Description of tuna gillnet capacity and bycatch in the IOTC Convention Area

Martín Aranda[1]

1. Introduction

Fisheries in the Indian Ocean are dominated by artisanal activities. Most of the coastal developing nations bordering the Indian Ocean rely on artisanal fisheries for the provision of food and income. The dominance of artisanal fleets in the region brings about, however, large uncertainty in data collection. The lack of data may undermine the scientific process and the effectiveness of the subsequent conservation and management measures (CMM). Part of the artisanal fleet possess high navigational autonomy and large production means e.g. gillnets exceeding allowed lengths. This activity is not yet officially defined as semi-industrial and is not subject to restrictions in place for industrial vessels (Vessel Monitoring System and restrictions on fishing capacity). High fishing pressure in coastal areas may also motivate expansion of activities in the high seas. This is particularly relevant in the cases of Iran and Pakistan (Anderson 2014). The inability of enforcing controls in the high seas and national EEZs, the relative ease to access to the gillnet activity and the low exigencies in quality of the local markets are likely encouraging the building of fishing capacity in artisanal and semi-industrial fisheries, which utilizes gillnet as the predominant fishing technology. Local markets absorb catches that otherwise will be discarded due to low value or lack of local demand. Thus, the low selectivity of this fishing technology may not be an impediment for the expansion of this modality of fishing.

This constitutes a threat for tuna and tuna-like species due to the high bycatch of young tuna individuals and other bonny fish, and for biodiversity as a significant share of the bycatch comprises sharks, marine mammals, turtles, and to a lesser extent seabird. One of the main difficulties to be faced to accurately manage the fisheries in this region is the institutional technical capacities of coastal nations to collect and submit data for artisanal fisheries e.g. lack of logbooks, observers on board and VMS in most cases. Despite the scarce data available it seems that gillnet fisheries in the Indian Ocean appear to have a meaningful level of bycatch of sensitive species much higher than that of other fishing technologies such as purse seine, pole and line and even longline (Ardill et al 2013). The real size of the artisanal fishing capacity remains uncertain despite the efforts conducted by diverse institutions and scientists, inter alia Moreno and Herrera (2013), to estimate the size of the artisanal fleet, and especially of the gillnet sector. The need to assess the extent of gillnet fisheries has been remarked by the IOTC WPEB, which has recommended to freeze or reduce gillnet fishing capacity and effort until sufficient information is available to assess the impact of this fishing modality on target and non-target resources.

The present study aims at describing and analysing the situation of fishing capacity and bycatch of gillnet fisheries in the IOTC area of competence. It conducts a comprehensive revision of the

[1] AZTI. Herrera Kaia Portualdea z/g, 20100 Pasaia, País Vasco, España

scientific and technical literature, the IOTC reports of the scientific and compliance committees, national reports, Conservation and Management Measures (CMM) and statistical data on nominal catches and available data on fishing capacity.

2. Definitions

In the IOTC context, fisheries are classified as coastal, and surface & longline fisheries. The coastal and artisanal terms are used indistinctly. Industrial fisheries, in turn, are those carried out by vessels included in the Record of Authorized Vessel[2] (IOTC 2016)[3]. Two factors are utilised to classify vessels as either artisanal or industrial, these are length overall (LOA) and area of operation. Industrial are those vessels larger than 24 m LOA regardless they operate in the EEZs or in the high seas. Vessels below 24 m conducting the fishing activity beyond the EEZ are also classified as industrial. Artisanal fisheries in turn are defined as those carried out by vessels below 24 m LOA which operates exclusively within the corresponding national Economic Exclusive Zone (EEZ). This definition of artisanal fisheries seems simplistic for the IOTC area, where a large array of fishing modalities coexists within the EEZs. According to the definition, artisanal vessels in the IOTC area include from non-mechanised pirogues that fish for subsistence to long liners, gillnetters or purse seiners of less than 24 m LOA with inboard motors, fish holds, hydraulic and electronic equipment, and preservation facilities. Thus, it includes under the same category vessels with very different technical and economic characteristics, market niches, and fishing power. Moreover, the definition may cause confusion since one fishing vessel smaller than 24 m LOA could be classified as either artisanal or industrial, depending on the area where it operates, which makes it difficult to control and enforce any regulation as most of them are not using geo-localization systems. Moreno and Herrera (2013) proposes to distinguish the semi-industrial component which should include vessels between
15-24 m fishing in the respective EEZ. Thus, the artisanal component would include all vessels up to 15 m fishing in the EEZs. It is likely that most of the vessels conducting gillnet fishing are artisanal and semi-industrial vessels. In fact, the large gillnets being increasingly operated in the IOTC area of competence require ample space on board for the net and related handling operations. Thus, the size of the vessels predominating in catches are likely of semi-industrial and industrial type.

IOTC's CMM 2008/04 defines as large-scale driftnet those gillnets, or combination of other nets, more than 2.5 kilometers in length. Resolution 12/12 forbids the use of these nets in the high seas of the Convention area. This resolution is based on the UNGA's resolution 46/215 which calls for a global moratorium on large scale driftnet fishing on the high seas.

---

[2] IOTC Resolution 14/04

[3] Surface (purse seiners, gillnetters, bait boats) and longline fisheries cannot be branded industrial fisheries since not all surface vessels are in the RAV.

3. Description and evolution of the fisheries

Fishing in the IOTC'S area is carried out by artisanal, semi-industrial and industrial vessels. Regarding the high seas, fishing is conducted in most cases by industrial vessels although Moreno and Herrera (2013) report a significant activity carried out by the so called semi- industrial vessels. Moreno and Herrera (2013) suggests that the average fleet size for purse seine, long-line, pole and line and oceanic gillnet was 7078 vessels in the period 2009-2012. Regarding gillnets, it has been recognised for years that the number of vessels are increasing year by year (MRAG 2012, Fonteneau 2011). One of the reasons for the expansion of gillnetters' capacity seems to be the cost of operation which is relatively low in comparison with other fishing technologies due to the passive nature of gillnets. The cost of the gear itself seems also rather low in comparison with other fishing technologies. It does not require any bait and can be operated from small boats with little or no mechanical devices. In fact, this fishing modality can heavily rely on manpower. These factors may explain in part why the technology is being increasingly used by fishing communities all around the sea basin. The low selectivity of gillnets does not seem to be a drawback for the building of capacity since most of the activity is operated from developing countries where a large part of the catch and bycatch is traded locally for human consumption and animal feed.

According to the IOTC's nominal catches database current levels of catches of tuna and tuna- like species captured with all type of gears are around 1.8 million tons of fish. Tunas amount 1.3 million tons (72%) of the nominal catches. Catches show a positive trend, having increased in 15% in the period 2000-2015. In turn, tuna catches have grown in 8% (see Figure 1).

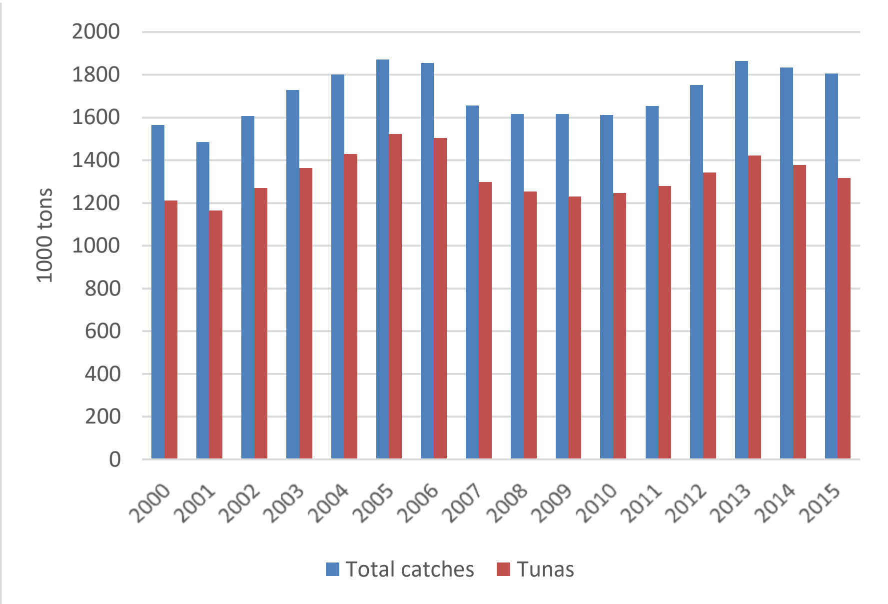

Figure 1: Evolution of total and tuna catches in the IOTC area of competence. Source: IOTC's nominal catch database

Artisanal fisheries are increasing its presence in nominal catches and show a positive trend, as seen in Figure 2, while the industrial fisheries are losing weight in catches.

