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General characterization of artisanal purse seine and handline fisheries of northern coast of Mozambique and their impact on tuna and tuna like species

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ABSTRACT

Artisanal purse seine and handline fisheries in the northern coast of Mozambique (10°30'S to 16°00'S) exhibit some targeting on tuna and tuna like species more than in other part of the country. The characterization of these two type of fisheries and their impact on tuna and tuna like species has based on Interviews and sampling during disembarkation on landing sites, conducted during 30 days, between May and June 2016, in the northern provinces of Cabo-Delgado and Nampula.

Results indicate that artisanal purse seine fishing is carried out in the open sea, using wooden engine powered boats, with average length of 7 to 9 meters, carrying an average of 18 fishermen. Fishing is carried out during the day and fishing trip lasts from 6 to 12 hours on average. Catch composition for this gear is dominated by neritic tunas and small pelagic fishes. The most common tunas are specifically kawakawa, skipjack tuna, frigate and bullet tunas. The amount of tunas landed vary from 0% to 40% in some districts such as Pemba (in Cabo Delgado) and Mozambique Island (in Nampula). An average catch rate ranging from 17 to 61 kg/boat.day was estimated for this fishery.

Handline fishing is carried out in both the estuarine and open sea environments. However, catch of tuna and related species is done in the open sea. Fishing is carried out using small canoes with an average length of three meters, taking one or two fishermen. Fishing is also carried out during the daytime but fishing trip has an average duration of less than 6 hours. This fishery impacts on larger spectrum of species compared to purse-seine, including neritic tunas, tropical tunas, billfish and serfish and also carangids and demersal fishes. The most representative IOTC species are bigeye tuna, skipjack tuna, indo-pacific sailfish and narrow-barred Spanish mackerel. The composition of tunas and related species in handline fishing may vary between 20 and 40% of total catch in open sea operations and catch rates may vary from 3 to 8 kg/boat/day.

1. INTRODUCTION

Mozambique has been a member of the IOTC (West Indian Ocean Tuna Commission), an intergovernmental FAO subsidiary organization, for the management of tuna and tuna-like species in the Indian Ocean, since 2012.

Under IOTC resolution 15/02, the members and cooperating states of this organization must be committed in collecting and reporting, to the IOTC Secretariat, tuna fisheries statistical data regarding their national flagged vessels operations in the region, including artisanal fisheries (IOTC 2016, IOTC 2014).

With a coastline of 2450 km, Mozambique, similarly to the other coastal countries in the region, faces the challenge of monitoring artisanal fisheries and thus complying with the IOTC resolutions regarding reporting fisheries statistical data for this segment. Despite exhibiting a sampling system for artisanal fisheries (SNAPA - Sistema Nacional de Amostragem da Pesca Artesanal) (Moreno 2012, Chaúca *et. al.* 2013, Mutombene *et. al.* 2015), Mozambique has been assessed by IOTC as partially compliant, mainly because catch data are reported partially aggregated and there is non-sampling of size frequency of IOTC primary species (Moreno 2012, Mutombene *et. al.* 2015). The geographical extension and complexity of the artisanal sector, which primarily do not target on IOTC species, associated with logistical (financial) limitations for implementation of the sampling system has been argued to be the primary causes affecting the effectiveness of data collection and reporting (Chaúca *et. al.* 2013, Mutombene *et. al.* 2015).

In order to concentrate efforts to address the issue of deficient monitoring of IOTC primary species in the artisanal fisheries, the northern coast was identified as a specific region where artisanal fisheries exhibit some targeting on tuna specie. This parcel of the country possess more than 70% of purse seines (108 seine nets in Cabo-Delgado and 139 in Nampula), which aside from small pelagics used to encircle tunas (IDPPE 2012, Chaúca et. al., 2013). This area also possess about 60% of handlines (3017 handlines in Cabo Delgado and 4259 in Nampula), which aside from small demersal fish is used to catch serfishes and coastal billfishes (IDPPE, 2012).

In the present study, we make characterization of artisanal tuna fisheries in the northern region focusing on handline and small purse seines. This represent a step towards the objective to establish a specific sampling program to improve the level of data collection and reporting to the IOTC, by increasing the sampling coverage at the main landing sites of this region, improving species discrimination (including for sharks) and by collecting size frequency data for IOTC primary species. Additionally, there is a need to improve the knowledge on tunas and tuna like species in order to support the promotion of a target oriented small scale tuna fishery in this region according the national strategic plan for development of tuna fisheries (PEDPA - Plano Estratégico de Desenvolvimento da Pescaria de Atum em Moçambique).

2. OBJECTIVES

General objective:

- Describe the tuna fishing carried out by the handline and small purse seines in the northern coast of Mozambique.

Specific objectives:

- Describe the characteristics of the means used to fish tuna and related species
- Describe the seasonality of the tuna fisheries;
- Determine the relative composition of tuna and related species in catches;
- Estimate the relative catches rates of tuna and related species;
- Describe the size structure of the tuna and tuna like species captured.

3. STUDY AREA

The study was carried out along the two northernmost coastal provinces of Mozambique, Cabo Delgado province and northern part of Nampula province. This area extends from latitude 10°29'S and longitude 40°45'E to latitude 16°00'S and longitude 40°46'E, from the border with Tanzania to the South of the Mozambique Island, and is designated Zone A (Fig 1). In the province of Cabo Delgado the area covers the all nine coastal Districts (Palma, Mocímboa da praia, Ibo, Macomia, Quissanga, Metuge, Pemba, Mecufi and Chiure), while in Nampula province the area covers five coastal Districts (Memba, Nacala Port, Nacala a Velha, Mossuril and Mozambique island) located out of Sofala Bank (zone B). The Northern coast is characterized by a very narrow platform with successions of sandy beach, sand banks, coral reefs, sea grasses, rocks, mangroves and many islands.

