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ASSESSMENT OF ECONOMIC VIABILITY OF THE ARTISANAL FISHERIES IN CABO VERDE - RECOMMENDATIONS FOR IMPROVEMENT

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ABSTRACT

The artisanal fishery of Cabo Verde plays an important role regarding food security, job creation and poverty reduction. Access to the fishery is controlled by a licensing system, but our analysis indicates that this system is inefficient in reducing catches, sustaining incomes. The fishery has many characteristics of open-access fisheries. This study assesses the economic viability of the fishery and how the management system can be improved upon. Current fishing effort is above the estimated level associated with maximum economic yield from most of the islands and adjustments are needed in effort. In order to move towards sustainable and efficient fishing it is necessary to change the number of vessels in the islands of Boavista, by -60%, Brava, by 9%, Fogo, by -57%, Maio, by -30%, Sal, by 14%, Santiago, by -13%, Santo Antão, by -7%, Sao Nicolau, by -19% and Sao Vicente, by -29%. On average the reduction need is -19%, which means a reduction in the total number of vessels which stands currently in current total number of vessels, which stands currently on 1,827, to 1,483. Low salaries, weak capacity to invest and strong dependence on one fishing gear and, consequently, short range of target species and fishing grounds, increases the associated risks to the economic viability of the fishery and results in low profits. Therefore, it is urgent to improve the management of the artisanal fishery in general. in this paper 9 policy interventions are identified, which aim to improve the biological and economic situation in the fishery.

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1 INTRODUCTION

Fisheries products are an important and consistently affordable dietary component worldwide. They provide more than 20 percent of the average *per capita* animal protein intake for 3 billion people, and more than 50 percent in some less developed countries. The *per capita* global fish consumption has doubled since the 1960s, increasing its important role in the fight against hunger and showing that today the fisheries sector is crucial to food security and human nutrition (FAO, 2018).

Recognising the importance of the contribution of small-scale fisheries to food security and poverty eradication, the UN Food and Agriculture Organization (FAO) Committee on Fisheries meetings in 2014 and 2018 focused on small-scale fisheries. The General Assembly of the United Nations has proclaimed 2022 as the International Year of Artisanal Fisheries and Aquaculture to improve the knowledge of this sector's contributions to the sustainable development goals (SDG) of the 2030 Agenda (FAO, 2018) as well as to raise awareness for policy makers about the importance of policies and programmes that promote sustainable artisanal fisheries.

Small-scale fisheries are not only an important sector which can help countries to reach the local and global goals mentioned above. Also, small-scale fisheries have an important link to gender issues, as it is very common that men are dominant in the fishing activity itself, while women are dominant in the processing and sale of fish. This is especially the case in many developing countries (FAO, 2018), as it is in the Cabo Verde Islands.

The Cabo Verde Strategic Plan for Sustainable Development 2017/2021 (CVSPSD 2017/2018) lists social inclusion, the reduction of unfairness and social and local asymmetries among the main pillars for sustainable development. It also states that, in order for the strategic plan to be efficiently executed, countries must improve in local and regional development and have policies that stimulate the autonomy and self-sufficiency of families, based on employment, production and incomes. Small-scale fisheries play an important role in this process.

However, small-scale fisheries are only able to contribute to these goals if they are well managed. But the sector faces serious social and economic challenges in many countries, and Cabo Verde is no exception.

The current situation indicates that fish stocks are under strong pressure because of exploitation, representing a risk to the medium/long term sustainability, especially of artisanal fisheries. Overfishing and climate change has resulted in the loss of traditional target species and reduction in income and number of jobs and increased concerns about food security (SPSD, 2016).

An open access system, which lacks property rights to restrict harvests is far from being socially efficient, and usually leads to over exploitation (see e.g. Habib et al, 2014**)**.

Small-scale fisheries in Cabo Verde are unique in terms of species harvested, species distribution, low recruitment, low growth rates of individuals and vulnerability of most of the target species due to climate change and overfishing. Also, there is seasonality in the fishing activity, mostly due to weather, and the lack of technology that can mitigate unfavourable climatic conditions. All this makes it harder for the fishers to achieve satisfactory economic outcomes.

To safeguard long-term economic viability, it is necessary to achieve ecosystem sustainability, increase the biomass of coastal resources, improve the traditional methods of capture used and increase incomes. Achieving all these goals simultaneously is a challenge.

When assessing the economic viability of small-scale fisheries, we should not focus solely on financial viability, where profitability is the only goal, because often small scale fisheries (SSF) are a part of a complex dynamic system where the goal is not always only profits, but also social wellbeing and the maintenance of livelihoods (Schuhbauer, 2017).

The wellbeing of fishermen and fisheries communities is interconnected with those in other parts of society, with a strong impact on the overall economic and social activities. This may call for different ways of thinking about how the sector should be economically and sustainably developed. These factors have resulted in increased interest in new policy and research agendas, especially since the Bangkok Conference in 2010 (WSSFC, 2010).

Cabo Verde uses no official definition for small-scale fisheries (SSF), but, the European Union (EU), has defined SSF as: "fishing carried out by fishing vessels of an overall length of less than 12 m and not using towed fishing gear" (Fabrizio, Carvalho, & Paulrud, 2015). A large part of the semi-industrial fleet is under 12m, however in this study we are only considering the artisanal fleet.

2 OBJECTIVES

We assess the economic situation of the artisanal fishery in Cabo Verde and suggest ways to increase economic viability, without endangering the sustainability.

2.1 Attainable objectives

The attainable goals of this project include:

(i) Description of the artisanal fishery, i.e., the: fleet, catch composition, operational costs, incomes, and profits, both at national and at island level.

(ii) Assessment of the state of the main target species exploited by the artisanal fleet and the stock situation, both national and at island level.

(iii) An estimate of the effort that corresponds to the maximum economic yield (MEY) for the main target species of the artisanal fleet, both at the national and island levels.