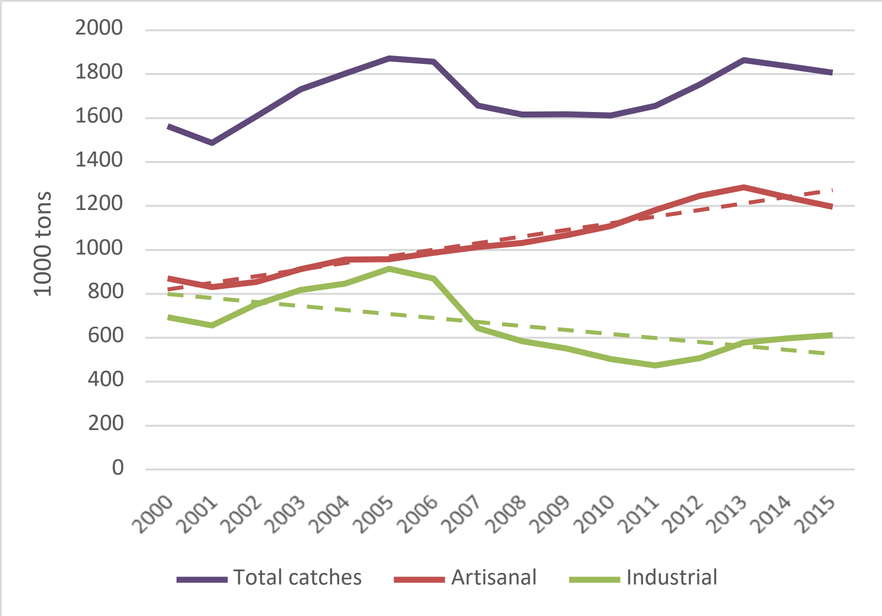

Figure 2: Evolution of total and tuna catches in the IOTC area of competence by type of fisheries. Source: IOTC's nominal catch database

Currently, fishing operations involving gillnets contribute in around 35% to the IOTC nominal catches. These catches amount 630 thousand tons of fish. It arises as the most important single fishing gear in terms of volume of catches. The presence of gillnet catches shows a growing tendency. This fishing activity takes place either inside the national EEZs or in the high seas. Fishing with large scale driftnets (> 2.5 kilometers) in the high seas takes place despite the world moratorium against the use of large driftnets in the high seas (UNGA resolution 46/215[4]). In turn, purse seiners and longlines contribute with approximately 17% and 15% respectively. And gillnet catches represent 53% of IOTC's artisanal nominal catches. This characteristic makes the Indian Ocean unique in comparison to other regions, where the predominant fishing activities are carried out by industrial fishing vessels. Figure 3 shows the evolution of catches by the main fishing gears in IOTC in the period 2000-2015. Notice that the presence of gillnets in catches are increasingly important and shows a positive trend. On the other hand, catches reported for purse seiner and long line fisheries are diminishing. Figure 4 shows the contribution of the fishing gears to the nominal catches. Notice that gillnets are the fishing gear contributing to most of the catches (34%), purse seiners and longlines contribute with 23% and 15% respectively.

[4] This supersedes resolution 44/225. This moratorium came into effect by 1992s. It is worth mentioning that UNGA resolution did not established a definition for large scale driftnets in terms of the length of the net. According to Anderson (2012) this resolution caused the cessation of activities of the Taiwanese gillnetters in the Indian Ocean.

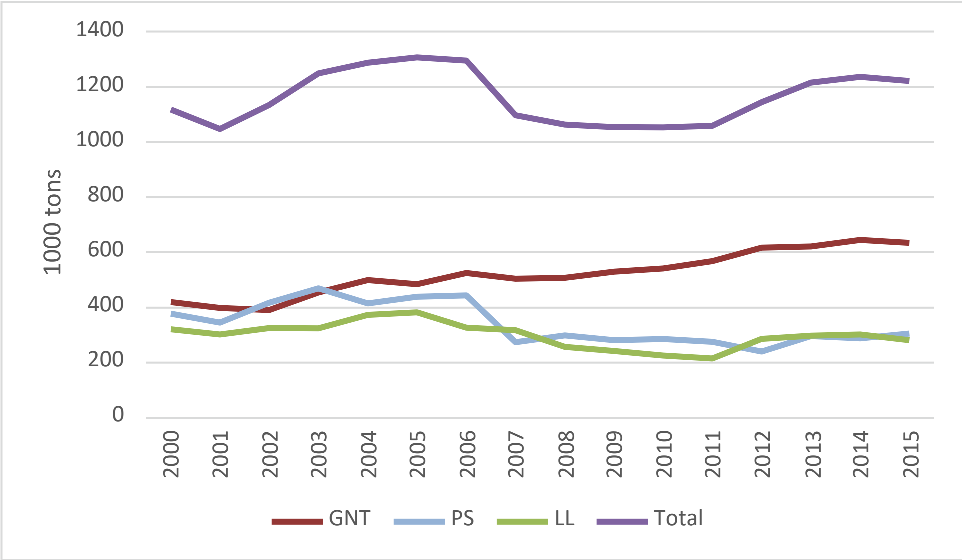

Figure 3: Comparative evolution of the catches by the three main fishing gears (2000-2015). Data source: IOTC nominal catch database

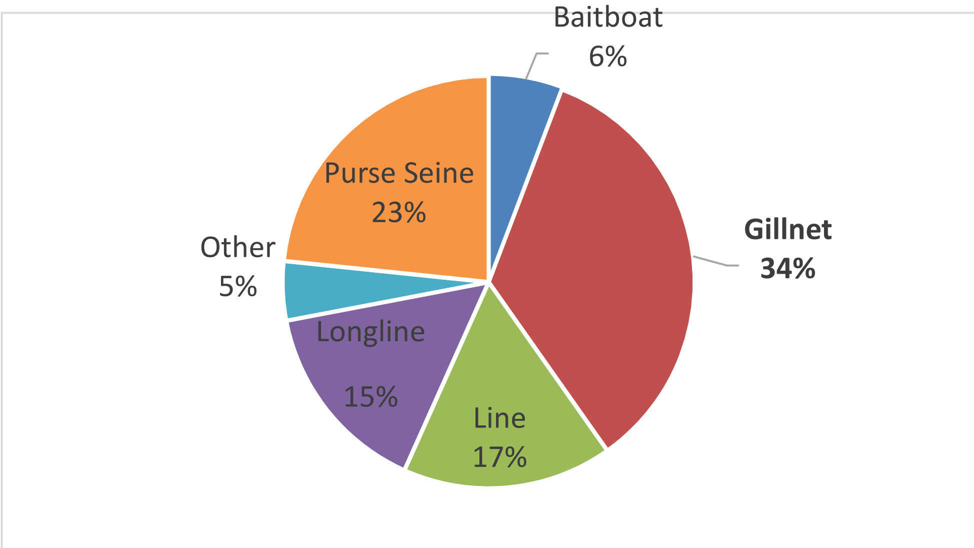

Figure 4: Contribution of fishing gear to the total nominal catch. Data source: IOTC nominal catch database

21 countries carry out gillnet fishing in the IOTC area. It is argued that gillnet fisheries contribute to the totality of catches for 6 countries in the IOTC area (MRAG 2012). The fishing fleets engaged in gillnets are mostly based in ports of India, Iran, Indonesia, Pakistan, Sri Lanka, Yemen, and Oman. According to Moazzan (2012), Somali vessels also target tunas using gillnets. Country participation in gillnet catches is seen in Figure 5.

Fonteneau (2011) and Anderson (2014) suggest that there is a problem of escalating gillnets capacity in the region. The IOTC CMM 12-12 prohibits fishing with gillnets larger than 2.5 kilometers in the high seas, hereinafter large-scale driftnets. Despite these restrictions, the

Indian Ocean is one of the few regions in the world where gillnetting is being increasingly carried out. Furthermore, there is very little empirical and scientific knowledge on the extent of gillnet fishing and bycatch. According to Anderson (2014), the Indian Ocean is likely the least region of the world regarding knowledge of gillnets' bycatch.

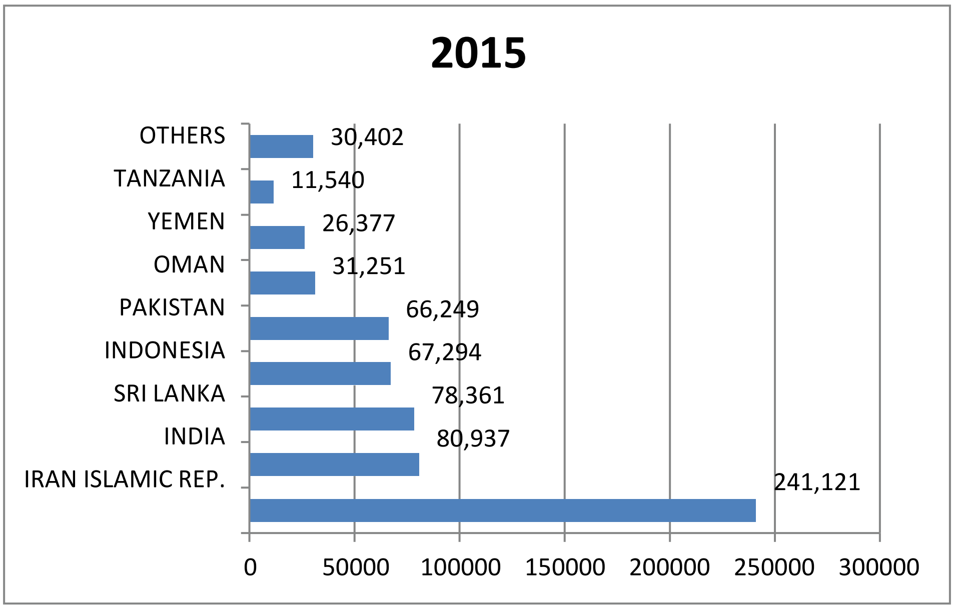

Figure 5: Contribution of national fleets to annual gillnets catch (2015). Notice that Iran, India, Indonesia, Pakistan and Oman represent 88% of the total catches. Data source: IOTC nominal catch database

4. Catches by tuna species

4.1 Catches of tropical tunas and stock status

The evolution of nominal catches of tropical tunas in the IOTC area of competence for the diverse fishing technologies concerned is shown in Figure 6. It is notable that purse seiners are the main fishing technology in terms of catches. The presence of purse seiners in catches follows a decreasing trend. In turn, gillnets show a positive trend since 2008. This is likely motivated by the exit of longlines from the region, which can be partially explained by the irruption of pirate activities in the IOTC area.