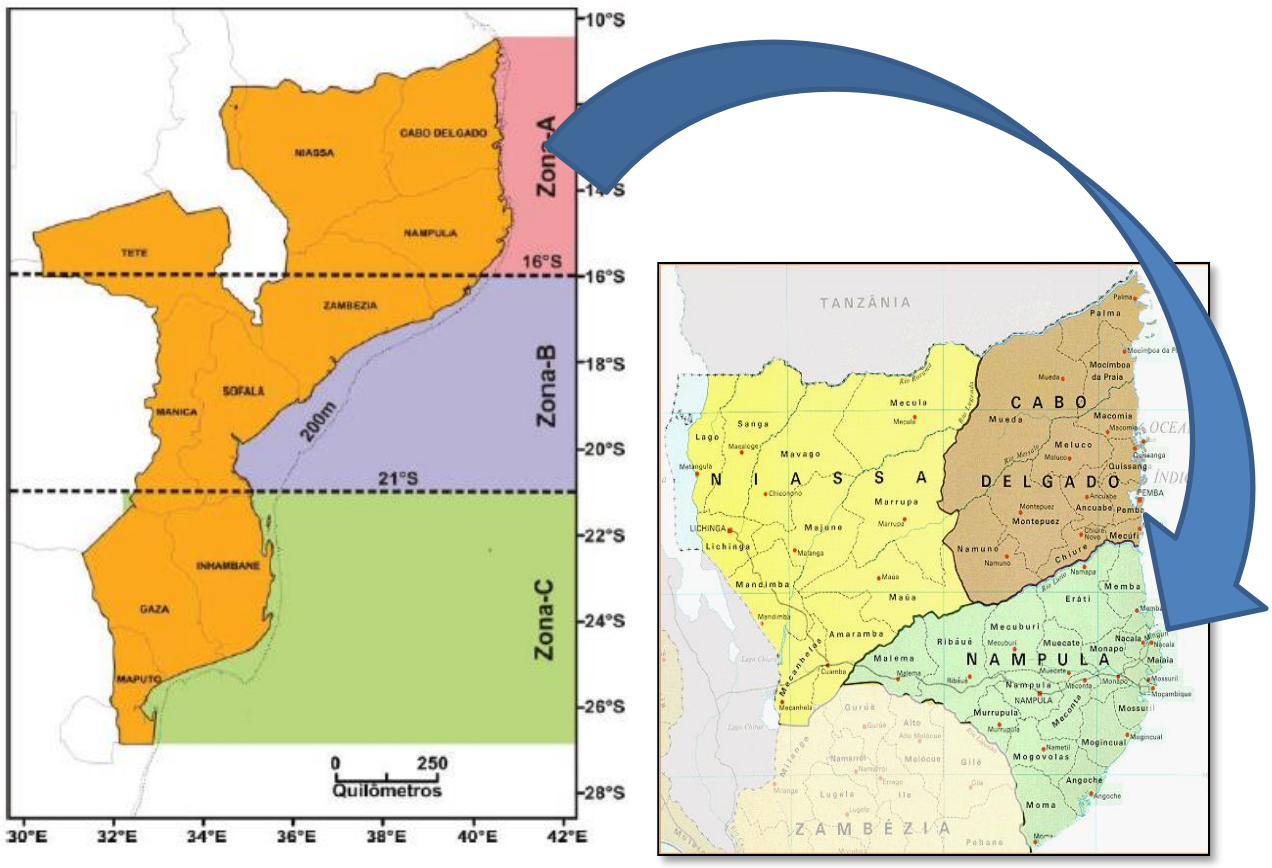

Figure 1. Mozambique coastal zones with focus on the Northern section, Nampula and Cabo Delgado Provinces

4. METHODS

The present work was based on sampling campaigns at the landing sites oriented to purse seiners and handline, and a structured interview administered to the fishermen of the two mentioned gears (Appendix I).

Sampling campaigns and interviews were carried out in coastal districts where there is a considerable landing of tunas and related species, namely Palma (in the stratum of Palma sede), Macomia (stratum of Pangane), Pemba (stratum of Paquitequete) and Mecufi (stratum of Sambeni and Mecufi sede) in Cabo Delgado, and Memba (Memba stratum), Nacala Porto (in Naherengue), Mossuril (in Chocas mar) and Mozambique island (in the stratum of Mozambique island) in Nampula. In both Provinces, sampling took place for 30 days divided into two phases of 15 days, the first being in March and June and the second in July.

During the period of campaigns, in order to maximize the number of samplings, in each District, an IIP technician remained based near the fishing center with the highest concentration of gears.

Sampling consisted in collection of data on catch, effort, specific composition and sizes of IOTC primary species were collected. Species identification was based on the IOTC identification guides and the data were recorded on the SNAPA sampling sheets.
Shortly after sampling was carried out, fishermen were interviewed aimed at collecting a range of information on the fishery, according to the local knowledge of the fishermen. Each interview was administered to a particular fisherman, each time.

5. RESULTS

5.1. Interviews to Artisanal Purse Seine and Handline Fishermen

5.1.1. Profile of the Interview

In Cabo Delgado, a total of 275 interviews were conducted, of which approximately 80% (211 interviews) were performed in Pemba and the remaining 20% in the other three Districts where the study was conducted (Table 1).
For purse seiners, 88% answered to be housefathers and only 12% were still dependent (Table 1). These are mostly (67%) fishermen with 41-60 years, although a significant fraction (31%) was between 21-40 years old (Table 1). For handline fishing, all the fishermen inquired answered to be housefathers mostly (71%) with 21-40 years old, although a significant fraction (29%) were between 41-60 years old (Table 1).

Table 1. Profile of the interview in Cabo Delgado (age and position in the family).

Gear	District	Nr. of interviews	Position in the family		Age			
			Housefather	Dependent	15-20	21-40	41-60	61+
Purse seines	Macomia	19	15	4		6	13	
	Mecufi	3	3				3	
	Palma	22	20	2	1	9	12	
	Pemba	120	13	1		3	11	
Subtotal – Purse seine		**164**	**51**	**7**	**1**	**18**	**39**	**0**
Handline	Macomia	1	1				1	
	Mecufi	8	8			4	4	
	Palma	11	11			10	1	
	Pemba	91	6			5	2	
Subtotal – Handline		**111**	**26**	**0**	**0**	**19**	**8**	**0**
Total		**275**	**77**	**7**	**1**	**37**	**47**	

In Nampula, a total of 48 interviews were carried out, of which 12 were in purse seine fishermen and 36 in handline fishermen. The majority of purse seines fishermen interviewed (95%) were

from Mozambique island (Table 2). The purse seine fishermen answered to de housefathers, with 58% in the 21-40 years old and 42% in the 41-60 years hold (Table 2).

In handline fishing, 96% of the fishermen inquired answered to be housefathers (Table 2). About 64% of inquired fishermen have 21-40 years old, 22% with 41-60 year old and 11% above the age of 60 years (Table 2).

Table 2. Profile of the interview in Nampula (age and position in the family)

Gear	District	Nr. of interviews	Position in the family		Age			
			Housefather	Dependent	15-20	21-40	41-60	61+
Purse seines	Moz island	11	11			7	4	
	Memba							
	Mossuril		1				1	
	Nacala Porto	1						
Subtotal – Purse seines		**12**	**12**	**0**	**0**	**7**	**5**	**0**
Handline	Moz island	4	4			2	2	
	Memba	7	7			7		
	Mossuril	22	21	1	1	11	6	4
	Nacala Porto	3	2	1		3		
Subtotal – Handline		**36**	**34**	**2**	**1**	**23**	**8**	**4**
Total		**48**	**46**	**2**	**1**	**30**	**13**	**4**

5.1.2. Socio-economic profile of the artisanal purse seine and handline fishermen

In Cabo Delgado the results of the surveys on the socioeconomic component suggest that purse seines fishing has a commercial purposes with about 90% of the production destined to sale and 10% to the consumption of the fisherman and family (Table 3). For the majority of the purse seine fishermen (74%) fishing is the unique source of income (Table 3). The majority (68%) are fishermen who are not boat owners or gear owners (Table 3). For handline fishing also most of the tuna and tuna like species catch (about 90%) is intended for sale (Table 3). Most fishermen (70%) are only engage in fishing as a source of income and the majority are boat and gear owners (Table 3).

Table 3. Socioeconomic profile of artisanal purse seine and handline fishermen in Cabo Delgado.

		Destiny of catch (tuna and tuna like species)		Fractions of sale and consumption		Sources of income				Boat Ownership		Gear Ownership	
Gear	District	Sell	Sell and consume	% Sells	% Consume	Agriculture	Trading	Bricklayer	Fishing	No	Yes	No	Yes
Purse seines	Macomia	3	16	92%	8%		5		13	10	8	10	8
	Mecufi		3	100 %	0	1			2	1	2	1	2
	Palma		22	78%	22%	1	1	3	17	16	6	15	7
	Pemba		14	82%	18%	1	1	2	10	12	2	12	2
Subtotal – Purse seine		**3**	**55**	**88%**	**12%**	**3**	**7**	**5**	**42**	**39**	**18**	**38**	**19**
Handline	Macomia	1		100 %	0	1					1		1
	Mecufi	1	7	94%	6%	4			4		8		8
	Palma		11	89%	11%	1		1	9	1	10		11
	Pemba		7	81%	19%			1	6	1	6	1	6
Subtotal – Handline		**2**	**25**	**91%**	**9%**	**6**	**0**	**2**	**19**	**2**	**25**	**1**	**26**

In Nampula the results suggest that tuna fishing by purse seines have commercial purposes and that most fishermen (63%) have fishing as their unique source of income (Table 4). They are mostly fishermen who are not boat owners but mostly gear owners (Table 4).

For handline fishing also most of the tuna and tuna like species catch (about 90%) is intended for sale (Table 4). Although most fishermen (53%) only engage in fishing, a considerable fraction (36%) is engaged also in farming as an alternative source of income (Table 4). Like in Cabo Delgado the handline fisherman from Nampula are boat and gear owners (Table 4).

Table 4. Socioeconomic profile of artisanal purse seine and handline fishermen in Nampula.