(iv) Analysis of the relationship between effort, catch and profits, both at national and island levels.

(v) Identification of management strategies to increase the economic viability of the artisanal fishery.

3 METHODS

The study area is the Archipelago of Cabo Verde, located in the southern part of the North Atlantic Ocean, 500 km from the westernmost point of the African continent, Dakar, Senegal (Figure 1), considering the artisanal fishing activities conducted by the operators of the nine inhabited islands over the period from 1997 to 2017.

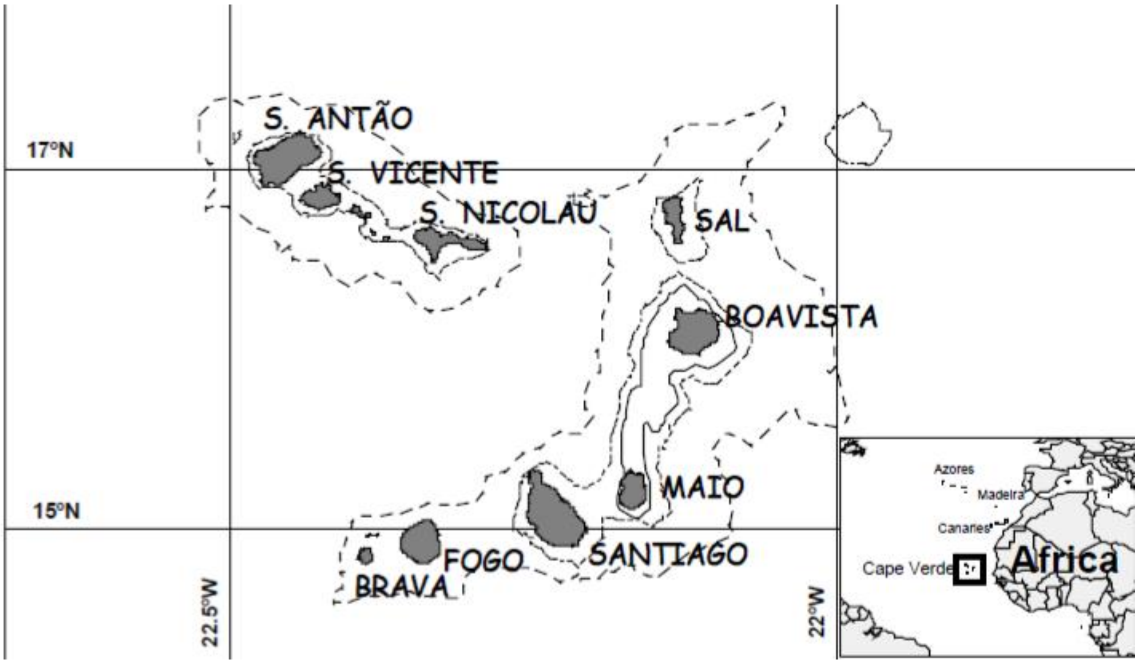


Figure 1 - Map of the Cape Verde Archipelago including bathymetric lines corresponding to depths of 200, 1000, and 3000 metres. (Source: Stobberup, 2005)

3.1 Data sources

The data is collected from different sources, with priority given to the official sources, whenever possible, using estimations or data from trusted sources when the official ones are not available.

3.1.1 Biological data

All the biological data used in this research, i.e., total length and body weight of fish were retrieved from the official authority for marine research in Cabo Verde (INDP). This data is available for five of the seven species mentioned in this study: (i) blackspot picarel, from 2005 to 2018, (ii) mackerel scad, from 2004 to 2018, (iii) bigeye scad, from 2004 to 2018; (iv) moray eels, from 2002 to 2018, and (v) grouper, from 2003 to 2018, but not for (vi) wahoo and (vii) yellowfin tuna.

Data on catch (Y) were sourced from INDP, the official authority for fishing statistics in Cabo Verde, in different formats:

(i) On catches from 1997 to 2012, including several specifications by gear, island, group of species and individual species; and

(ii) For 2013, 2014, 2015 and 2017, with specifications by island and species, and for 2016, with specifications by group of species only.

Effort (E) in number of days at sea and number of vessels, as well as data on the number of fishermen was sourced from INDP, the official authority for fishing statistics in Cabo Verde, and DGRM, the institution responsible for designing and implementation of the policies for fisheries. This data was also in different formats:

(i) Days at sea and number of vessels, from 1997 to 2012, with specifications by gear, island, group of species and species, and total number of fishermen per island, from 1997 to 2012.

(ii) From INDP, data on days at sea, for 2013, 2014, 2015 and 2017, with specifications by island, group of species and species, and, from DGRM, data on number of fishermen and vessels per island, from 2013 to 2016.

(iii) From previously un-published data, provided by Fisheries Inspectors on different islands. Number of vessels per island in 2018 is considered to be the same as in 2017.

The number of fishermen per vessel and per fishing gear were estimated by using the mean of fishermen per vessel on each island.

Most of the socio-economic data had to be estimated, using the data mentioned above, while data on prices for the first sale, fixed cost and variable cost was retrieved from several different sources:

(i) Evolution of price for the seven main species, for Santo Antão, São Vicente and Santiago Islands, from 2009 to 2017 (INE, 2018). São Nicolau, Maio, Fogo and Brava Islands are considered to have equivalent market, thus, equivalent prices to Santo Antão Island, and, in a similar analysis, Santiago Island's prices are applied to Sal and Boavista Islands.

(ii) Depreciation of the vessel and the engine are estimated to amount to 10% per year (Carvalho, 2006). The values are calculated for the last year, and used to determinate the value for the previous years, using Net Present Value calculations, assuming that it did not change very significantly in those years, or the changes did not have significant impact.

(iii) Salaries of the fishermen (profits divided by the mean of fishermen per boat, plus one, which represents the "part going to the" vessel owner, plus motorisation rate, which represents the part going to the engine owner) and the fuel consumption, with data from 2007 to 2017 provided by the national Agency for Economic Regulation (ARE).