Bigeye tuna

It is notable that gillnet fisheries are increasing their presence in the catches of this species, while longlines substantially diminish and purse seiner fisheries slightly falls (Figure 7). The average catch (2012–15) by main fishing gear is as follows: longline 57.0%; purse seine 9%; line other 8%; and other 16%, including gillnets. According to the report of the 19th meeting of the IOTC Scientific Committee (IOTC 2016), the bigeye tuna stock is determined to be **not overfished and is not subject to overfishing**. The reduction of fishing effort since 2007 by large scale longline fleets from Taiwan, China, Japan and Republic of Korea has lowered the pressure on the resource. However, increased catch or increases in the mortality on immature fish will likely increase the probabilities of breaching reference levels in the future. Continued monitoring and improvement in data collection, reporting and analysis is required to reduce the uncertainty in assessments. The increasing presence of gillnet fleets and their lack of reporting of data, particularly from artisanal fleets fishing beyond their CPC EEZs, bring uncertainty into the assessment of this and other stocks.

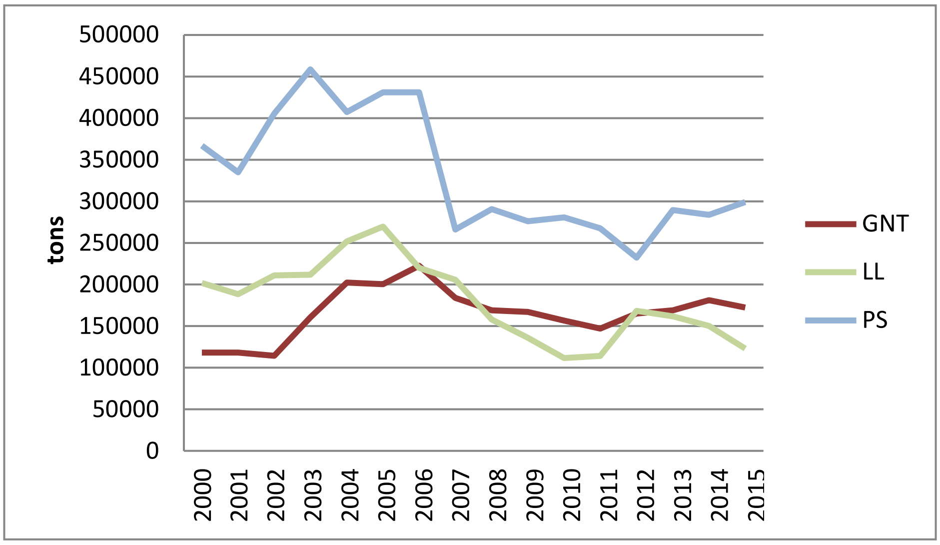

Figure 6: Catches of tropical tunas by the main fishing technology (2000-2015). Data source: IOTC nominal catch database

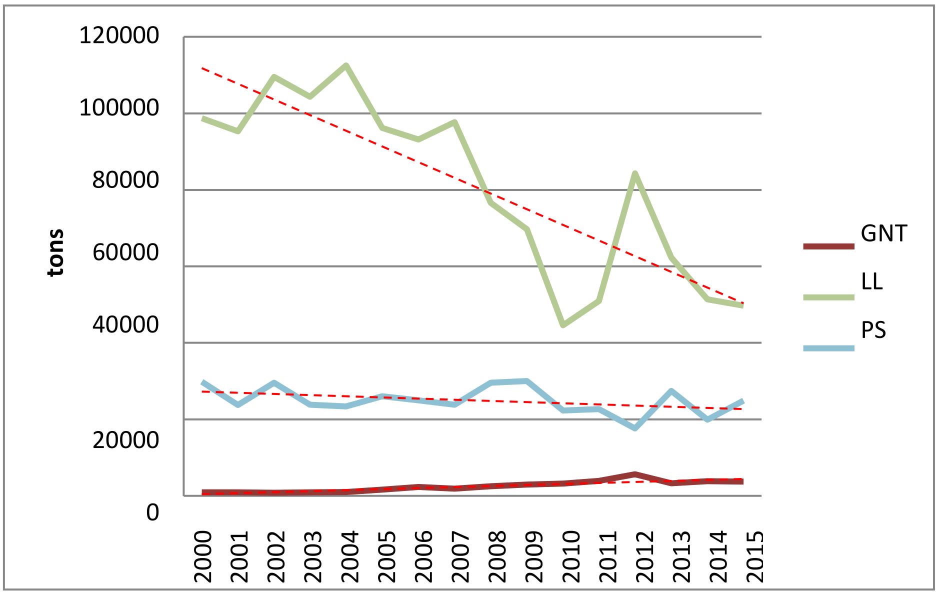

Figure 7: Catches of bigeye tuna by the three main fishing technologies and their tendency (2000-2015). Data source: IOTC nominal catch database

Yellowfin tuna

In the last 10 years longlines have lost presence in catches and exhibit a decreasing trend. Purse seine catches have grown in recent years. In the other hand, longlines show a steady increase in catches, being the only gear with a general positive trend (Figure 8). Average catch by main fishing gear: Purse seine 34%; longline 19%; handline 19%; gillnet 16%; troll 7%; pole and line 5%; and Other 2%. The report of the 19th meeting of the IOTC Scientific Committee (IOTC 2016 a) states that the yellowfin tuna stock is determined to **remain overfished and subject to overfishing**. The increase in longline, gillnet, purse seine and handline effort and catches in recent years has increased the pressure on the stock, with recent fishing mortality exceeding the MSY-related levels. There is a risk of continuing to exceed the MSY-based biomass reference point if catches increase or remain at current levels. The stock status is driven by unsustainable catches of yellowfin tuna taken over the last four years, and the relatively low recruitment levels in recent years. In addition, it seems that gillnets fisheries are occupying the place left by longlines in the region. The longline fleets belong to large developed nations while gillnet fleets belong to developing nations with less institutional capacity to comply with data collection and submission requirements. This situation is aggravated by unreported catches of driftnets fleets not authorized to fish in the high seas.

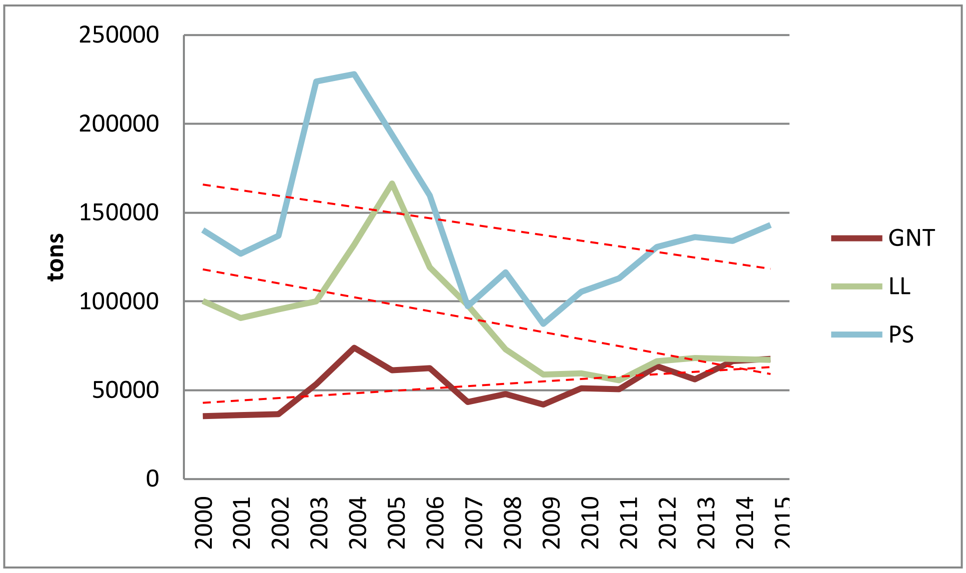

Figure 8: Catches of yellowfin tuna by the three main fishing technologies and their tendency (2000-2015. Data source: IOTC nominal catch database

Skipjack tuna

In the last five years, purse seiner catches show a declining trend (see Figure 9). The causes of this decline in catches are not fully understood. In the same period gillnets show a slight increasing trend. Average catch composition by main fishing gear (2012-2015) are: PS 30%; GNT 26%; P&L 21% and other 24%. According to the report of the 19th meeting of the IOTC Scientific Committee (IOTC 2016), the skipjack tuna stock is determined **to be not overfished and is not subject to overfishing**. There remains considerable uncertainty in the assessment, and the range of runs analysed illustrate a range of stock status to be between 0.73–4.31 of SB_{2013}/SB based on all runs examined. At present, no additional management measures are required. However, continued monitoring and improvement in data collection, reporting and analysis is required to reduce the uncertainty in assessments.

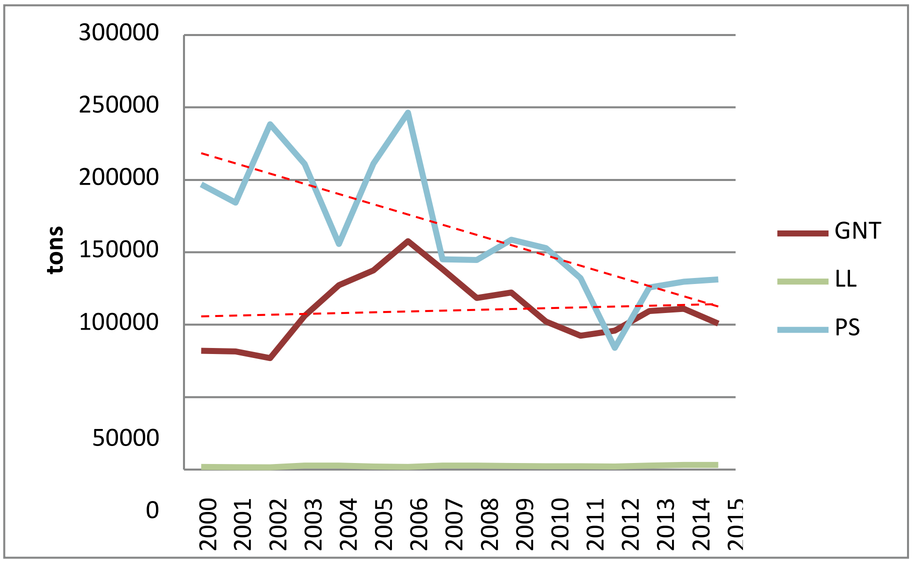

Figure 9: Catches of skipjack tuna by the three main fishing technologies and their tendency (2000-2015). Data source: IOTC nominal catch database

4.2 Catches of neritic species

Neritic species are harvested predominantly by the artisanal fleet, being gillnets the main fishing technology. Currently, gillnet fisheries contribute to 58% of the nominal catches of neritic species.