Gear	District	Destiny of catch (tuna and tuna like species)		Fractions of sale and consumption		Sources of income				Boat Ownership		Gear Ownership	
		Sell	Sell and consume	% Sell	% Consume	Farming	Boat construction	Guard	Fishing	No	Yes	No	Yes
Purse seines	Moz Island		11				1	3	7	8	3	4	7
	Memba												
	Mossuril												
	Nacala Porto	1		100%	0	1					1		1
Subtotal – Purse seines		**1**	**11**	**100 %**	**0**	**1**	**1**	**3**	**7**	**8**	**4**	**4**	**8**
Handline	Moz island		4	79%	21%		1	1	2	2	2	1	3
	Memba	7		95%	5%		1		6	3	4	3	4
	Mossuril	11	11			12		1	9	1	21		22
	Nacala Porto	1	2			1			2		3		3
Subtotal – Handline		**19**	**17**	**91%**	**9%**	**13**	**2**	**2**	**19**	**6**	**30**	**4**	**32**

5.1.3. Characterization of the Fishing Units

In Cabo Delgado purse seine fishing is conducted from wooden engine powered boats ranging from 6 to 12 m in total length (Table 5). The operations are performed by a crew of 16 to 21 fishermen. (Table 5). Handline fishing is conducted with wooden canoes with average 3 metres in total length, moved by paddles generally with one fisherman (Table 5).

Table 5. Characterization of fishing units in Cabo Delgado.

Gear	District	Propulsion			Boat material	Boat length	Crew number
		Paddles	Sail	Engine	Wood		
Purse seines	Macomia		2	16	18	9	21
	Mecufi	1		2	3	6	16
	Palma	2	3	17	22	8	18
	Pemba	1		13	14	12	19
Subtotal – Purse seine		**4**	**5**	**48**	**57**	**9**	**19**
Handline	Macomia	1			1	3	1
	Mecufi	8			8	3	1
	Palma	10	1		11	3	2
	Pemba	7			7	5	1
Subtotal – Handline		**26**	**1**	**0**	**27**	**3**	**1**

In Nampula results also indicates that purse seine fishing is conducted from wooden engine powered boats (Table 6). The operations are performed by a crew of 18 fishermen on average (Table 6). Handline fishing is conducted with wooden canoes with average 4 metres in total length, moved by paddles generally with one fisherman (Table 6).

Table 6. Characterization of fishing units in Nampula.

Gear	District	Propulsion			Boat material	Boat length	Crew number
		Paddles	Sail	Engine	Wood		
Purse seine	Moz island			11	11		
	Memba						
	Mossuril						
	Nacala Porto			1	1	14	18
Subtotal – Purse seine		**0**	**0**	**12**	**12**	**14**	**18**
Handline	Moz island	4			4		
	Memba	7			7	4	3
	Mossuril	16	6		22	3	1
	Nacala Porto	3			3	4	1
Subtotal – Handline		**30**	**6**	**0**	**36**	**4**	**1**

5.1.4. Seasonality of artisanal tuna fishing

In Cabo Delgado, most of the purse seine and handline fishermen reported that tuna fishing is more pronounced in winter and is independent of tide (Table 7). They further affirmed that fishing for tuna and tuna like species is carried out during the day, every days of the week (Table 7). Regarding the Fishing trip, there is indication that purse seine has a longer duration than handline fishing. For purse seine 60% of the inquired fishermen stated that the trip takes between 8-12 hours and 26% said that it takes between 5-7 hours (Table 7). For handline, 56% stated that fishing trip takes between 5-7 hours and 37% stated that it takes between 8-12 hours (Table 7).

Table 7. Seasonality of artisanal tuna fishing in Cabo Delgado

Gear	District	Season of tuna fishing			Tide			Days of the week	Period of the day			Trip duration (h)		
		Winter	All year	Summer	Neap	Spring	Neap and Spring	Every days	day	Day and night	Night	0 - 4	5 - 7	8 - 12
Purse seine	Macomia	14	4				17	17	14		3	5	3	11
	Mecufi	3			1	2		3	3			1	2	
	Palma	22			2		20	22	21			1	8	13
	Pemba	14			8	1	5	14	13	1		1	2	11
Subtotal – Purse seine		**53**	**4**	**0**	**11**	**3**	**42**	**56**	**51**	**1**	**3**	**8**	**15**	**35**
Handline	Macomia		1			1			1			1		
	Mecufi	8				3	5	8	8				8	
	Palma	10	1			1	10	11	11				2	9
	Pemba	7			1		6	7	6	1		1	5	1
Subtotal – Handline		**25**	**2**	**0**	**1**	**5**	**21**	**26**	**26**	**1**	**0**	**2**	**15**	**10**

In Nampula, for purse seine, despite the low number of inquired fishermen, there is indications that seasonality of tuna fishing is similar to Cabo Delgado (Table 8). With regard to handline, 41% of the inquired fishermen stated that tuna fishing is carried out throughout the year, 41% in summer and 18% catching tuna and tuna like species in winter (Table 8). Fishing is independent of tide and takes place every days of the week during the daytime period with an average trip duration of 5-7 hours (Table 18).

Table 8. Seasonality of artisanal tuna fishing in Cabo Delgado

Gear	District	Season of tuna fishing			Tide			Days of the week	Period of the day			Trip duration (h)		
		Winter	All year	Summer	Neap	Spring	Neap and spring	Every days	Day	Day and night	Night	0 - 4	5 - 7	8 - 12
Purse seine	Moz island													
	Nacala Porto	1						1	1	1			1	
Subtotal – Purse seine		**1**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**0**	**0**	**1**	**0**
Handline	Moz island		1						1					
	Memba		1	6	4		3		7				6	1
	Mossuril	1	7	3			11	7	11					
	Nacala Porto	3				1	2	10	3			1	3	
Subtotal – Handline		**4**	**9**	**9**	**4**	**1**	**16**	**17**	**21**	**0**	**0**	**2**	**9**	**1**

5.1.5. General trend in catch and fishing effort

In Cabo Delgado there is unanimous perception from the purse seine and handline fishermen point of view that the effort has been increased over the years (Table 9). With regard the catches in purse seines 80% of the inquired fishermen mentioned that there is reduction over the years and 20% mentioned that there is increase in catches (Table 9). In the handline fishing there is a general perception of reduction of catches over the years (Table 9).

Table 9. General trend of catch of tuna and tuna like species and effort in Cabo Delgado.

Gear	District	Trend in fishing effort		Trend in catch	
		Reduction	Increase	Reduction	Increase
Purse seine	Macomia		18	9	9
	Mecufi		3	3	
	Palma		22	22	
	Pemba		1	1	
Subtotal – Purse seine		**0**	**44**	**35**	**9**
Handline	Macomia		1	1	
	Mecufi		7	7	
	Palma		11	11	
Subtotal – Handline		**0**	**19**	**19**	**0**

In Nampula, the perception of both purse seines and handline fishermen is that the level fishing effort trend to increase while the level of captures has been decreasing over the years (Table 10).

Table 10. General trend of catch of tuna and tuna like species and effort in Nampula.

Gear	District	Trend in fishing effort		Trend in catch	
		Reduction	Increase	Reduction	Increase
Purse seine	Nacala Porto		1	1	
Subtotal – Purse seine		**0**	**1**	**1**	**0**
Handline	Memba		7	7	
	Mossuril		22	22	
	Nacala Porto		3	3	
Subtotal – Handline		**0**	**32**	**32**	**0**

5.1.6. Composition of tuna and tuna like species in the catches

Cabo Delgado

According results of the interviews the main IOTC primary species in artisanal purse seine fishing are *Auxis thazard*, *Auxis rochei*, *Euthynnus affinis* and *Katsuwonus pelamis* with 83,3%, 78,5%, 76,1% and 57,1% of the inquired fishermen stating that catch a lot such species respectively (Figure 2).