Those variables are used to calculate revenues and profits in the following way:

(iv) **Revenue (R) –** the unit price times the total catch, i.e. R=PY; and

(v) **Profits (Π) –** Revenue (R) less the total cost (C), which again is the sum of FC and VC, i.e.

$$\pi = R - FC - VC \tag{1}$$

3.2 Data analysis

The analysis is constructed in multiple steps, in order to describe the artisanal fishing activity in Cabo Verde.

The state of stocks exploited is analysed in two ways, compilation and analysis of the scientific reports done previously, and use of numerical methods to determine the state of stocks of the main species studied, using biological data collected by INDP.

In this study, we specifically use the Gordon-Schaefer (GS) bioeconomic model to estimate E(MEY), suggested by Habib et al. (2014). This model, originated from Gordon and Schaefer, requires limited data to identify the relationship between effort and harvest in open access and values of maximum economic yield managed fisheries, that can be used as indicators for the establishment of fleet size. It can potentially identify the underlying relationship between incorporated variables, stock, effort, and harvest, under open access and maximum economic yield managed fisheries (Habib et al., 2014).

Fisheries based on highly productive biological resources with large r (intrinsic growth rate) and K (carrying capacity) may sustain a large fishing effort under open access. In all populations, natural surplus growth is small for both high and low stock level and the largest for some intermediate level. However, the Gordon-Schaefer model is based on the logistic growth function:

$$F\ (X) = rX\left(1 - \frac{X}{K}\right),$$

(2)

where $F(X)$ is surplus biomass growth per unit of time; X is stock biomass. The equation describes a parabolic curve as a function of X.

The harvest rate (H) is assumed by the simple relation of Schaefer catch function,

$$H\ (E, X) = qEX,$$

(3)

where E is fishing effort and q is a constant catchability coefficient. Sustainable yield occurs when harvest equals the surplus growth; that is, when rate of change of biomass,

$$\frac{dx}{dt} = F(X) - H(E, X) = 0.$$

(4)

This implies $qEX = rX(1 - x/K)$ based equations (1) and (2). Therefore, biomass at equilibrium, X, is solved to be

$$X = K\left(1 - \frac{qE}{r}\right).$$

(5)

Inserting equation (4) into (2) gives the long-term catch equation

$$H(E) = qKE\left(1 - \frac{qE}{r}\right) = qKE - \frac{q^2KE^2}{r}.$$

(6)

Dividing both sides of equation (5) by effort (E) gives the linear relationship between catch per unit of effort (CPUE) and fishing effort:

$$CPUE = \frac{H}{E} = p * H(E).$$

(7)

Assuming constant price, equation (5) can be used to define total revenue (TR) in equilibrium as a function of standardised effort:

$$TR(E) = p * H(E),$$

(8)

where p denotes a constant price per unit of harvest. Total cost of fishing effort (TC) is given by

$$TC(E) = c * E,$$

(9)

where c denotes unit cost of effort including opportunity cost of labour and capital.

From equations (7) and (8), the equilibrium resource rent (Π) can be derived as a function of fishing effort (E)

$$\pi(E) = TR(E) - TC(E).$$

(10)

Parameters are estimated by regression of the catch per unit effort data on the corresponding effort data. In equilibrium, we have considered that the average revenue is equal to marginal cost, so

$$\frac{\rho H}{E} = C,$$

$$\frac{H}{E} = \frac{C}{\rho}.$$

(11)

By using the unit cost of harvest and the resource rent per unit harvest, we can find the open-access equilibrium level of the fish stock. The unit cost of harvest follows by use of Schaefer catch function and total cost of fishing effort (TC)

$$C\ (X) = TC\,\frac{E}{H} = \frac{cE}{qEX} = \frac{c}{qX}.$$

(12)

This demonstrates that the unit cost of harvest decreases with an increase in the stock size. With the constant price of fish, the resource rent per unit harvest is

$$b(X) = p - \frac{c}{qX}.$$

(13)

At the open-access equilibrium, the stock level $X\,\infty$ follows from b ($X\infty$ = 0), and open access stock biomass (∞),

$$X\infty = \frac{c}{pq}.$$

(14)

The long-term harvest function can be expressed by

$$H\ (E) = aE + bE^2.$$

(15)

So, CPUE could be expressed by

$$CPUE = a + aE,$$

(16)

where a and b are parameters estimated by linear regression of the catch per unit of effort against effort.

Effort at maximum sustainable yield can be obtained from equation (14) by taking the partial derivative of H with respect to E and setting it equal to zero as

$$E\ (MSY) = \left(-\frac{a}{2b}\right).$$

(17)

Therefore, using the Gordon-Schaefer model, the effort at open access yield can be obtained by equating

$$c = \frac{pH(E)}{E},$$

$$cE = pH(E) \equiv E(OAY) = \frac{\frac{c}{p-a}}{b}.$$

(18)

The maximum economic return is realised at a lower total fishing effort for positive economic rent that is only obtained at efforts lower than E_{OA}.

This classical problem, where OAY represents the level of effort where cost is same as revenue, meaning that there is no profit.

MSY, and corresponding E_{MSY}, represents the level of adjustment needed, in order to obtain the maximum sustainable yield of the fishery, and MEY, and corresponding E_{MEY}, represents the level of adjustment needed, if the objective is to obtain the maximum economic yield of the fishery (Figure 2).