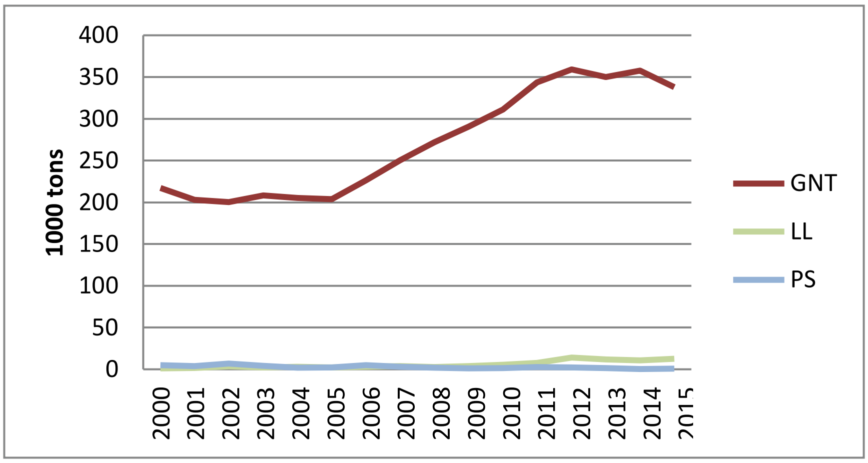

Figure 10: Comparative evolution of the neritic species catches by the three main fishing technologies in IOTC fisheries (2000-2015). Data source: IOTC nominal catch database

Kawakawa

In the last five years catches of this species have grown steadily, being gillnets the main single technology. The category others in the graph below comprises small purse seiners, handlines and trolling. The last Scientific Committee report (IOTC 2016 a) considers that this species is **not overfished and not subject to overfishing**. There is, however, a reported lack of data for the different gears and only data poor approaches are being conducted by scientists. The continued increase of annual catches for kawakawa is likely to increase the pressure on the Indian Ocean stock. The Scientific Committee recommends improving data collection and reporting to assess the stock using more traditional stock assessment techniques. Given the rapid increase in kawakawa (Figure 11) catch in recent years, some measures need to be taken to reduce the catches in the Indian Ocean.

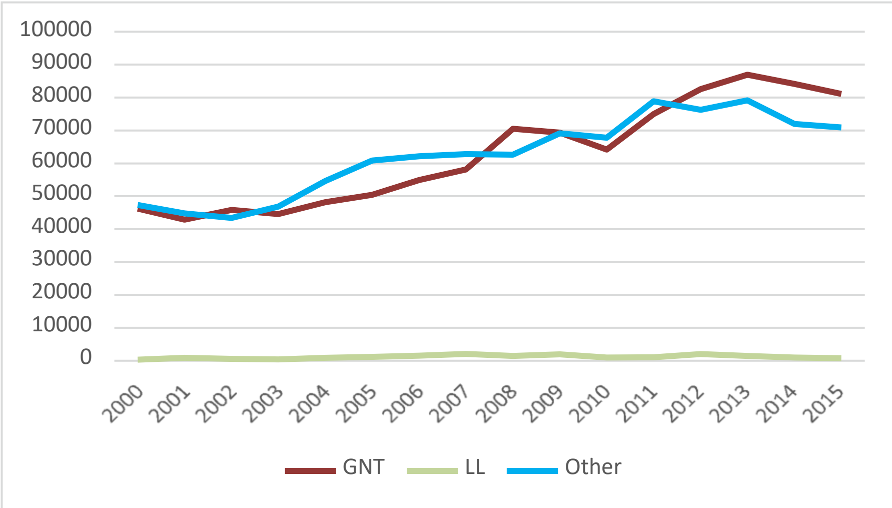

Figure 11: Catches in tons of kawakawa by the main fishing technologies (2000-2015). Data source: IOTC nominal catch database

Longtail tuna

In the last five years, catches of this species show a growing tendency, being gillnets the main single fishing technology (Figure 12). Nominal catches have experience a peak in 2012 and have slightly decreased since then. The category others in the graph below comprises Danish seine, small purse seiners, handlines and trolling. According to the Scientific Committee report catches are above MSY since 2011 although dropped below MSY in 2015 (IOTC 2016 a). The Committee considers that this species is **both overfished and subject to overfishing**. The Scientific Committee recommends improving data collection and reporting to assess the stock using more traditional stock assessment techniques. Abundance index series from I.R. Iran, Oman, India and Indonesia are required.

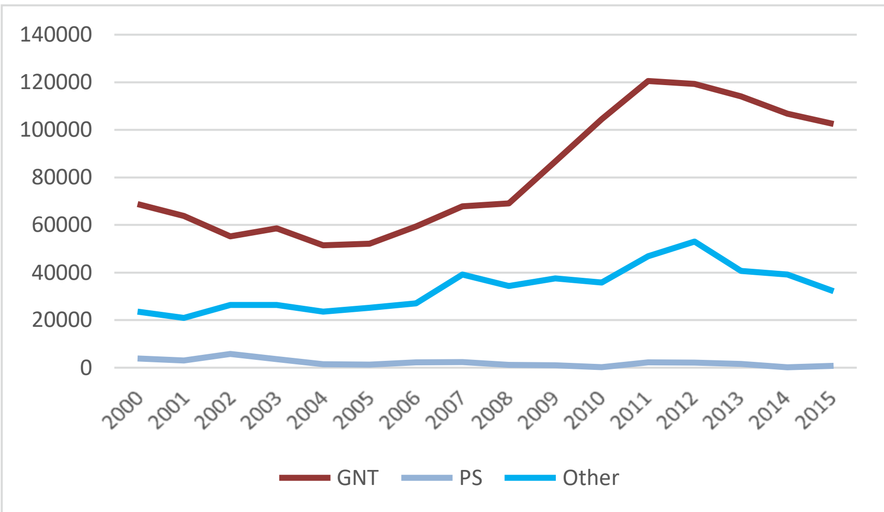

Figure 12: Catches in tons of longtail tuna by the main fishing technologies (2000-2015). Data source: IOTC nominal catch database

Frigate tuna

In the last five years, nominal catches of this species have grown substantially in the IOTC area of competence (Figure 13). The resource is harvested predominately by a large variety of technologies such as Danish seine, small purse seine and trolling, amongst others. Gillnets are the most important single technology and show also an increasing trend, while longline has lost weight in nominal catches. There is a **high uncertainty on the status of the stock**, mainly due to the lack of data for many gears. The Scientific Committee has recommended to apply precautionary measures and not to exceed current levels of catch.

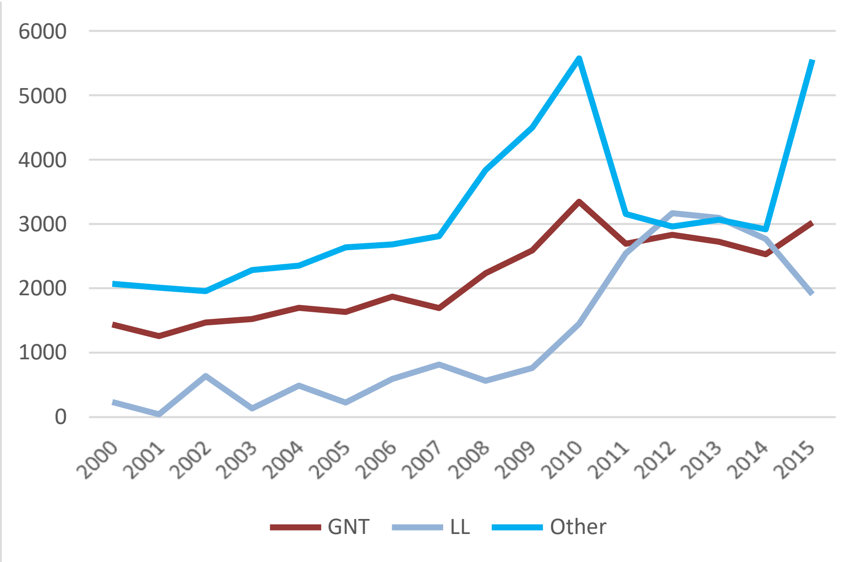

Figure 13: Catches in tons of frigate tuna by the main fishing technologies (2000-2015). Data source: IOTC nominal catch database

5. Fishing capacity by main gillnet countries

Iran: This fleet is composed of 11300 vessels consisting on boats, dhows and vessels, which operate in coastal and offshore waters (IOTC 2016 a). Gillnet and purse seine are the two main fishing methods used by Iranian vessels to target large pelagic species (especially tuna and tuna-like) in the IOTC area. In addition, some small boats use trolling in coastal fisheries. Gillnetters yield 95.9% of catches, purse seiners 2.1%, and trolling boats 2%. In the Western Indian Ocean, Iran has significant gillnet fisheries targeting yellowfin tuna, skipjack tuna and other tuna outside its EEZ (Moreno and Herrera, 2013). The Arabian Sea, in turn, is a traditional fishing ground for Iranian gillnets. The fleet operated in that fishing ground amounted 4355 in 2011 (Moreno and Herrera, 2013). This fleet targets mostly neritic tunas. According to MRAG (2012), in 2011 58% of the gillnet fleet was composed of vessels below 3 GRT. Due to the small size of these vessels most of the catches are likely carried out in the EEZ, approximately within 20 nautical miles of the coast. Moazzam (2012), in turn, reports 6500 gillnetters. In relation to artisanal gillnet fisheries, Iran has a large fleet comprising 3926 in 2011 (Moreno and Herrera 2013). These vessels catch mostly neritic species i.e. long tail, kawakawa, and frigate tuna, especially in the Persian Gulf.