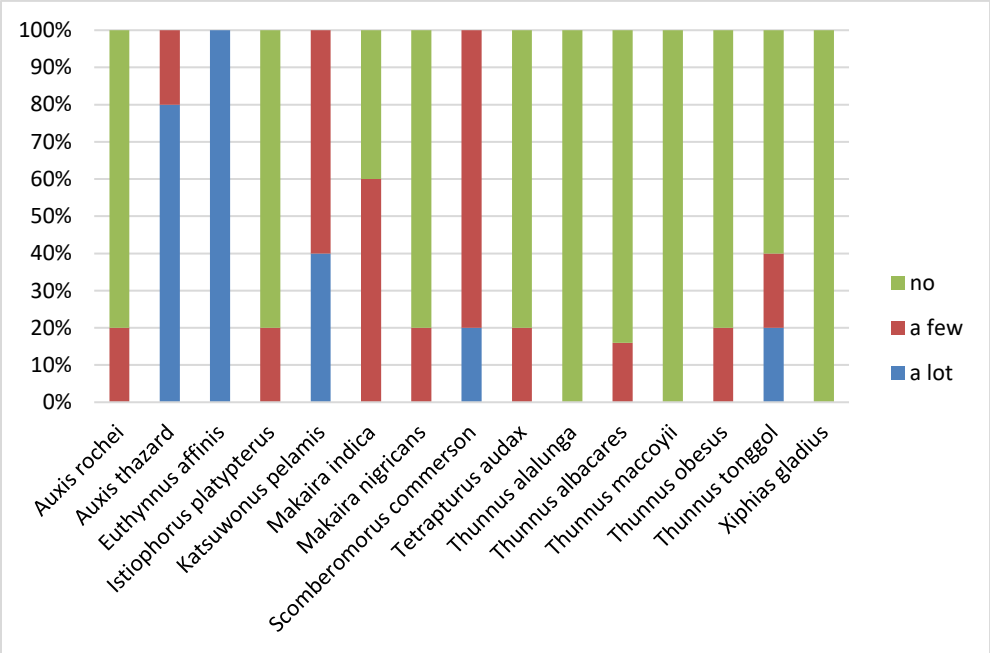

Figure 2. Estimative of catch of IOTC primary species in Cabo Delgado artisanal purse seine fishing.

Based on the fishermen perception, handline fishing seems to have greater diversity of IOTC primary species in the catch (figure 3). For all species there was less than 15% of the inquired stating that do not capture such species (Figure 3). The main species captured in the handline fishing is *Scomberomorus commerson* with 90% of the inquired claiming high catches (Figure 2). The remaining species shown in figure 3, except for *Xiphias gladius*, had about 50% of the inquired stating that they capture a lot, and about 50% saying they capture little such species.

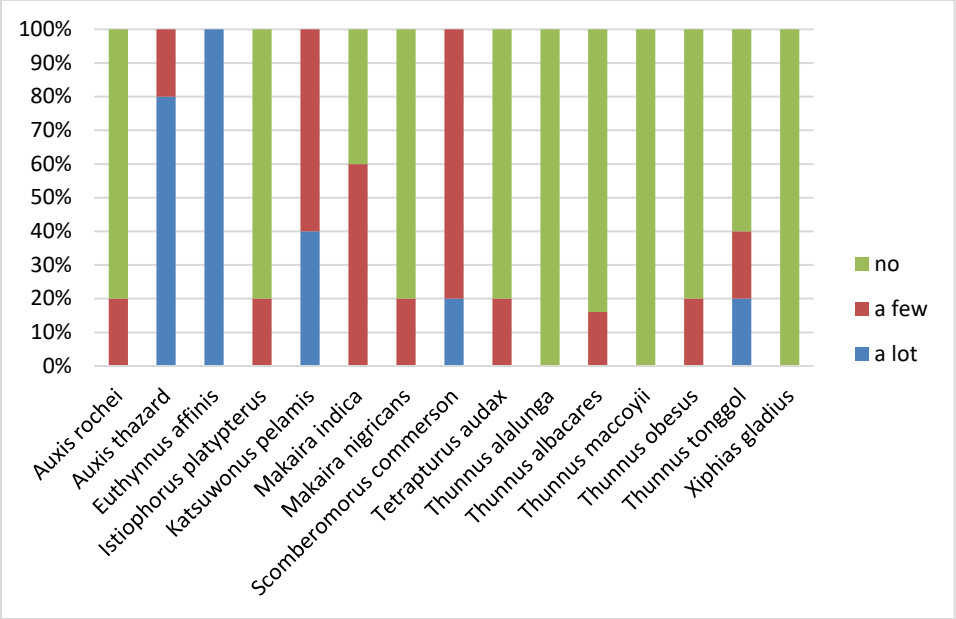

Figure 3. Estimative of catch of IOTC primary species in Cabo Delgado artisanal handline fishing.

Nampula

In Nampula artisanal purse seine fishing, the main species captured are *Euthynnus affinis* (100% of the inquired stating high catches), *Auxis thazard* and *Katsuwonus pelamis* (66% stating high catch and the remaining 34% stating little catch) (Figure 4).

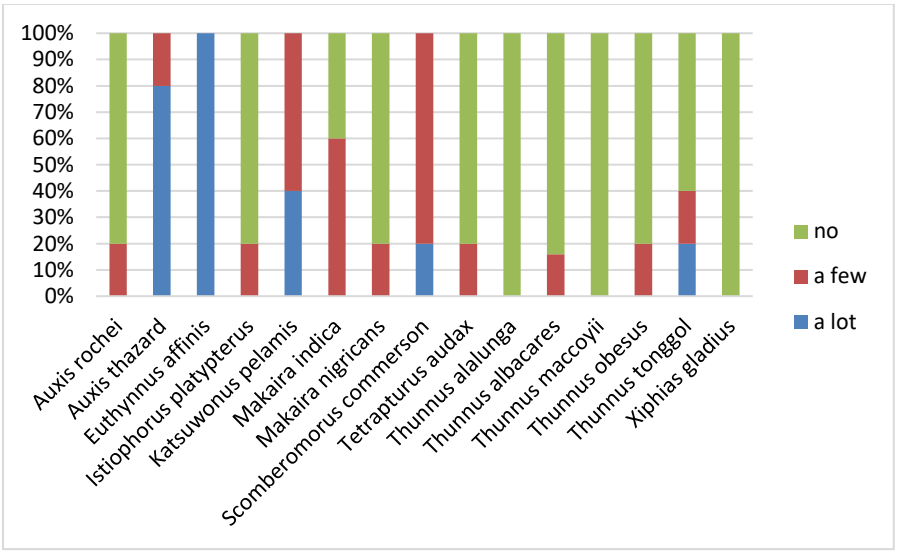

Figure 4. Estimative of catch of IOTC primary species in Nampula artisanal purse seine fishing.

In the handline fishing the main species captured are *Euthynnus affinis* (100% of the inquired stating high catch) and *Auxis thazard* (80% stating high catch and the remaining 20% stating little catch) (Figure 5). Other species potentially impacted by purse seines is *Katsuwonus pelamis* (40% stating high catch and the remaining 60% stating low catch) (Figure 5).

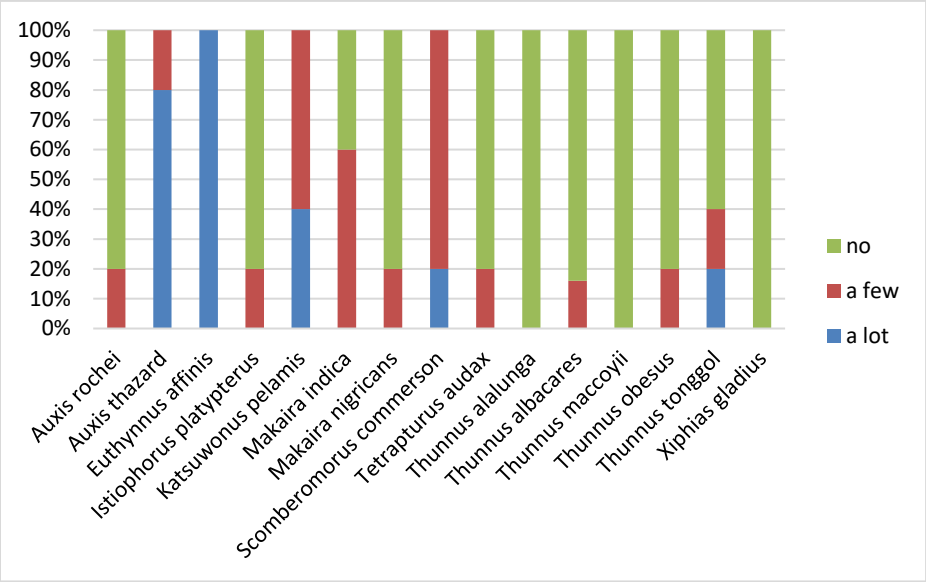

Figure 5. Estimative of catch of IOTC primary species in Nampula artisanal handline fishing.