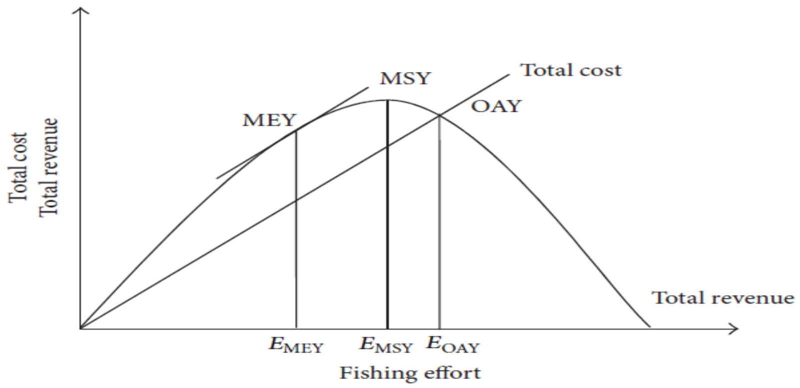


Figure 2 - The Gordon-Schaefer model (Source: Habib et al, 2014)

Maximum economic yield (MEY) is attained at the profit maximizing level of effort which is obtained using (9)Π'(E) = 0 or dTR(E)/dE = dTC(E)/dE. Therefore, the effort at MEY can be calculated as:

$$E(MEY) = \frac{\frac{c}{P} - a}{2b},$$

(19)

where a and b are the numerical parameter values, obtained from a linear regression of effort and CPUE. Their estimation is based on catch and effort data.

The corresponding number of vessels is established dividing the E(MEY) and E(MSY) by the average early number of days at sea per vessel.

Also, a sensitivity analysis is conducted to determine the changes on CPUE and catch levels, corresponding to different effort levels.

4 ARTISANAL FISHERIES SECTOR IN CABO VERDE

A general overview of the artisanal fishery in Cabo Verde is provided, as well as specificities of the different islands in the archipelago.

4.1 Geographic and demographic situation of Cabo Verde

Cabo Verde is a small archipelago, with 10 volcanic islands, inhabited by more than 500 thousand people.

Its location, in the Sahel zone, also means that it is highly influenced by climate change. In addition, the poor level of upwellings in the costal line, a narrow continental shelf, with an accentuated increase in depths, not far from the coast (figure 2), and low level of rain, contributes to a low level of mineral source incomes (WSSFC, 2010), resulting in a poor primary production. This affects all the subsequent food chain and leads to a low level of biomass (Agrawal & Gopal, 2012).

Despite the low primary production, the location and isolation make it a hot spot of biodiversity (DGA, 2014). Endemism rate is estimated to be around 10% of a total of 315 fish species (Freitas, 2014).

This local genetic diversity and variability of wild stocks, in many cases unexplored, represent a valuable reserve that can support sustainable production of fish, in the medium to long term, and increase production, resilience, efficiency and profitability (FAO, 2018).

4.2 Fisheries sector

Cabo Verde has 800,000 km^2 of Exclusive Economic Zone (EEZ), an extensive coastal line and a fishing potential between 36,000 and 46,000 tones, mainly composed of tunas, but with other important coastal species, small pelagics and demersals (DGRM, 2016).

Like most islands which lack other natural resources, the people of Cabo Verde have seen fisheries as a way to survive and its products have been the main and most accessible source of animal protein throughout its history.

Fisheries play an important role in food security, in a country with a consumption *per capita* that has been increasing during the last years, estimated to be around 25 kg of fish *per* year (DGRM, 2016). However, it is necessary to emphasise that FAO esteemed an annual *per capita* consumption around 11,9 kg in 2013 (FAO, 2016).

The Fisheries contribute to the GDP between 1 and 2%, which in 2017 was about 1,800 million US dollars (INE, 2018), but that does not include indirect contributions, i.e. from the fish processing industry. According to Gomes & Medina (2015), this contribution is between 2% and 3% or between 7% and 10%, depending, respectively, on the point of view, primary (catch) or secondary activity (processing plants and sale).

Fisheries sector is also important for job creation (see Table 1).

Table 1 - Contribution of Fishing Industry to employment in Cabo Verde (Sources: INE, DGRM and information from processing plants)

Fishing Industry		**Population of Cabo Verde**		
		15 years or older	**Active**	**Employed**
		392,355	232,198	203,775
Processing Plants	1,749	0.45%	0.75%	0.86%
Artisanal Fishery	4,811	1.23%	2.07%	2.36%
Industrial & Semi-industrial Fishery	1,113	0.28%	0.48%	0.55%
Middlemen	986	0.25%	0.42%	0.48%
Total	8,659	2.21%	3.73%	4.25%

Additionally, the fishing sector generates related economic activities such as: (i) vessel repairs and maintenance; (ii) recreational activities, with significative impacts on tourism; and (iii) loading, unloading and transhipment of fish. This brings to the Porto Grande of Mindelo (PGM) around 350 operations of foreign vessels every year and generates more than 17 million euros a year in revenues (ENAPOR, 2019).

All these activities constitute Blue Economy Growth, defined by World Bank as "sustainable use of ocean resource for economic growth, improved livelihoods, and jobs, and ocean ecosystem health, including many activities: Renewable Energy, Fisheries, maritime transport, waste management, tourism, and climate change" (WB, 2019).

In Cabo Verde, fisheries have a strong impact in almost all other sections of society which is why the FAO has identified it to become a pilot country for implementing the Blue Growth Initiative (Womdim, 2017).

Later, with Resolution No. 112/2015, the government of Cabo Verde adopted a charter to promote the Blue Growth initiative in Cabo Verde. This charter serves as a framework for all policies and investments related to the development of a sustainable ocean economy, with three main objectives:

(i) Promote a durable development of the ocean and coastal zone.

(ii) Minimise the environmental degradation, the loss of biodiversity and the unsustainable use of marine resources.

(iii) Maximise the social and economic benefits to people.

Once again, these three objectives are strongly connected with the best practices in fisheries management, and fisheries have contributed and can contribute more to them.

4.2.1 The current fisheries management system

The management system in Cabo Verde is of the classical traditional triangle form (Figure 3), Monitoring, Control and Surveillance (MCS), research, and administration. These are headed by a ministry, which also preside over the National Council of Fisheries.