Oman: The national fleet comprises 22400 vessels (IOTC 2015 a). The fleet consists of three segments: artisanal fleet (694 dhows and 21616 fibre glass boats), coastal fleet (93 vessels) and industrial fleet (3 vessels). Gillnets are employed by the artisanal fleet and by the coastal fleet. In addition, the coastal fleet employs a combination of gillnets and longlines. The industrial fleet has been reduced from 10 vessels in 2011 to 2 in 2014. This reduction has been part of a government program aimed at making the industrial fleet more efficient. The national government reports that artisanal and coastal fleets have increased in the number of vessels and fishermen (IOTC 2015 a).

According to Moreno and Herrera (2013) the dhows fleet (10 – 24 m) operates in the Arabian Sea. These boats employ gillnets exclusively, using nets of 2 – 8 miles in length (Moreno and Herrera 2012). This fact differs from what is reported in the National Report (IOTC 2015 a), where is stated that dhows also fish with other technologies such as longlines and handlines. Artisanal vessels from 1 to 10 m LOA target yellow fin tuna using gillnets and handlines (MRAG 2012).

Pakistan: In 2011, 3126 vessels ranging from 35 to 50 GRT (10 – 15 m LOA) composed the Pakistani fishing fleet fishing in the Arabian Sea (Moreno and Herrera 2013). This fleet targets yellowfin tuna, skipjack tuna, long tail tuna, frigate tuna and kawakawa. According to Gillet and Herrera (2011) many of these vessels do not conduct small scale activities since are fully decked and powered. In turn, Shaid et al (2015) report 700 Pakistani gillnetters engaged exclusively in tuna fishing. According to Moazzam (2012) the Pakistani gillnet fleet is entirely composed of locally built wooden vessels. These vessels operate in the continental shelf and offshore waters within the EEZ and beyond the national jurisdiction. According to Anderson (2014) the Pakistani fleet has high navigational autonomy and travel into the high seas (Anderson 2014). Moreno and Herrera (2013) reports only 10 gillnetters operating in the Western Indian Ocean beyond the Pakistani EEZ. It is questioned that the high levels of catches declared by the country are conducted exclusively in the EEZs. This could mean that the offshore fleet is fishing also in the EEZ. This fleet targets tropical tunas i.e. yellowfin and skipjack tuna, which constitute 85% of its catches.

Yemen: There are evidences of a large gillnet fishing capacity. MRAG (2012) reported that in 2002 a fleet comprising 9925 vessels between 5 to 26 m LOA. Gillet (2011) estimates that around 90% of the catches of that country come from gillnet fisheries. Moreno and Herrera (2013), in turn, reports an artisanal fleet of 1500 vessels (12 to 18 m LOA) that use handlines and troll lines predominately and that can also use gillnets.

India: A large array of fishing gear is used in India to target neritic and oceanic tunas (Moreno and Herrera 2013). It seems that around 50% of the Indian tuna catches in 2014 comes from gillnets (IOTC 2015 b). The Indian national report informs that the coastal fleet is made up of 288 vessels which are mainly gillnetters. In addition, the fleet comprises purse seiners, hook and line boats, etc. (IOTC 2015 b). Using extrapolations from Pakistan and Iran, MRAG (2012) estimates that Indian gillnetters may range from 2400 to 3700 vessels. Mechanised vessels are mostly based on Western India. In contrast, Moreno and Herrera (2013) reports that India has around 14100 mechanised gillnet vessels. There are reports that more than 75000 motorised and 104000 non-motorised boats use diverse gear, including gillnets (Moreno and Herrera 2013).

Indonesia: Only 2 gillnetters below 100 GTs are reported in Indonesia (IOTC 2016 b). It is noteworthy that 11% of the nominal gillnet catches of IOTC are reported by Indonesia (Figure 4).

Sri Lanka: MRAG (2012) reported that the country's fishing fleet comprised 46138 vessels. 9% of these vessels could carry out operations beyond the national EEZ. These vessels are concentrated in the southwest of the country. According to the Sri Lanka National report (IOTC 2016 e), the pelagic fleet comprises 5023 vessels, out of which 1603 are authorized to fish beyond the EEZ. Vessels employing gillnets, as well as other gears, comprise 3000 vessels ranging from 8 to 15 m LOA. The fleet authorised to employ gillnets, and other gear, in the high seas comprises 1584 vessels between 10.3 and 15 m LOA.

The table below provides an overview of some of the most important countries carrying out gillnet and driftnet fisheries. Notice that the heterogeneity of sources and the fact that many vessels do not have gillnets as the main technology makes it difficult to provide a concrete measure of gillnet/driftnet capacity in the seabasin.

Table 1. An overview of recent references on gillnet/driftnet fleets size

Country	National fleet	Reference	Gillnet fleet size	Reference
Iran	11300 vessels	IOTC (2016 a)	6500 vessels	Moreno and Herrera (2013)
Oman	22400 (artisanal, coastal and industrial)	IOTC (2015)	Undefined but it seems that the majority can employ gillnets amongst other gears.	IOTC (2015)
Pakistan			700 gillnetters	Shaid et al (2015)
Yemen	1500 artisanal vessels	Moreno and Herrera (2013)	Predominant use of longlines although also able to use gillnets	Moreno and Herrera (2013)
India	180000 vessels, including motorized and non-motorized boast using a large variety of gear	Moreno and Herrera (2013)	14100 mechanized gillnetters	Moreno and Herrera (2013)
Sri Lanka	5023 vessels in the pelagic fleet	IOTC (2016 e)	3300 vessels authorized to use gillnets (and other gears) Out of these vessels, 1584 vessels are authorized to use gillnetters (and other gear) in the	IOTC (2016 e)

6. Technical characteristics

Gillnets are built of polyamide sections, which in most cases are made of monofilament nets. Multifilament is also employed in its construction but to lesser extent. The length of the fishing net is highly variable within the seabasin and depending on the area where the net is operated i.e. inshore or offshore. Khan (2013) reports that Pakistani gillnets operated close to shore have around 4.5 km in length and 15-20 m in depth. Thus, these are large scale driftnets according to the IOTC definition (IOTC 12/12). According to Fonteneau (2011), most of the gillnets in the seabasin may have between 10 - 20 m in depth and arise as a risk for shallow water species that need to breath fresh air such as dolphins, turtles and whales. This also constitutes a threat to sharks and billfishes. It appears that the hanging ratio of these gillnets is low and this have implications for the low selectivity of these fishing gears.

Pakistani tuna gillnets of 10 - 12 km in length, fishing beyond the EEZ, are reported by Moazzam (2012) and Khan et al. (2013). Moazzam and Nawaz (2014) report Pakistani driftnets which are 20 kilometres in length operating from Karachi and Gwadar. The presence of large driftnets in inshore, offshore waters and beyond national EEZ is regarded as a serious threat to biodiversity in IOTC area of competence. Figure 14 shows a schematic view of large gillnet gears operating in IOTC area of competence (Fonteneau 2012).

As mentioned before gillnet are composed of several sections. In Indonesia, these sections may be around 30 m in length. Concerning mesh sizes, Shaid (2015) describe Pakistani nets as having mesh sizes between 13 - 17 cm. In turn, Novianto et al (2016) reports a mesh size of around 4 inches (14 cm) for Indonesia.

There is little information about the operation of these gears. Pakistani authors report that nets are set in the evening and hauled after 12 hours (Moazzam and Nawaz 2014). Thus, the catch suffers a long soaking period. This seems to have implications on the rate of bycatch. Furthermore, it produces a loss of fish quality. Regarding the length of the fishing trip, Novianto et al (2016) describes that in Indonesia fishing trips may last 10-15 days/trip for vessels without refrigeration facilities. Fishing vessels with refrigeration facilities may carry out trips lasting between 30-45 days (Khan 2013). WWF (2012 a) reports that vessels operating in shallow waters along the Pakistani coast conduct fishing trips around 20-22 days long. Vessels operating beyond the EEZ may take trips of about 60-90 days. Figure 14 and Figure 15 illustrate the issue of large scale driftnets operating beyond EEZs.

Gillnets can be used at different depths. Thus, a variety of combinations can result from this versatility characteristic which increases the number of species that can be harvested by this technology. It seems that there are two types of gillnet; one targeting king mackerel and other for tunas. Gillnets can also be used attached with other fishing gear. Herath (2012) describes that in Sri Lanka some gillnetters attach long lines at the end of the net, combining two modalities of fishing in the same fishing trip. It is also worth commenting that during the time the gillnet is in the water fishermen may use a large variety of gear, e.g. handlines.

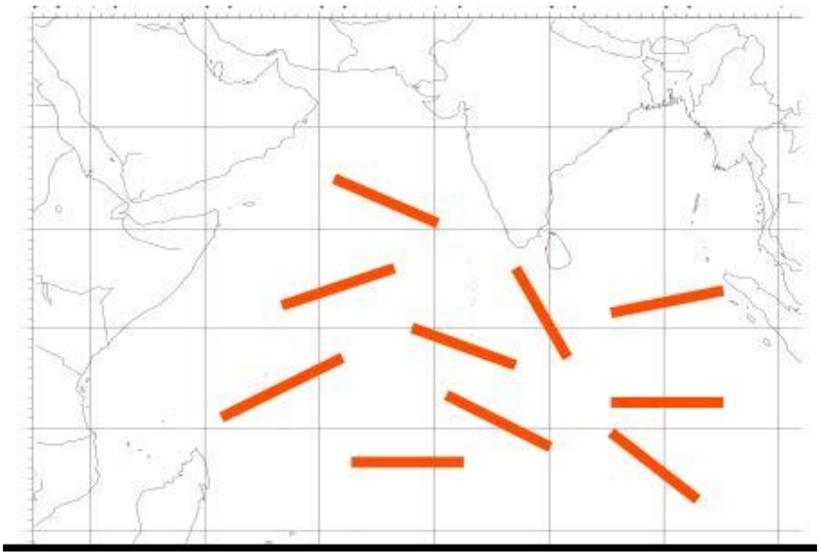

Figure 14: Schematic conceptual view of the total length of drifting nets that may be deployed daily by a fleet of 3000 vessels using nets longer than 2.5 kilometres. After Fonteneau (2012).