5.2. Sampling campaigns during disembarkation at landing sites

5.2.1. Catch composition

Cabo Delgado

In the Cabo Delgado purse seine fishing, the capture of IOTC primary species (tuna, billfish and serfish) represented about 42% of the total production (Figure 6). The production of this group was dominated by *Euthynnus affinis* (15%), *Auxis rochei* (10%) and *Auxis thazard* (9%) (Figure 7). Other IOTC species captured to a lesser extent were *Scomberomorus commerson* (3%) and *Katsuwonus pelamis* (2%) (Figure 7). In this fishery there is also an incidence of small pelagic fish mainly of sardines (39%) (Figure 6), composed of *Sardinops ocellatus* (27%), *Amblygaster sirm* (8) and *Sardinella albella* (4%) (Figure 7). In addition to sardines, the artisanal purse seine fishing also target on other small pelagics including *Decapterus sp*., *Leiognathus Sp.* and *Stolephorus* Sp. (Figure 6).

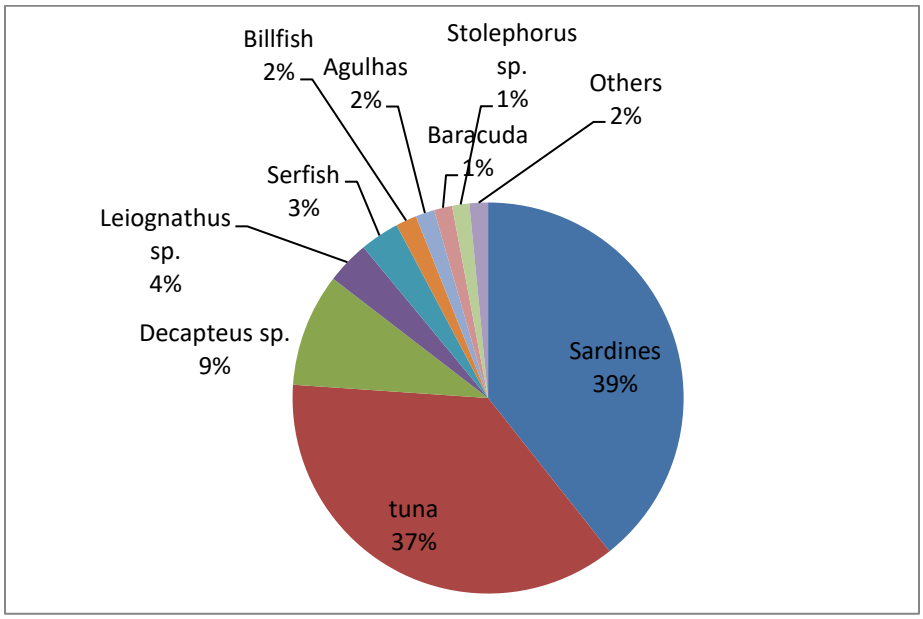

Figure 6. Catch composition of the artisanal purse seine fishing by commercial categories of species in Cabo Delgado.

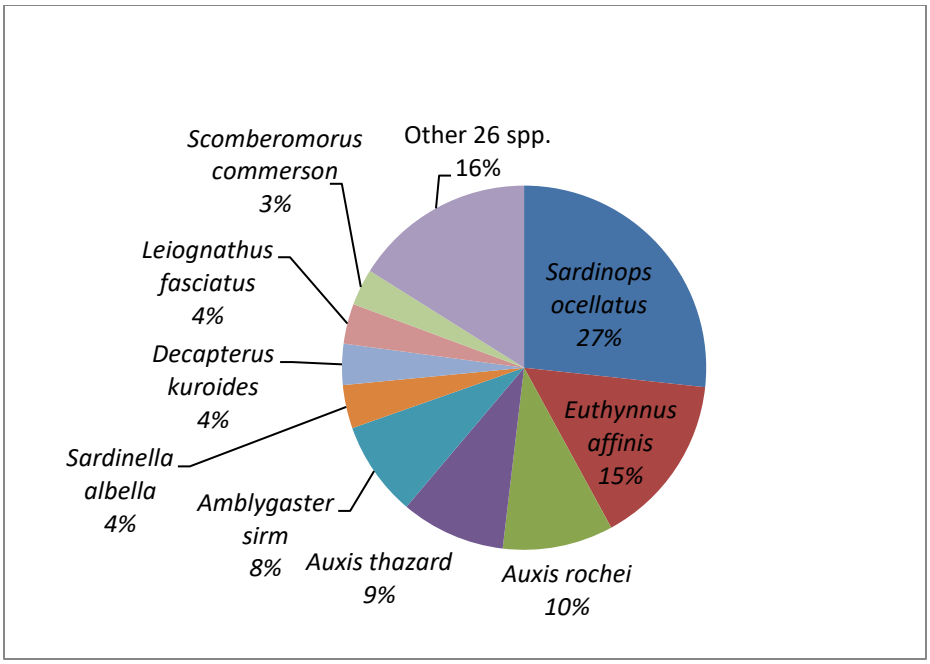

Figure 7. Catch composition of the artisanal purse seine fishing by species in Cabo Delgado.

Handline catches were also dominated by the primary IOTC Species (tunas, billfish and serfish) which accounted for about 43% of the total production (Figure 8). In terms of species, the production of this group was dominated by *Istiophorus platypterus* (10%), *Katsuwonus pelamis* (9%), *Thunnus obesus* (8%), *Scomberomorus commerson* (7%) and *Makaira indica* (3%) (Figure 9). Other IOTC Species captured to a lesser extent were *Makaira mazara*, *Auxis thazard*, *Thunnus albacares* and *Auxis rochei*. In addition to the IOTC primary species, artisanal handline fishing also target on Carangids and demersal species like rays, Nemiterus sp., and Lethrinids (Figure 8).

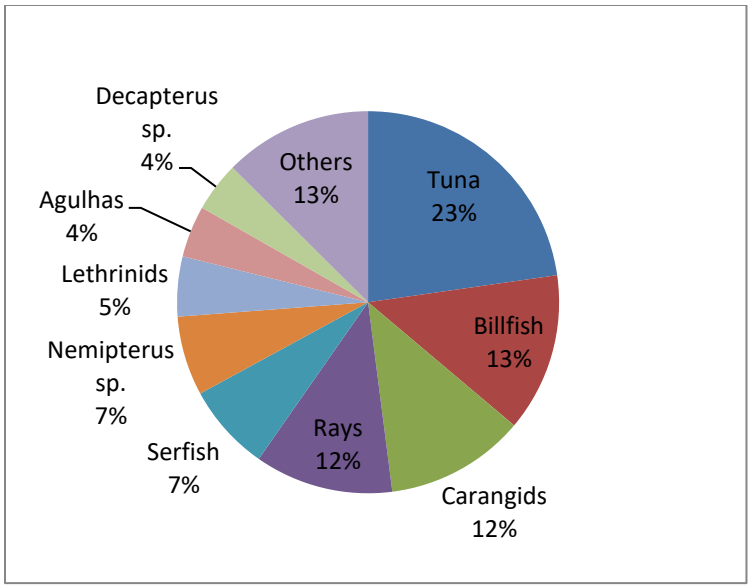

Figure 8. Catch composition of the artisanal handline fishing by commercial categories of species in Cabo Delgado.

