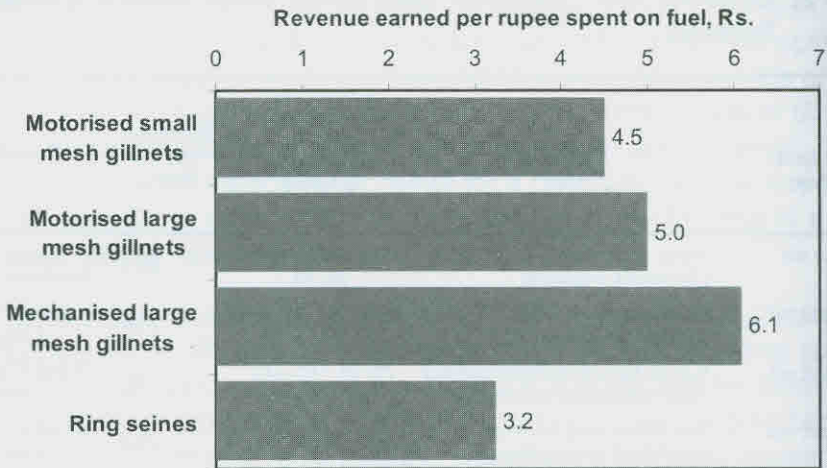


Fig. 1: Comparative fuel efficiency of gillnet and ring seine operations (Source: Thomas, 2001; Edwin, 1997)

the gillnet landings in the various locations of India and reported that the bulk of the landings comprised of juveniles. Luther *et al.* (1994) reported the landing of juveniles of lesser sardines by gillnets of less than 28 mm mesh size and stressed the need to regulate gillnet fishing. *Sardinella gibbosa* caught in gillnets with mesh size of 23 mm and below were 100% juveniles, while in 30 and 32 mm mesh gillnets, no juveniles were caught. A form of gillnet known as *podivalai* in vernacular, operated along the Tuticorin coast, which has a mesh size range of 70-100 mm, landed exclusively small sized seerfishes (Muthiah *et al.*, 2003).

The threat to marine turtles by gillnets is a serious problem in India. This is more pronounced along the coasts of West Bengal, Orissa, Andhra Pradesh and Tamil Nadu. Orissa coast is one of the four significant arribada beaches of the olive ridley sea turtle in the world and nesting usually occurs during December – January and March – April. About 90% of the incidental turtle catch occurred in the east coast and the rest in the west. Out of the total 1880 turtles incidentally caught, 61% was caused by gillnets, followed by trawls, 13.7% (Anon, 2000). Bhupathy and Karunakaran (2003) reported that there is high adult mortality (12% females) due to the incidental catch of sea turtles in gillnets, along the Nagapattinam coast of Tamil Nadu. As there is no effective mechanism to prevent incidental catch of turtles in gillnets, fishery closures in areas of intense nesting during the nesting period is the only possibility.

Entanglement of marine mammals in gillnets has been reported wherever marine mammals and substantial gillnetting occur in the same area (Jefferson and Curry, 1994). Twenty-two species of marine mammals have been catalogued from the seas around India and as all marine mammals are protected under the Indian Wildlife Protection Act 1972, there is no organized exploitation for these animals. However, there have been illegal catches of the dugongs, which go either unnoticed or unreported (Rajagopalan and Menon, 2003). There is no reliable data on the number of mammals, which are caught incidently or illegally. The available data on marine mammals from the Indian seas are drawn mostly from capture or stranding reports from different parts of the coast and stored in the National Marine Living Resource Data Centre (NMLRDC) of Central Marine Fisheries Research Institute, Cochin. The data mostly relate to whales, dolphins and dugongs. Yousuf *et al.* (2009) estimated that 9000–10,000 cetaceans are killed by gillnets every year along the Indian coast. A total of 44 cetaceans was recorded as incidental catches at Chennai, Kakinada and Mangalore fishing harbours during 80 days of observation (Yousuf *et al.*, 2009). Anon (2010) reported that 50% of the dolphin mortality occurring in the Chilka lake in Orissa was due to gillnets. Chilka is home to about 158 Irrawaddy dolphins listed as 'vulnerable' in the IUCN Red list of threatened species. Between 1995 and 2007, 51 dolphin deaths were documented, 74% of which was caused by entanglement in gillnets (Anon, 2010). Reports on bird mortality from gillnets are almost nil from India.

Ghost fishing

There are no authentic reports on ghost fishing from Indian waters. The use of gillnets of very thin PA monofilament yarn (0.12 to 0.16 mm dia) which lasts hardly for 3 to 6 months is very common in all the states of India, both in the marine as well as inland water bodies (Thomas *et al.*, 2005). This is going to create ghost fishing problem in the coming years as these nets are not repaired and tonnes of monofilament nets are abandoned in the sea, reservoirs etc. A comparison of ghost fishing by monofilament and multifilament gillnets has shown that monofilament gillnets poses considerable threat to marine species once control of the nets is lost (Ayaz *et al.*, 2006).

Mitigation measures

The use of multi-mesh gillnets, very small mesh sizes, and very thin PA monofilament yarn for fabrication of the nets, and uncontrolled increase

Promoting use of multifilament netting material as well as the use of biodegradable seams can mitigate unaccounted mortality caused by ghost fishing by lost gillnets. Use of acoustic scaring devices such as pingers has been reported to reduce bycatch of harbour porpoises (Kraus *et al.*, 1997; Trippel *et al.*, 2003). Use of netting treated with barium sulphate which makes the nets acoustically reflective and stiffer has been reported to reduce the incidental catch of marine mammals and birds in gillnets (Mooney *et al.*, 2007).

Conclusion

On the whole, Indian gillnet sector can still be considered as small scale as generally nets up to 2.5 km long are deployed. However, the tendency towards large-scale operations is becoming evident, due to increasing trend in the vessel capacities and fleet lengths of gillnets. Monitoring and documentation of bycatch of cetaceans, sea turtles and sea birds are essential on a regular basis, in Indian waters. From the limited data available, the incidental capture of dolphins and other marine mammals in the large mesh gillnets is quite insignificant in the Indian seas, compared to the Pacific, Atlantic and Indian Oceans. PA monofilament gillnets using very thin yarns need to be used cautiously and there should be secure arrangements for disposal of derelict and abandoned gillnets.

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