There is very limited information on crew size in gillnetters in the IOTC area. Novianto et al (2016) informs that in Indonesia the average crew size is 12 people. WWF (2012a) reports crew sizes of 9 to 13 fishermen for smaller vessels, while for those carrying out offshore fishing the crew consist of 16 to 23 men.

It seems that the technical characteristics of gillnets and their operations are not properly regulated. Moazzam (2012) reported that as 2011 no restrictions on vessel construction, access mechanisms, mesh sizes, and nets lengths were imposed in Pakistan for general or targeted fisheries. The lack of proper regulation at regional or national level may explain the ease of access to fisheries which are less exigent in terms of investments and market conditions. Trading of fish at sea seems also common, at least between Pakistani and Iranian gillnetters. This is due to attractive prices offered by Iranian operators which are better than those offered at Pakistani ports (WWF 2012 b).

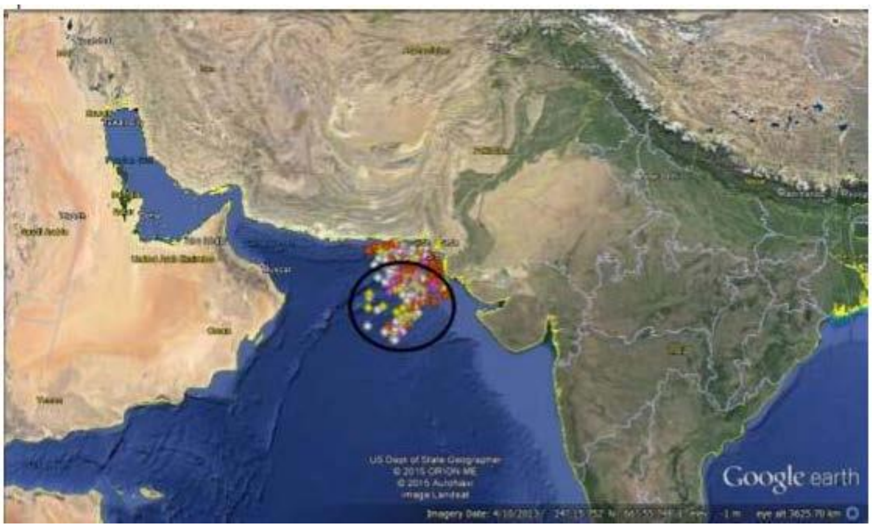

Figure 15: Satellite view of the operations of four Pakistani drift netters. After Shahid et al. (2015).

7. Bycatch

Theoretically, the mesh size of gillnets may confer a high selectivity to this gear. Gillnets in the Indian Ocean, however, are made of several net panels with diverse mesh sizes. This fact likely reduces the selectivity of a given gillnet (MRAG 2012). Consequently, gillnet fishing in the region is regarded as a non-selective fishing activity. Another factor likely affecting gillnets selectivity is the hanging ratio employed. It is possible that low hanging ratios are employed and thus the nets are less selective. Bycatch produced by gillnet fishing is in many cases landed and traded. This is especially reported for trips of short duration. Bycatch of vessels with higher navigational autonomy may tend to discard due to limitations in storage facilities. Thus, the levels of discards in artisanal gillnet fisheries should be lower than in other fisheries (Anderson 2014). It is worth pointing out that there is no information about discards rates as no observer programs are available for the gillnet fisheries. Fish coming from gillnets are of lower quality due to the long soaking time in warm waters and poor preservation facilities on board. Thus, prices are consequently low. Since the market does not reject bycatch, especially in the case of sharks (with the exception of the Iranian market), bonny fish and in some cases dolphins, there is little incentive to improve selectivity or to use other more selective technologies. Figure 16 shows bycatch of sharks in gillnet fisheries off Oman. It can be noticed that small tunas are landed for commercialization.

7.1 Sharks

The figure below shows the nominal catch of sharks in the IOTC competence area. Catches of around 64000 tons are reported for 2015. Gillnets represent 78% of the shark catches. The figure shows that gillnet sharks catches follow a decreasing trend, which is likely related to legal measures but also to possible overfishing in the region. Longline is the second fishing gear in terms on impact on sharks and show a steady trend although in absolute terms is much lower than that of gillnets. The impact of purse seiners is negligible[5].

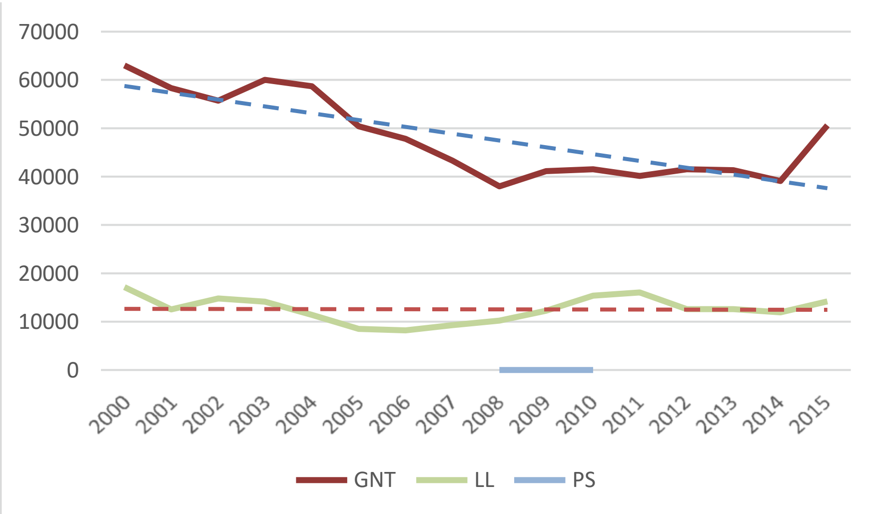

Figure 16: Nominal catches of sharks by the three main fishing technologies. Data source: IOTC nominal catch database

[5] Murua et al (2013) estimated a level of shark catch of around 160000 tons. Among the different métier identified, Gillnet (GN) and a composition of Gillnet and Longline (GN-LL) are the most impacting métiers with 61 % of the total estimated shark species catches, around 97000 tons.

Moazzam (2012) describes bycatch composition in Pakistani tuna gillnet fisheries based on catch records. He differentiated bycatch from neritic waters and offshore waters. Sharks were present in both waters although were not the predominant species. In neritic waters, the predominant species are talang queenfish (*S. commersonianus*), kingfish (*S. commerson*), amongst other bonnyfish being sharks in bycatch thresher shark (*A. superciliosus*) and silky shark (*C. falsiformis*). In offshore waters, the bycatch consists mainly on sailfish and marlins (e.g. *I. platypterus, M. indica, T. audax*). Sharks present in bycatch were threshers (*A. superciliosus*) and mako (*I.oxyrinchus*) in offshore waters. Moazzam (2012) concludes that around 55% of the sharks landed are originated in gillnet fisheries.

Figure 17: Breeds of shark and blacktip shark fished off the coast of Oman. © Blue Planet Society. Source: https://twitter.com/Seasaver/status/854340983655366656

In another analysis on tuna bycatch in Pakistani gillnet fisheries, Shaid et al (2016) informs on bycatch of gillnet operations collected by onboard observers during January 2013 to December 2015. This study reports that sharks were the most dominating species in bycatch, followed by turtles and cetaceans. Marine birds were not generally caught in the pelagic gillnet. Dominating shark species were shortfin mako, (*I. oxyrinchus*) and pelagic thresher (*A. pelagicus*) which contributed about 46 and 24 % respectively in the total shark catches. Other common species were silky (*C. falciformis*) and scalloped hammerhead (*Sphyrna lewini*) contributing 7 and 5 % respectively. Oceanic whitetip (*C. longimanus*) was also found enmeshed but on very rare occasions. In addition to these, many other shark species were also occasionally caught as bycatch. Rays appeared also as part of the bycatch and species such as spintail mobula and pelagic stingray were regularly caught in gillnet operations. According to Shaid et al. (2016) rays are usually discarded due to low commercial value.

Shaid et al (2015) report on bycatch of sharks in Pakistani gillnets fisheries in the Arabian Sea. A survey with four fishing vessels was carried out in the period January 2013 – June 2015, with a total of 526 fishing days. The survey was conducted employing four fishing vessels. 4537 sharks were recorded as bycatch. The study found out a bycatch rate of 33.31 sharks per square kilometer of net deployed. It is worth commenting that some sharks may die entangled and then sink. Thus, that level of mortality remains unknown for observers and crews. According to Shahid et al (2015), shark meat is locally traded and skin and other residues are also traded as food for animals. So, little or no discards of sharks are reported in this fishery. It is worth commenting again that some sharks may die and sink. Thus, they will not be transported to markets.

Shaifar (2016) reports on the results of a study on by-catch of Iranian fisheries. Data was sourced from the Iran Fishery Organization (IFO) data collection system and logbooks. It is estimated that 95.9% of the catches come from gillnet fisheries. Total catches amounted 251551 tons and bycatch represented 8% of the total catch. Out of this amount (39054 tons) sharks represented 18% of the bycatch. Billfish and other species represented 50% and 32% respectively. Figure 18 shows a fishing operation of an Iranian fishing vessel. Notice that the gillnet has caught a swordfish.