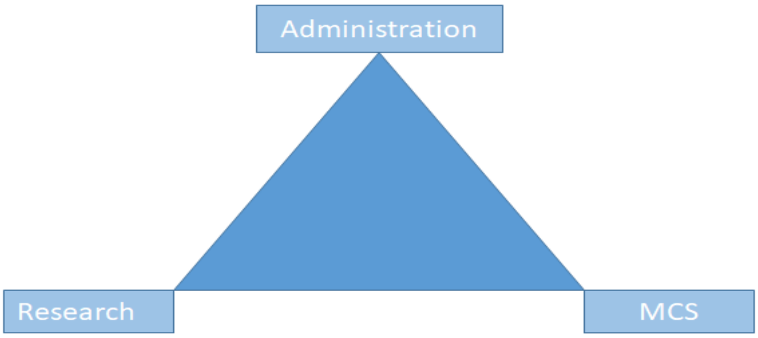


Figure 3 – National Management System

The General Direction for Maritime Resources (DGRM), which is directly under the Ministry of Maritime Economy, is the central office which designs, implements and coordinates the maritime policies, marine resources, fisheries, and aquaculture, scientifically supported by the National Institute for Fisheries Development (INDP).

Access to fisheries is controlled by licences, meaning that all vessels, national and foreign, must obtain a fishing license to operate in the country's EEZ. Also, as part of the licence, all national vessels must obtain an authorisation to fish in international waters.

The Inspection and Quality Assurance Unit (UIGQ) ensures the promotion and compliance in the national territory of fishing legislation and sanitary regulations for fishery products and activities, carrying out MCS and quality audits in establishments and vessels, with the support of laboratory analyses.

For some of the main species, Maximum Sustainable Yield (MSY) estimates exist (for both the industrial and artisanal fleet), based on assessments done by INDP in 2014 (see Table 2).

Table 2 - Maximum sustainable yield for 3 of the commercial species in Cape Verde (Source - INDP)

RESOURCES	MAXIMUM SUSTAINABLE YIELD (MSY-Tons)
mackerel scad (*Decapterus macarellus*)	2,500 – 2,700
bigeye scad (*Selar crumenophthalmus*)	1,000
blackspot picarel (*Spicara melanurus*)	300
tunas (all species)	25,000

Cabo Verde is party to the 1982 UN Convention on the Law of the Sea since August 1987. It is Party to the 1993 FAO Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas (“Compliance Agreement”) since January 2006.

Also, the management is done in accordance with different regional bodies, i.e., at the sub-regional level Regional Sub-Commission for Fisheries (RSCF), regional level, International Commission for the Conservation of Atlantic Tunas (ICCAT), and global level, especially the regulations and recommendations of the Food and Agriculture Organization (FAO). The country is also members of the Fishery Committee for the Eastern Central Atlantic (CECAF) and Ministerial Conference on Fisheries Cooperation among African States Bordering the Atlantic (COMHAFAT-ATLAFCO).

4.2.2 Financing of the fisheries sector

Access to bank credit and/or other means to support the acquisition and/or construction, repair and maintenance of vessels, is identified as the biggest challenge faced by the operators in Cabo Verde (UNIDO, 2016), especially in the artisanal fishery.

Solving this problem would increase the radius of fishing activities, allowing fair competition among the producers and between them and foreign fleets operating within the Cabo Verde EEZ (UNIDO, 2016).

4.2.3 Fleet

The current fleet classification system is composed of Industrial, Artisanal and Semi-industrial fleet. (see Table 3)

Table 3 – National fleet classification and composition of Cabo Verde in 2017 (Source: DGRM)

Fishery	Number of Vessels	Total Length
Artisanal	1,588	3 to 8 meters long
Semi-industrial	151	6 to 24 meters long
Industrial	1	76 meters long

The artisanal vessels are mainly constructed from wood, some of them covered by fiberglass. They are operated by 2 to 4 fishermen using mainly hand lines and targeting demersal and tunas, in trips no longer than half a day. The industrial type vessel is a big purse seiner, targeting tunas, normally at far distances from the original port, on trips that can take up to one month.

All the fishing vessels that do not fit into the descriptions above are described as semi-industrials. They normally operate as seiners, targeting pelagic species, with trips lasting between one and three days (Figures 4).

(a) (b) (c)

Figure 4 – Different types of fishing vessels in Cabo Verde, artisanal (a) industrial (b) (Source: Atunsa, 2018) and semi-industrial (c)

4.2.4 Catch statistics

The collection of catch and effort data in Cabo Verde began in 1981. The national statistics for fisheries are the responsibility of INDP, which has a special division for this purpose. This division is composed of a focal point and a net of data collectors spread over the different islands where the data is collected.

Data from artisanal fisheries, below presented, are collected by the systematic sampling suggested by Shimura in 1984 (INDP, 2012), and then extrapolated, to obtain the national effort and catch data.

4.2.5 Value chain

The value chain in Cabo Verde differs between fisheries sectors. The high quantity demanded, and the low price paid, almost exclude the artisanal fleet from exporting, so almost 100% goes to local consumption, the local fish markets, restaurants and bars, and retailers.

The semi-industrial catches can go through a different chain, depending on the species, the quality, and quantities. Big quantities of mackerel scad and tunas, with a high level of freshness, go to the fish processing plants, and low quantities of other species caught go to local consumption.

The value-chain is usually different for catches of the industrial fleet. Generally, large quantities of high-value fish, where the major part is exported frozen directly after unloading are sold to wholesalers and/or processing plants overseas. A small quantity of small tuna is sent to local processing plants.

The different value-chains and marketing options for small-scale and industrial fisheries are shown in Figures 5 and Figure 6, but, in this study, we focus on the artisanal fishery, where, traditionally, almost 100% of the catch goes to the local markets and then to the and consumers, restaurants, hotels and general public.