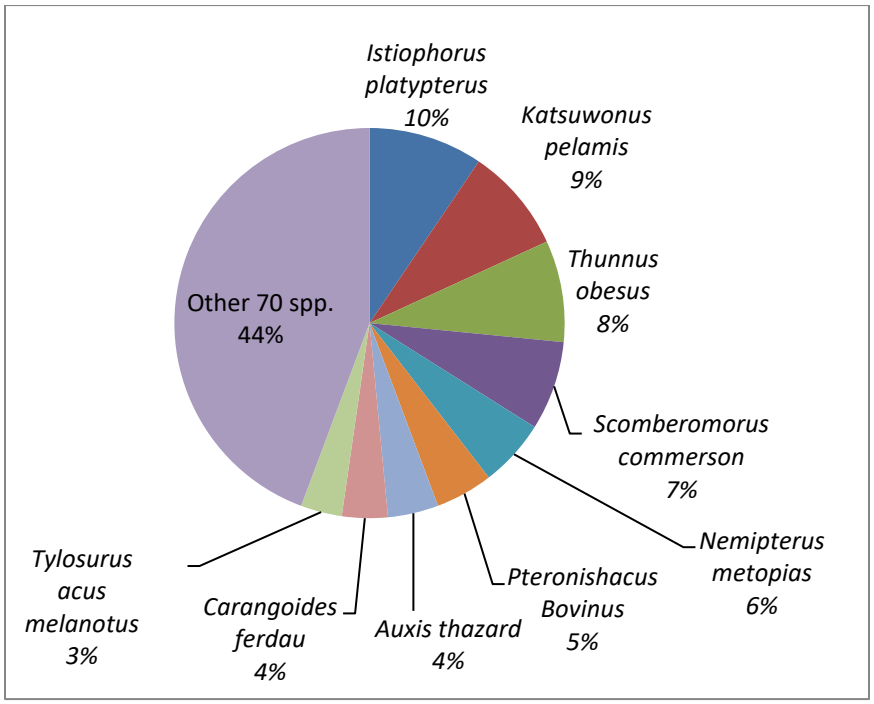

Figure 9. Catch composition of the artisanal handline fishing by species in Cabo Delgado.

Nampula

In Nampula artisanal purse seine fishing, the capture of IOTC primary species accounted for about 39% of the total production (Figure 10). The production of this group was composed of *Auxis thazard* (22%) and *Euthynnus affinis* (17%) (Figure 11). In this Fishery, similarly to Cabo Delgado, there is also incidence of small pelagic fish, mainly sardines (18%) dominated by *Amblygaster sirm* (Figures 10 and 11).

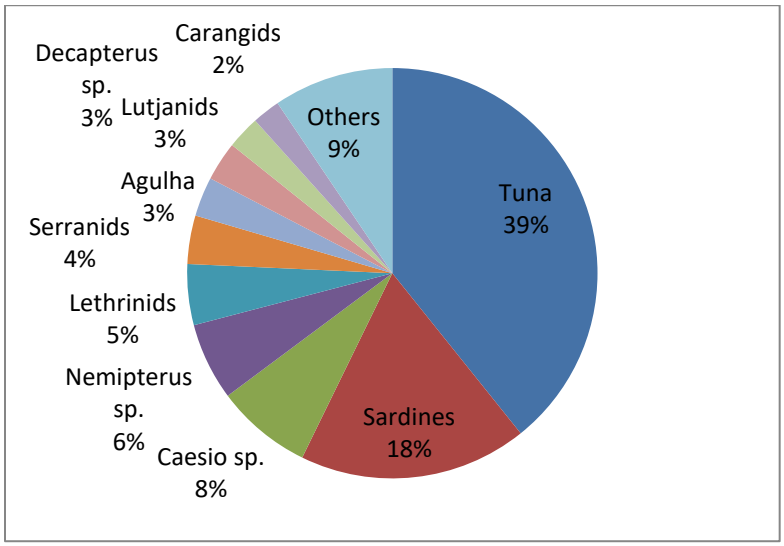

Figure 10 Catch composition of the artisanal purse seine fishing by commercial categories of species in Nampula.

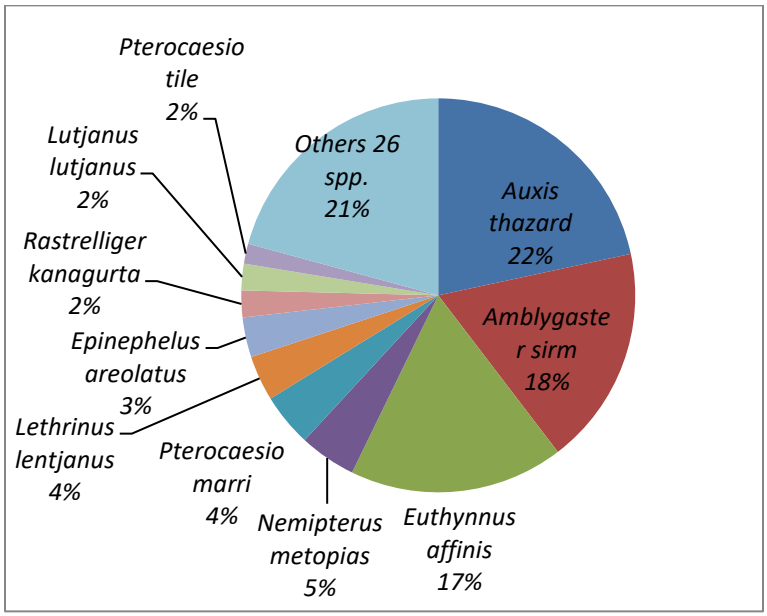

Figure 11. Catch composition of the artisanal purse seine fishing by species in Nampula.

In the artisanal handline fishing, catches were also dominated by the primary IOTC Species which accounted for about 28% of total production (Figure 12). In terms of species, the production of this group was dominated by *Thunnus obesus* (12%), *Katsuwonus pelamis* (8%) and *Euthynnus affinis* (4%) (Figure 13). In addition to the IOTC species, artisanal handline fishing also target on Carangids and demersal fish such as deep-water snappers (*Etelis Sp.*), emperors (Lethrinidae) and rabbitfishes (Siganidae) (Figures 12 and 13).

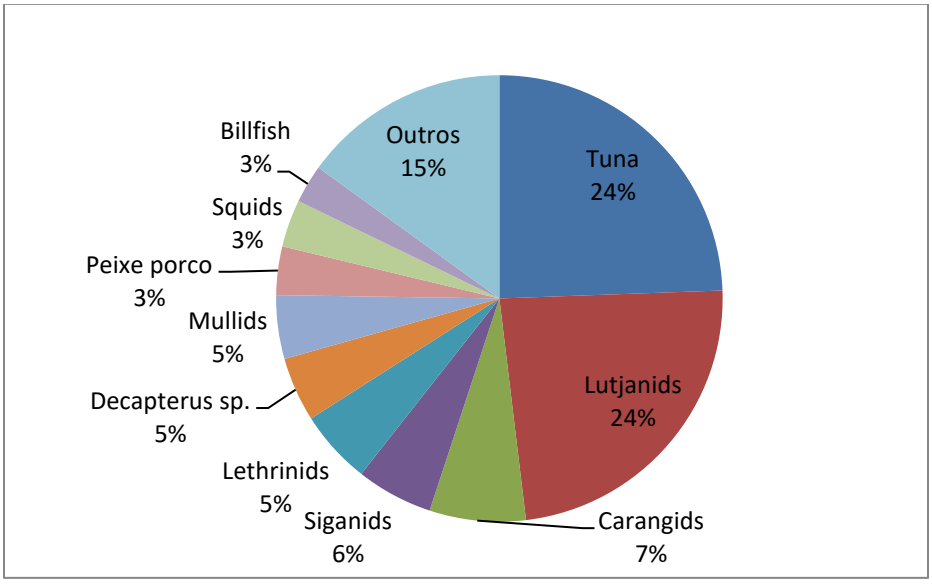

Figure 12. Catch composition of the artisanal handline fishing by commercial categories of species in Nampula.