Shaifar et al (2013) conducted a study on catch composition and bycatch in Iranian gillnet tuna fisheries. The study took place between October and December 2012 and consisted on port sampling. The catches of 10 vessels selected randomly were sampled. The team found out a level of bycatch of13.6% (33 tons). Sharks represented 55% of the bycatch. . The remaining bycatch consisted on dolphins and turtles, and other species. The latter were discarded while sharks were landed.

Novianto et al (2016) conducted a study on shark bycatch in Indonesian gillnet fisheries in the Eastern Indian Ocean, to the south of Java waters, in August 2014-Octiber 2015. Three fishing trips were conducted in three vessels (homeport of Cilacap) with scientific observers onboard. This fleet targets tropical tunas, swordfish and billfish. 244 tons of sharks were recorded, consisting on 13 species, with an average catch of 9.5 tons per month. Threshers predominated in the bycatch. The greatest number of species caught with driftnets were small tooth (*A. pelagicus*) and bigeye threshers (*A. superciliosus*), amounting 47.7% and 14.25% respectively. It is worth recalling that IOTC resolution 12/09 bans retention, transhipment, landing, storage and trade of threshers. This ban is in place to all fishing vessels in the IOTC record of authorized vessels. Moreover, Resolution 13/06 prohibits all fishing vessels in the IOTC authorized vessels fishing on the high seas to retain, tranship, land, or store any parts of oceanic whitetip shark. Other species represented 21.32% of the bycatch. Bonny fish, turtles, dolphins and squids were also recorded. Notably, length distribution showed that all pelagic threshers were immature. Bycatch of two other species of sharks i.e. silky sharks and white tip shark comprised only immature individuals.

Figure 18: An Iranian tuna driftnet operation in the Indian Ocean. Notice a swordfish on board. © Ronan Bargain

7.2 Cetaceans

High risk of cetacean mortality was one of the main reasons for adopting the moratorium on large scale driftnets. In fact, interactions between gillnets and cetaceans usually produce high cetacean mortality. Small cetaceans regularly swim into gillnets for depredation of entangled fish and become entangled too (Romanov et al 2014). It seems impossible to operate gillnets without some levels of small cetacean bycatch. As it has been widely reported, gillnet fisheries are considered as the primary gear responsible for cetacean mortality (MRAG, 2012; Anderson, 2014). Amongst the species of cetaceans which may interact with gillnet fisheries in the Indian Ocean are Indo-pacific bottlenose dolphin (*Tursiops aduncus*), common bottlenose dolphin (*Tursiops truncates*), risso dolphin *(G. griseus)*, spinner dolphin *(S. longirostris)*, and diverse whales such as Bryde's whale, Eden's whale, amongst others. Generally, dolphins inevitable caught in gillnet operators are used as bait for longlines and other hook modalities or thrown back to the sea (Anderson 2014). It is also worth commenting that the presence of dolphins in tuna catches have triggered the emergence of markets for dolphin meat for human consumption. This activity is reported as being expanded since 1990s in countries such as Sri Lanka, Pakistan and India. It seems particularly relevant in Sri Lanka although fishermen are landing less quantity due to legal restrictions (Anderson 2014). As also observed in shark catches, the fall in dolphin catch rates can also be attributed to overfishing. This situation seems to take place in both coastal waters and high seas.

In India, large mesh gillnetting is documented as a threat to small cetaceans (Kumarran 2012, Anderson 2014). Yousuf et al (2009) estimates a bycatch between 9000 to 10000 dolphins per year. Focusing on the Northern Arabian Sea, Moazzam (2012) reports that around 25 – 35 dolphins are killed every month in Pakistani coastal gillnet fishing operations. There is evidence that entangled dolphins die immediately. Thus, no survival may occur after an encounter with the net. According to Moazzam (2013) a WWF study on quantifying dolphin mortality in Pakistani gillnet fishing started in October 2013 funding that 1 - 4 dolphins die in each fishing trip. The study further revealed mortality of several dolphin species including Indo-Pacific humpback dolphin (*S. chinensis*), bottlenose dolphin (*T. aduncus*), spinner dolphin (*S. longirostris*), Pan-tropical spotted dolphin (*S. attenuata*), long beaked common dolphin (*D. capensis tropicalis*), and Risso's dolphin (*G. griseus*), striped dolphin (*S. coreuleoalba*), and rough tooth dolphin (*S. bredanensis*). Some cases of entrapments of whales e.g. Bryde's whale and dwarf sperm whale were reported by Moazzam (2013). Figure 19 shows an entanglement of an unidentified whale and a turtle in the same gillnet.

Based on previous studies on bycatch rates[6] Anderson (2014) estimates the bycatch of cetacean in gillnet fisheries in the Western and Central Indian Ocean to be around 60000 individuals. At country level, bycatch of small cetacean should be around 24000 individuals per year for Iran, 10000 for India and Sri Lanka and 7000 for Pakistan, being these the four major gillnet countries in the sea basin.

Figure 19: Turtle and whale enmeshed in the same gillnet in the Indian Ocean. © Ronan Bargain

7.3 Turtles

Moazzam and Nawaz 2015[7] (quoted by Shaid et al 2016) refers to an observed program which reported 28000 turtles enmeshed in the Pakistani tuna gillnets. Seasonality is noticeable for turtles, which are present in catches especially between September and December. Among turtles, Olive Ridley turtle (*L. olivacea*) seems to be most abundant, whereas green turtle (*Ch. mydas*) is the second more frequent turtle tuna gillnets. On a few occasions hawksbill turtle (*E.*

[6] Anderson (2014) points out that his estimates are not intended to be precise but rather indications of the potential scale of the problem.
[7] Moazzam, M., and Nawaz, R., 2015. Turtle mortality in fishing operations in Pakistan. In: Anonymous (ed.) Proceedings of the Regional Symposium on Sea Turtle Conservation in Asia 24-25 March 2015, Karachi, Pakistan. IUCN, Karachi, Pakistan. Pp 52-65.

imbricata), loggerhead (*C. caretta*) and leatherback (*D. coriacea*) were also observed to be entangled. Enmeshment of turtle is more frequent in offshore waters than in inshore and neritic waters.

Shaid et al (2016) reports on a survey on turtle bycatch in gillnet Pakistani fisheries. Surveys were carried out in North East Arabian Seas in the period January 2013 to June 2015. 600 marine turtles (413 *L. olivacea,* 178 *C. mydas,* and 9 *E. imbricata)* were found entangled. 90% of these turtles were released alive.

7.4 Seabirds

According to Zydelis et al (2013) there is very little data about seabird bycatch in the Indian Ocean. It is, however, reported that Socotra cormorants interact with gillnets in the region.

Note:

Table 2 shows a comparison of the impact of the three most important fishing gear (i.e. gillnet, purse seine and longlines) on the main group of bycatch species. Notice that gillnets and longlines fleets take the highest proportion of sharks in relation to their catches. The highest proportion of sharks in the catch is found in the case of Sri Lankan gillnetters (12% of the catch). The rate of shark bycatch of that fleet is around 120 tons of sharks for each 1000 tons of catch. In relation to small cetaceans, it is estimated that Iranian gillnetters catch around 24694 individuals per year. In turn, EU purse seiners has the lowest impact on sharks, representing around 0.04% of the fleet catches. The small cetacean and turtles bycatch is thought of being negligible in EU PS fisheries (Ardill et al. 2013).

Table 2. Comparison of the levels of bycatch of three main fishing gears in the Indian Ocean.

Country	Gear	Nominal gear catch (t)	Sharks bycatch (t)	% of sharks in gear catch	% of sharks in gear bycatch	Rate of shark bycatch (per 1000 tons of catch)	Small cetacean bycatch (individuals)	Turtles bycatch	Scientific study
Iran	GNT	187860	14090	7.5	55	75	24694		Shahifar (2012); Anderson (2014), for dolphins
India	GNT	69075	2400	3.4		34	9500		MRAG (2012); Yousuf (2009) for dolphins
Pakistan	GNT	62719	4660	7.4		74	7300		Moazzam (2012); Anderson (2014), for dolphins
Sri Lanka	GNT	87469	10620	12		120	9900		Herath (2012); Anderson (2014), for dolphins
EU	PS	191484	74	0.04	1.16	0.4	Negligible	Negligible	Amandé et al. (2010)
Japan	LL	16071	1051	6		60			Ardill et al. 2013
Taiwan	LL	67224	4530	7.3	84	73			Ardill et al. 2013
China	LL	8073	417	5.2	66	52			Ardill et al. 2013
Indonesia	LL	31503	3900	8.6	12.3	86			Ardill et al. 2013
Spain	LL*	7136	650	8.8	21.1	88			Ardill et al. 2013
Portugal	LL*	2266	167	7.3	15.7	73			Ardill et al. 2013
Korea	LL	2724	144	5.3	18.7	53			Ardill et al. 2013

Note: Percentage of shark bycatch over the fleet nominal catches data have been estimated using catches for the year of the surveys described in each scientific study. (*) Swordfish longline

8. Data on gillnet fisheries and compliance with CMM

Non-reporting and misreporting of data are amongst the more acute problems in evaluating the extent and impact of gillnet fisheries in the IOTC area of competence. According to the last IOTC report on catch data and statistics, the nominal catches recorded for gillnet fisheries in the IOTC database are considered of poor to fair quality (2016 c). This depends on the country's fleet and period. Over the last forty years (1976-2015), only around 65% of the nominal catches, 15% of the catch-and-effort, and 20% of the size frequency statistics of gillnet fisheries recorded in the IOTC database are considered of good quality.

The evaluation of data submission by country reports that Iran has not provided catch-and-effort and size data fully complying with the IOTC standards.

Regarding India, the Secretariat has estimated gillnet from aggregated catches provided by the country. This is considered to undermine the quality of the catches of neritic tunas. India has not reported catch-and-effort and size data for its gillnet fisheries.