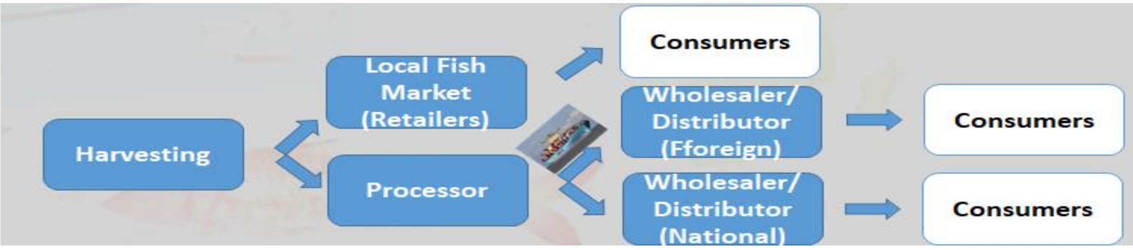


Figure 5 – Scheme of Value Chain in Artisanal and Semi-industrial Fisheries

Still, incidentally, catches from the artisanal fishery are sent to processing plants, to be transformed and then sold to local or foreign wholesalers, and then to retailers and/or end consumer, i.e. the general public, but this is uncommon.

Almost all the industrial catch goes directly for export, processed or not, which can be a foreign wholesaler or processor, and then to the end consumer. Even though, a small part of it, generally processed, is sold to retailers in the national market and then to the end consumer, i.e., the general public.

Figure 6 (previous page) - Scheme of Value Chain in Industrial Fisheries

4.2.6 Exports

Fish exports from Cabo Verde are limited to a relatively few products and their total only reach 5% of the total imported products. In terms of value, this means a proportion of 57.6 against 551 million EUR, respectively (WTO, 2015)

Usually, fisheries products amount to around 80% of total merchandise exports (Figure 7). Therefore, the impact of the fisheries sector on the foreign exchange balance is very high. The main products exported are presented in Table 4.

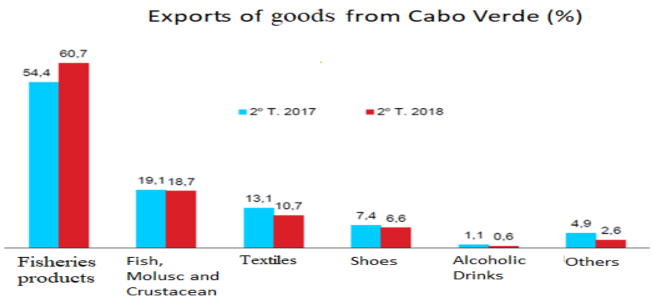


Figure 7 – Exports from Cabo Verde in 2nd trimesters of 2017 and 2018

Table 4 – Main Fishing Products Exported from Cabo Verde

Type of Product	Species
Frozen	*Thunnus obesus, Auxis spp, Thunnus albacares, Katsuwonus pelamis and same Molluscs*
Cans	*Thunnus obesus, Thunnus albacares, Auxis spp; Katsuwonus pelamis and Scomber spp*
Fresh	*Seriola spp, Decapterus macarellus, Thunnus obesus* and *Thunnus albacares*
Oil	Shark liver oil
Dry	*Prionace glauca*
Alive	*Palinurus charlestoni*

Exports of frozen fish have grown since 2013, representing a change in the share, that used to be dominated by cans, among the types of exported products (Figure 8).

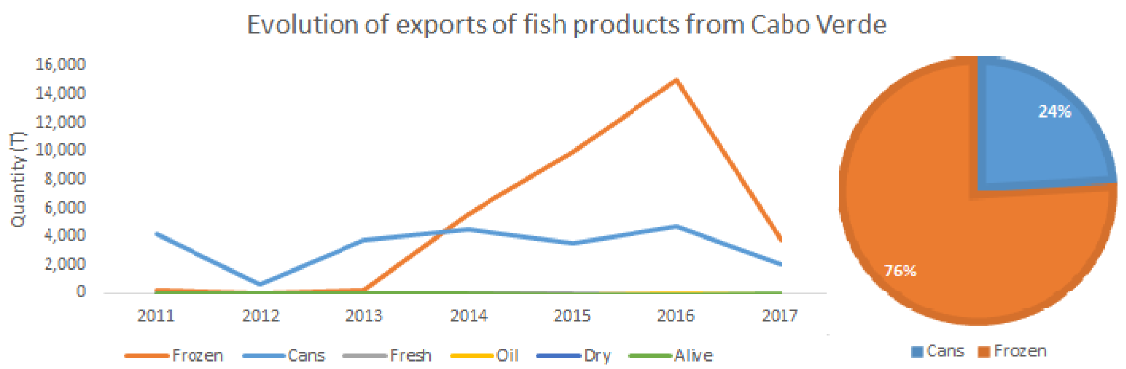


Figure 8 – Exports of fish and fishing products in Cabo Verde, from 2011 to 2017, and share of different types of products, in 2016

4.2.7 Imports

The Cabo Verde fisheries do not produce enough to meet domestic demand from processing. Therefore, there is considerable import of fish to the country for processing. Most of the mackerel and tuna are imported by the processing plants and processed before being exported again.

Also, many fisheries products that are not produced in Cabo Verde are imported, with molluscs representing 10% in share of 2017 (Figure 9). This is an important industry as it creates numerous jobs in the country. In Sao Vicente Island alone, this industry employs more than thousand people, and its increasing in size.