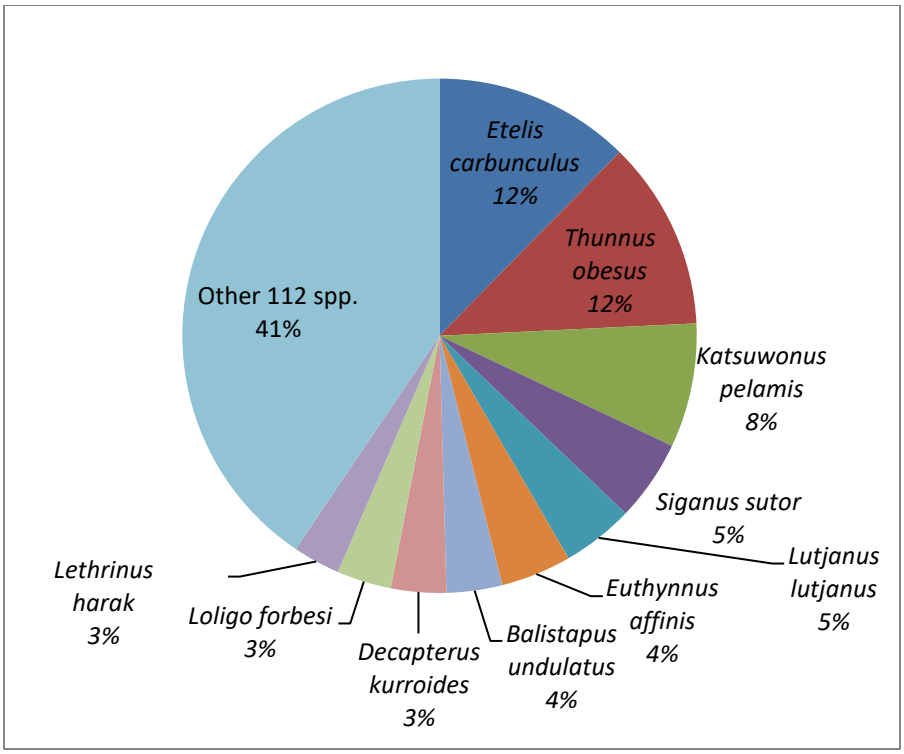

Figure 13. Catch composition of the artisanal handline fishing by species in Nampula.

5.2.2. Estimative of catch rates

In Cabo Delgado province, from the total 96 purse seine landings sampled a total catch of 14 tons were obtained. From the total of 211 handline sampled, a total catch of 1,7 tons were obtained. The CPUE was estimated at 146 kg /boat.day and 17,5 kg /boat.day for purse seine and handline fishing respectively. The average catch estimated for IOTC primary species was 61 kg/ boat.day and 7,6 kg /boat.day for purse seine and handline respectively. Figure 14 shows the CPUE of the IOTC primary species for purse seine and handline based on sampled gears in Cabo Delgado.

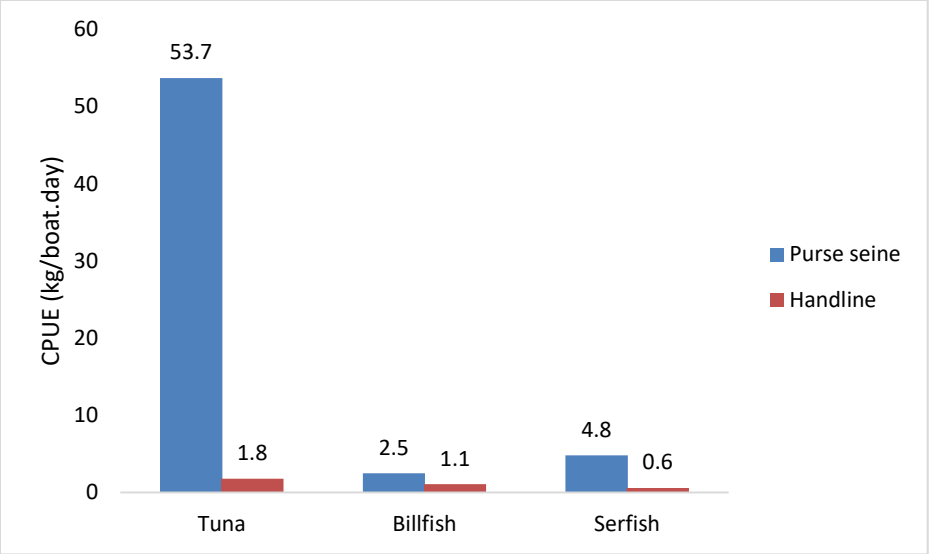

Figure 14. Catch rates of tuna, billfish and serfish in the artisanal purse seine and handline fishing of Cabo Delgado.

In Nampula province, from the total 65 purse seine landings sampled, a total catch of 2,8 tons were obtained. From the total of 206 handline landings sampled, a total catch of 2,3 tons were obtained. The average CPUE was estimated at 42,3 kg /boat.day and 11 kg / boat.day for purse seine and handline respectively. The average catch estimated for IOTC primary species was 16,6 kg /boat.day and 3,2 kg/ boat.day respectively. Figure 15 shows the CPUE of the IOTC primary species for purse seine and handline based on sampled gears in Nampula.

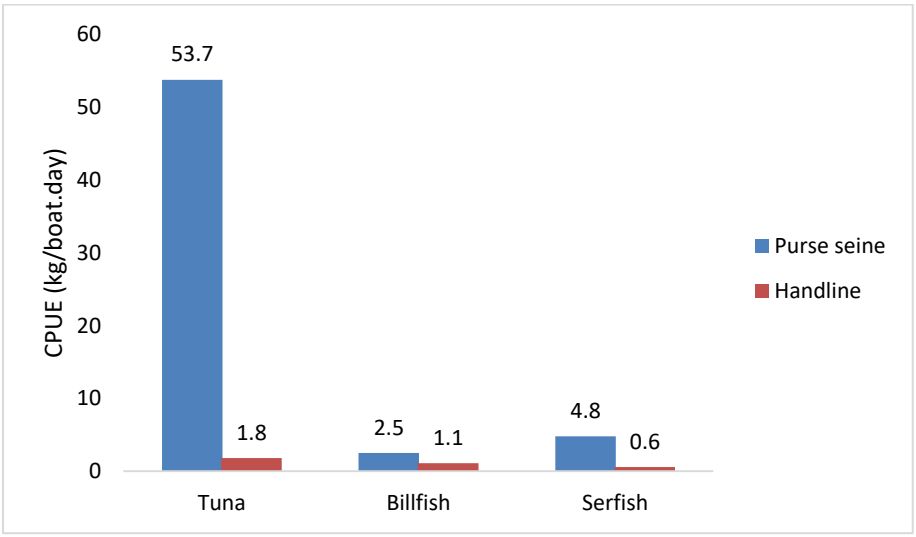

Figure 15. Catch rates of tuna, billfish and serfish in the artisanal purse seine and handline fishing in Nampula.

5.2.3. Average size of tuna and tuna like species

Tables 11 and 12 below show the average lengths (± standard deviation) of the IOTC primary species sampled during the campaigns conducted in Cabo Delgado and Nampula, respectively.

In Cabo Delgado, the species best represented in terms of sample size in purse seines were *Euthynnus affinis*, *Auxis thazard* and *Auxis rochei*, while in handline were *Katsuwonus pelamis* and *Scomberomorus commerson* (Table 11). Although the number of samples is not representative to ensure a faithful comparative analysis of the average length of species captured by the two gears it is possible to note that there is a tendency of the handline to capture larger individuals comparatively to purse seine (Table 11).

Table 11. Average total length (CT) of IOTC species caught in artisanal purse seine and handline fisheries of Cabo Delgado.

	Purse seines		**Handline**	
Species	CT (cm)	N	CT (cm)	N
Auxis rochei	30 (±2.8)	27		
Auxis thazard	30(±5.7)	52	32(±9.2)	13
Euthynnus affinis	35(±6)	81		
Istiophorus platypterus			116(±50.1)	6
Katsuwonus pelamis	39(±8.3)	10	48(±14.1)	33
Makaira Indica			110(±61.5)	4
Makaira Mazara			78	1
Scomberomorus commerson	46(±13.2)	4	58(±21.1)	28
Thunnus alalunga			49(±33.9)	2
Thunnus albacares			70	1
Thunnus obesus			36(±17.6)	10

In Nampula, the species best represented in terms of sample size in purse seine was *Euthynnus affinis*, while in handline were *Euthynnus affinis*, *Thunnus obesus* and *Katsuwonus pelamis* (Table 12).

Table 12. Average total length (CT) of IOTC species caught in artisanal purse seine and handline fisheries of Nampula.