Since 2014 Sri Lanka is collecting logbook data from the offshore fisheries. Catches for the coastal fisheries are still uncertain.

Regarding Indonesia, the secretariat estimated catches for the gillnet fishery from the total aggregated catches submitted by the country. This likely affects the quality of the catches of both tropical tunas and neritic tunas. Since 2006 Indonesia has been reporting catches by gear and species to the Secretariat but the completeness and quality of the datasets reported remains uncertain. To date, Indonesia has not reported catch-and-effort and size data for its gillnet fisheries.

Pakistan reported catches to IOTC secretariat for the past 10 years. However, there are discrepancies between the national data and the WWF Pakistan data, the data are thought to be unreliable. Pakistan also reported size data for year 2013-14 its gillnet fisheries but not by IOTC standard.

Regarding Oman, the country has not provided size data. Catch and effort remain inconsistent.

As for compliance with CMM, under resolution 14/06 transhipment of tuna and tuna like species must be carried out only at ports. LSTLVs are the only vessels allowed to tranship at sea. There is evidence that transhipment of fish is being conducted at sea by semi-industrial gillnet vessels of Pakistan, which trade fish with Iranian vessels. In turn, the reported utilization of large driftnets in the high seas, which exceeds the length of 2.5 kilometres, is considered illegal and act against the Resolution 12/12 which forbids the use of these nets in the high seas of the Convention area. This also contravenes UNGA's resolution 46/215 which calls for a global moratorium on large scale driftnet fishing on the high seas. Illegal incursions of Indian vessels in waters of the British Indian Ocean Territory have also been reported (IOTC 2016 d).

9. Conclusions

- There is evidence of an increasing trend in fishing capacity in the region. Many of these boats are artisanal vessels which operate predominantly with driftnets.
- Artisanal vessels seem to be gaining navigational autonomy and onboard and conservation facilities to conduct large trips even beyond their national EEZs. Thus, a re-examination of the official definitions of artisanal vessels seems to be required since a semi-industrial sector is in place. Application of CMMs yet in force for industrial fleets such as purse seiners and large longlines to the emerging semi-industrial driftnet fleet should be examined.
- It is reported that gillnet usually surpass the limit of 2.5 kilometers in the high seas (i.e. large-scale driftnets). Thus, contravening IOTC's and UNGA's resolutions.
- Examination of nominal catches make evident that the gillnet activity is escalating in the region and displacing other fishing technologies, particularly longlines.
- Gillnets have a large potential for bycatch of non-target fish and sharks and ecologically sensitive species such as marine mammals, turtles and to a lesser extent seabird.
- High levels of bycatch are reported, while there is no information about discards rates as no observer programs are available for the GN fisheries. The capacity of the sea basin markets to absorb bycatch may discourage fleets to improve selectivity of gears.
- Evaluation of stock status and a proper knowledge of the removals of bycatch species is undermined by the lack of data on catches by gear. Weakness in reporting from gillnet nations seems to require action to build institutional capacities in these countries in the fields of data collection, VMS systems, logbooks and observer programs.
- There is in general high uncertainty on the extent of fishing capacity and level of catches and bycatch. Considering the contribution of the gillnet fisheries to IOTC species and bycatch species catch (around 35%) and the continuous increase of gillnets catches/capacity, it results evident that fishing capacity and catch/bycatch of this gear type is a major component of the IOTC fishery. However, there is a lack of fisheries statistics submission to IOTC and, hence, compliance with Resolution 15/01 and 15/02 on provision of nominal catch and catch and effort data which hinders the stock assessment of IOTC species. This brings about considerable uncertainty about the situation of the target and non-target species.

- The following measures might be necessary to deter escalating gillnet expansion in the region: A cap on gillnet capacity growth; a moratorium on the operation of gillnets above 2.5 kilometers in length within EEZs; counteracting illegal gillnets operations through mandatory authorizations; and the enforcement of the prohibition of transshipment in the high seas.

References

Anderson, R. C. (2014) Cetaceans and Tuna Fisheries in the Western and Central Indian Ocean. IPNLF Technical Report 2, International Pole and Line Foundation, London. 133 pages.

Ardill, D., Itano, D., and Gillett, R. (2011). A review of bycatch and discard issues in Indian Ocean tuna fisheries. *Indian Ocean Commission and SmartFish.* 44pp.

Amandè, M. J., Ariz, J., Chassot, E., de Molina, A. D., Gaertner, D., Murua, H., Planet, R., Ruiz, J. and Chavance, P. (2010). Bycatch of the European purse seine tuna fishery in the Atlantic Ocean for the 2003–2007 period. Aquatic Living Resources, 23(4), 353-362.

Fonteneau, A. (2011). Potential impact of gillnets fisheries on Indian Ocean ecosystems? Slide presentation at IOTC Working Party on Ecosystems and Bycatch, Lankanfinolhu, North Malé Atoll, Republic of Maldives, 24-27 October 2011.

Gillet, R. (2011). Bycatch in Small-scale Tuna Fisheries: A Global Study. FAO Fisheries and Aquaculture Technical Papers Volume: 560

Gillett, R. and Herrera, M. (2009). Estimating the fishing capacity of the tuna fleets in the Indian Ocean. IOTC-2009-SC-INF13.

Herath, H.L. (2012). Management of shark fishery in Sri Lanka; IOTC–2012–WPEB08–10 Rev_1

IOTC (2015a). Sultanate of Oman National Report to the Scientific Committee of the Indian Ocean Tuna Commission, 2015. IOTC–2015–SC18–NR20[E]

IOTC (2015b). India's National Report to the Scientific Committee of the Indian Ocean Tuna Commission'2015. IOTC–2015–SC18–NR09[E]

IOTC (2016a). Report of the 19 Session of the IOTC Scientific Committee. Seychelles, 1–5 December 2016. IOTC–2016–SC19–R[E]: 215 pp.

IOTC (2016b). Indonesia National Report to the Scientific Committee of the Indian Ocean Tuna Commission, 2016. IOTC–2016–SC19–NR10

IOTC (2016c). Report on IOTC data collection and statistics. IOTC–2016–WPDCS12–07_Rev1

IOTC (2016d). Report of the 13th Session of the Compliance Committee. IOTC–2016–CoC13–R[E]

IOTC (2016e). Sri Lanka National Report to the Scientific Committee of the Indian Ocean Tuna Commission. IOTC–2016–SC19–NR27.

Khan, M., Nawaz R. Mehmood, K., Nawaz, R., Shahid, U (2013). An update on the Shark bycatch of tuna gillnet fisheries of Pakistan. IOTC–2013–WPEB09–15

Moazzam, M. (2012). Status report on bycatch of tuna gillnet operations in Pakistan. IOTC 8th SESSION OF THE WORKING PARTY ON ECOSYSTEMS AND BYCATCH (WPEB)

Moazzam, M. (2013). An assessment of cetacean mortality in the gillnet fishery of northern Arabian Sea. WWF Report PAK 2013.

Moazzam, M. and Nawaz, R. (2014). By-catch of tuna gillnet fisheries of Pakistan: A serious threat to non-target, endangered and threatened species. Mar. Biol. Ass. India, 56 (1), 85-90, January-June 2014.

Moreno, G. and Herrera, M. (2013). Estimation of fishing capacity by tuna fishing fleets in the Indian Ocean. Report presented at the 16th Session of the Scientific Committee of the Indian Ocean Tuna Commission. Busan, Republic of Korea, 2–6 December2013. IOTC–2013–SC16– INF04.

MRAG. 2012. A review of bycatch in the Indian Ocean gillnet tuna fleet focussing on India and Sri Lanka. ISSF Technical Report 2012-05. International Seafood Sustainability Foundation, Washington, D.C., USA.

Murua, H., F. J. Abascal, J. Amande, J. Ariz, P. Bach, P. Chavance, R. Coelho, M. Korta, F. Poisson, M. N. Santos, and B. Seret. (2013). Provision of scientific advice for the purpose of the implementation of the EUPOA sharks. Final Report. European Commission, Studies for Carrying out the Common Fisheries Policy (MARE/2010/11 - LOT 2).

Romanov, E., Anderson, R.Ch., Bach, P., and Moazzam, M. (2014). A concept note on the need to develop an IOTC identification guide for marine mammals. IOTC Working Party on Ecosystems and Bycatch (WPEB) Tokyo, Japan.

Shahifar, R., Barghahi, R., Noori,D., and Khorshidi, S. (2012). Estimation of Bycatch and Discard by Iranian fishing vessels (Gillnets) In IOTC competence of area in 2012. IOTC-2013-WPEB09-40[1].

Shahid, U., Moazzam Khan, M., Nawaz, R., Dimmlich, W., and Kiszka, J. (2015). A preliminary assessment of shark bycatch in tuna gillnet fisheries of Pakistan (Arabian Sea). IOTC-2015- WPEB11-46_Rev_1

Shahid, U., Moazzam Khan, M., Nawaz, R., Razzaq, S.A and Ayub, S. (2016). Bycatch analysis of tuna gillnet fisheries of Pakistan: An analysis of bycatch data from 2013-2015. IOTC-2016-WPEB12-INF11

Yousuf, K. S. S. M., Anoop, A. K., Anoop, B., Afsal, V. V., Vivekanandan, E., Kumarran, R. P., and Jayasankar, P. (2009). Observations on incidental catch of cetaceans in three landing centres along the Indian coast. *Marine Biodiversity Records*, *2*, e64.

WWF a. (2012). Tuna situation analysis. Pakistan. PAK Report 2012.

WWF b. (2012). Stakeholder's Workshop for Sustainable Tuna Fisheries Development in Pakistan. Event Report December 2011. PAK Report 2012.

Žydelis, R., Small, C., and French, G. (2013). The incidental catch of seabirds in gillnet fisheries: A global review. Biological Conservation, 162, 76-88.