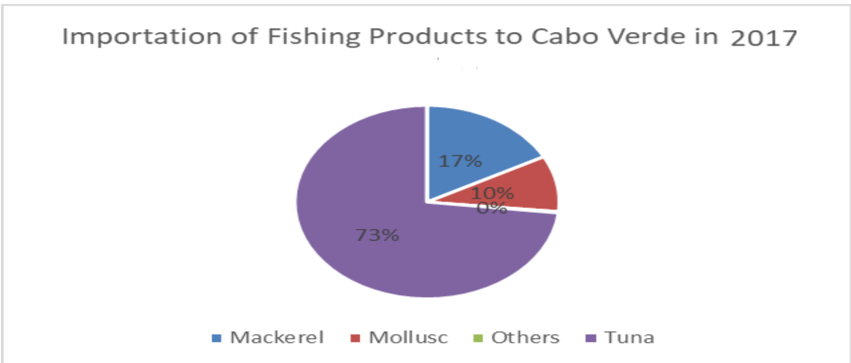


Figure 9 – Share of different types of import products to Cabo Verde in 2017

4.3 The Artisanal fishery

Artisanal fishery is the oldest one practiced in Cabo Verde Islands, suggested to exist even before permanent settlement of the islands (caboverde-info, 2019). It is also the largest fishery in Cabo Verde in terms of number of vessels and fishermen.

The importance of the artisanal fisheries is great due to its contribution to nutrition, food security, sustainable livelihoods and poverty alleviation among the islands, providing almost half of the total national catch today, while historically even a larger share (Figure 10).

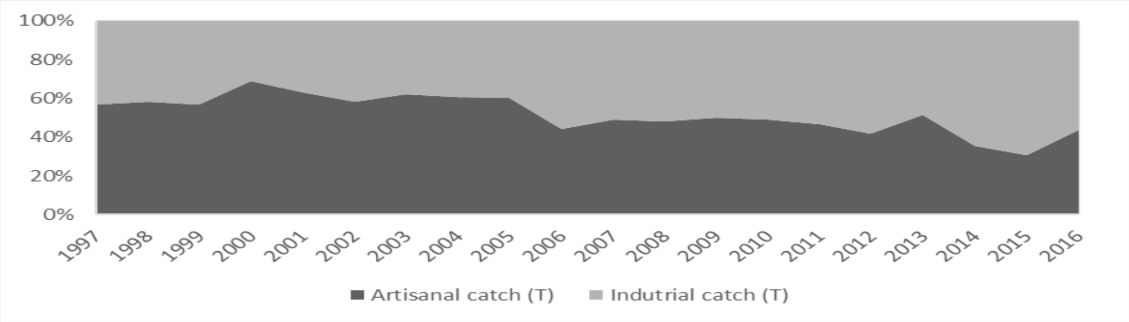


Figure 10 – Share of catch from 2007 to 2016, by the different fisheries categories, in Cabo Verde (INDP), where industrial catch represents the total of semi-industrial and industrial.

The artisanal fisheries provide fish to local communities and islands. Normally, the catches are handled by fish traders, traditionally called *peixeiras*, that often are the boat-owners or spouses of the fishers. They sell it directly to the final consumers (Monteito, 2016).

With the production of the artisanal sector decreasing during the last years, the supply does not meet the demand, so, there are no discards (Baptista, Gomes, & Santos, 2008)

4.3.1 Legal framework for the artisanal fisheries

The first initiative to build a legal framework for the artisanal fisheries was in 1975 (Law n. 14/75), which defined the limits of the territorial waters, followed by other legislation, which resulted in the first general definition of the principles and policy for the exploitation of the marine resources (Decree-Law No. 17/87). This decree was revised in 2005 and again in 2015, resulting in the present Legislative-Decree (No. 2/2015), that, in combination with specific regulation, regulates all the artisanal fishing activities.

The registration of artisanal vessels is regulated by a Legislative-Decree (n. 26/2016), that establishes rules for vessels flying a national flag, marks, documents, gross tonnage, ownership, and construction contracts. This registration also requires a pre-authorisation from DGRM, since a Dispatch N. 02/2015, from the minister of infrastructure and maritime economy, also it established conditions for new vessels to enter the fishery.

The management is executed according to a Fishery Management Plan (FMP), that defines the general policy for the sustainable management of marine resources. Within the scope of the Regional Project for Fisheries in West Africa – Cabo Verde (PRAO-CV), was preparation for the FMP for the period 2016-2020, but it was never officially adopted, as the previous one, valid for period 2004-2014.

The FMP is executed through a two-year Fishery Management Plan. The present one was adopted by the Resolution n. 1/2016 and still valid, supported by the Resolution n. 8/2018. For the artisanal fishery it defines some main rules (see Table 5).

Table 5 - Fisheries management measures for Cabo Verde

Measure	**Target**	**Definition**
reserved zone	artisanal fishery	3 nautical miles
minimal catch size	grouper	27 cm (total length)
	seabream	28 cm (fork length)
	mackerel scad	18 cm (fork length)
	bigeye scad	16 cm (fork length)
	blackspot picarel	17 cm (fork length)
	costal lobster	9 cm (carapace length)
	deep lobster	11 cm (carapace length)
	life bait	6 cm
closed season	mackerel scad	July 15th to September 14th
	bigeye scad	July 15th to September 14th
	costal lobster	May 1st to October 31st
	deep lobster	July 1st to November 31st
mesh size	gill net	0.03 cm
limit unity number	beach seiner	23 unit

Half of the fishermen are not aware of this legal framework (INDP, 2011).

4.3.2 *Effort of the artisanal fleet*

In 2017 there were 1.815 vessels in the artisanal fisheries, 83% of them motorised, distributed to 75 landing sites, and operated by 5.078 fishermen, 2 to 3 per vessels on average (see Table 6).

Table 6 – Artisanal fisheries data, on vessel ports and fisherman, in 2017 (DGRM and Fisheries Inspectors reports)

	Santo Antão	São Vicente	Santiago	Sal	Boavista	São Nicolau	Brava	Fogo	Maio	Total
vessels	156	162	581	216	124	142	129	207	98	1815
motorization rate	86%	97%	64%	98%	90%	99%	95%	80%	91%	83%
fishermen	640	514	1863	482	318	267	251	514	229	5078
ports	11	5	15	6	3	7	4	15	9	75

The biggest increase is seen between 2011 and 2017, years where the survey was updated (Figure 11).