	Purse seines		Handline	
Species	CT (cm)	N	CT (cm)	N
Auxis rochei	20	1		
Auxis thazard	47	1		
Carcharhinus leucas			154	1
Euthynnus affinis	39 (±10.2)	87	35 (±11.7)	36
Istiophorus platypterus			158 (±66)	6
Katsuwonus pelamis			57.2 (±15.7)	20
Makaira indica			141	1
Scomberomorus commerson			71 (±18)	5
Sphyrna lewini			51	1
Thunnus alalunga			81.5 (±0.7)	2
Thunnus obesus	48	1	79 (±18.5)	27

6. CONCLUSIONS

Purse seine fishing

- The artisanal purse seine fishing takes place in the open sea, using wooden engine powered boats, which has on average 7 to 9 meters in length, which carry on average 18 fishermen.

- Most purse seine fishermen are housefathers who have dependents and are mostly in the 41-60 years old while a significant part is 21-40 years old. These purse seine fishermen are mostly non-boat owners and fishing is their only source of income. Tuna and tuna like species fishing is for commercial purposes although a small fraction of the catch (about 10%) is reserved for family consumption.

- Tuna fishing by purse seine is most pronounced in winter. Fishing is done in the daytime regardless of the type of tide and day of the week. The fishing trip for purse seiners lasts from 6 to 12 hours.

- The IOTC species potentially captured in purse seine fishing are the neritic tunas *Euthynnus affinis*, *Auxis thazard* and *Auxis rochei* and skipjack tuna (*Katsuwonus pelamis*). The composition of tunas and tuna like species in purse seine in some periods may account to 40% in some Districts such as Pemba (in Cabo Delgado) and Mozambique island (in Nampula). In addition to the IOTC species IOTC, purse seine potentially impacts small pelagics such as sardines (Clupeidae), mackerels (Decapterus sp.) and anchovies (Stolephorus sp.).

- The average catch rate of IOTC primary species in purse seine fishery can ranges from 17 to 61 kg/ boat.day.

- There are indications that purse seine captures smaller individuals in terms of size compared to handline art. In the purse seine, the average total length of species best represented in terms of sample size in Cabo Delgado was 35 (± 6) cm for *Euthynnus affinis*, 30 (± 5.7) cm for *Auxis thazard* and 30 (± 2.8) cm to *Auxis rochei*. In Nampula the *Euthynnus affinis* was the best represented species with average total length of 39 (± 5.7) cm.

Handline fishing

- Handline fishing is carried out in both the estuarine and open sea environments. However, catch of tuna and related species is done in the open sea.

- Handline fishing is carried out using small canoes, moved by paddles, with an average of three meters in length taking one or two fishermen.

- Most handline fishermen are housefathers and are mostly between 21-40 years old despite a significant part are between 41-60 years, and above 60 years old. These fishermen are mostly boat owners and aside of fishing have agriculture as another source of income. Tuna and tuna like species fishing are captured for commercial purposes although a small fraction of the catch (about 10%) is reserved for family consumption.

- Handline tuna fishing is carried out over the year. Fishing is conducted in the daytime regardless the tide and day of the week but fishing trip has an average duration of less than 6 hours.

- Handline impacts on a larger spectrum of species compared to purse-seine with catches including neritic tuna, tropical tuna species, billfish and serfish. The most representative species are bigeye tuna (*Thunnus obesus*), skipjack tuna (*Katsuwonus pelamis*), indo-pacific sailfish (*Istiophorus platypterus*) and narrow-barred Spanish mackerel (*Scomberomorus commerson*). Besides IOTC primary species handline also targets on carangids, demersal fish such as emperors, snappers, breams (Nemipterids), and rabbitfishes (Siganidae).

- The composition of tunas and related species in handline fishing may vary between 20 and 40% of total catch in open sea operations and catch rate may vary from 3 to 8 kg/boat/day.

- In handline fishing, the average total length of species best represented in terms of sample size in Cabo Delgado was 48 (±14) cm for *Katsuwonus pelamis* and 58 (±21) cm for *Scomberomorus commerson.* In Nampula, the average total length of species best represented in terms of sample was 35 (±11) cm for *Euthynnus affinis*, 79 (±18) cm for *Thunnus obesus* and 57 (±17) cm for *Katsuwonus pelamis.*

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APPENDIX 1: SCRIPT OF THE INTERVIEW

REPÚBLICA DE MOÇAMBIQUE

MINISTÉRIO DO MAR ÁGUAS INTERIORES AND

INSTITUTO NACIONAL DE INVESTIGAÇÃO PESQUEIRA

Av. Mao Tsé Tung, 389 C.P. 4603 Telefs. (21) 490307/490536 Fax. 00258 (21) 492112 -Maputo - Moçambique

Artisanal Tuna Fishing

Interview to be submitted to fishermen of Purse seines and handline and other fishing gears catching tuna, billfishes or serfish (minimum of 30 interviews for each type of gear in each Fishing center)

1. **Identification of the Interview**

Gear		**Nome do Barco**	
Interview number		District	
interviewer		stratum	
Date		Fishing center	

2. **Identification of the fisherman:**

Fisherman code		Place of residence	
Age		Nr. of dependents	
Sex		Position in the family	

3. **Socio-economic information:**

How long have you been fishing in the area?	
What is the destination of tuna, billfish and serfish?	
Which % you Sells and consume?	Sells_____% Consume_____%
Which type of fish do you eat more?	
What other fish do you catch?	
Selling price for tunas, billfishes and serfish (Kg or box)?	
Selling price for other species (Kg or box)?	
Other sources of income (activity)?	-

How much you earn per month in these other activities?	

4. Boat details and gears:

Name of the boat:			
Boat Ownership?	Yes/No	Boat propulsion?	Engine/ sail/ paddles
Gear Ownership?	Yes/No	Propulsion?	Wood/ fiberglass/ metal
Fisherman only?	Yes/No	Boat length?	
Boat is purchased locally?	Yes/No	Crew number?	
Boat is made by the owner?	Yes/No	Gear length?	
Gear is purchased locally?	Yes/No	Type of hooks and sizes?	
Gear is made by the owner?	Yes/No	Net mesh size?	

5. Fishing locations where tuna, billfish and serfish are caught:

Name of the fishing ground	**Type of environment** (Estuary, open sea, before the islands, besides the islands)	**Bottom** (Rock, corals, seagrass, sand, mud)
FISHING DEPTH?		

6. Effort and seasonality:

In what months of the year Fishing the tuna, saw and marlins?	
Do you fish tuna, billfish or serfish more on Summer or Winter?	
In what tide do you fish tuna, billfish or serfish?	
How many days per week do you go for fishing tuna species?	
In which days of the week do you go for fishing?	
Do you go for fishing tuna during the day or night	
What is the trip duration?	
Which fishery do you conduct outside the tuna season	

7. Catch rates (Kg/trip or ton/trip) and seasonality

Catch rate of tuna, billfish and serfish during:		**Catch rate of other resources during:**	
Summer	Winter	Summer	Winter
Spring tide	Boat material tide	Spring tide	Boat material tide
Day	Night	Day	Night

8. Catch composition:

Which species do you capture and what is the relative amount in the catches?

Common name	**Scientific name**	**No / a few / a lot**
Yellowfin tuna	*Thunnus albacores*	
Bigeye tuna	*Thunnus obesus*	
Skipjack tuna	*Katsuwonus pelamis*	
Albacore	*Thunnus alalunga*	
Southern bluefin tuna	*Thunnus maccoyii*	
Swordfish	*Xiphias gladius*	
Black marlin	*Makaira indica*	
Blue marlin	*Makaira nigricans (mazara)*	
Striped marlin	*Tetrapturus audax*	
Indo-pacific sailfish	*Istiophorus platypterus*	
Longtail tuna	*Thunnus tonggol*	
Kawakawa	*Euthynnus affinis*	
Frigate tuna	*Auxis thazard*	
Bullet tuna	*Auxis rochei*	
Narrow-barred Spanish mackerel	*Scomberomorus commerson*	
Sharks		
Rays		
Turtles		
Seabirds		
Mammals		

9. General information on fishery and fishing center

Nr. of boats		Year fishery starts	
Nr. of gears per boat		Provenance of fishermen	
Fishing trip duration		Trend on effort	
Average catch per trip		Trend on catch	

10. Other relevant information provided during the interview.