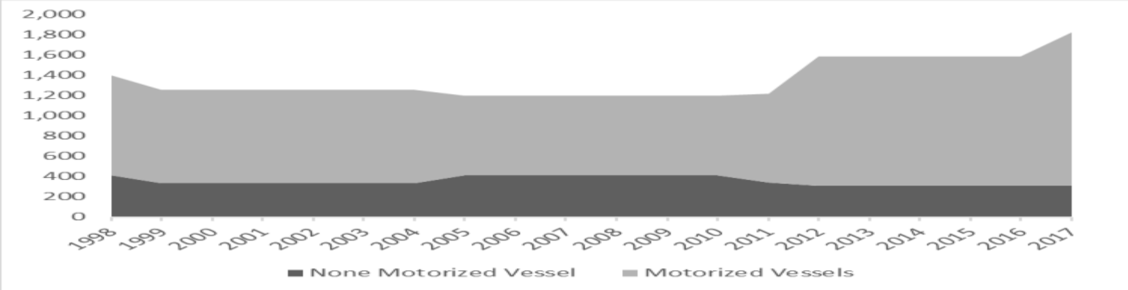


Figure 11 – Evolution of the number of artisanal vessels in Cabo Verde, from 1998 to 2017 (INDP)

The increase in the number of vessels in 2011 and 2017 does not correspond to the increase in the effort. The climax was reached in 2000. Hand-line represents 98% of the total effort in 2017, with 110,233 days at sea. (Figures 12).

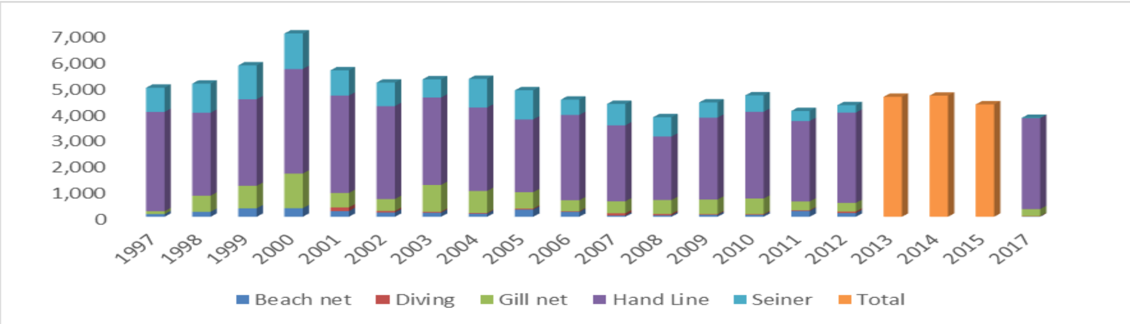


Figure 12 – Share of the different fishing on effort on artisanal fishery in Cabo Verde, by days at sea, from 1997 to 2017 (INDP). Data for 2016 are not available.

Hand line fishing has the largest share of the artisanal catch in Cabo Verde, representing 92% of the total catch in 2017, very distant from the second fishing gear in this field, seiner, with 7% of the total catch (Figure 13).

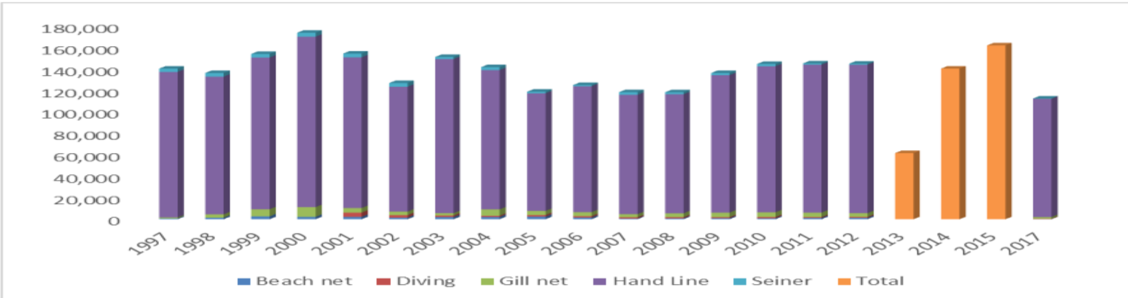


Figure 13 – Trends of share of the different fishing gear on artisanal catch in Cabo Verde, in tonnes, from 1997 to 2017 (INDP). Data for 2016 are not available.

Share on catch and effort of different islands, by fishing gear are shown in Appendix 1.

4.3.3 *Artisanal fleet catch*

Catches show a declining trend since 2000, with a reduction of around 46% by 2017, where Sao Vicente Island has evidenced the most significant reduction, 77 %, and Santiago Island has the largest share in the study period (Figure 14).

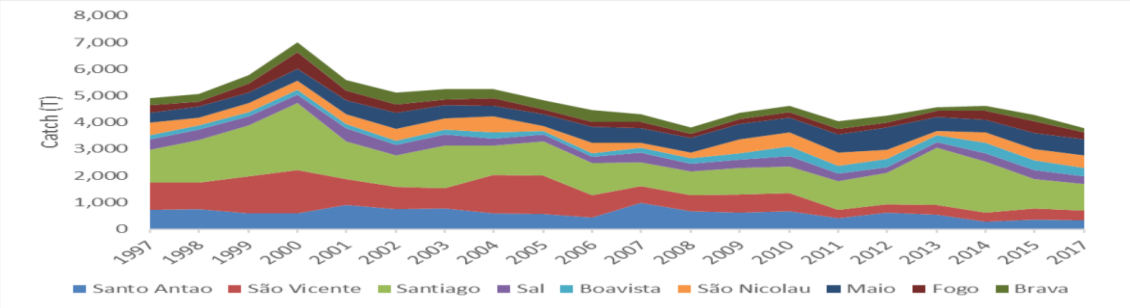


Figure 14 – Share of the different islands on catch of artisanal fishery in Cabo Verde, from 1997 to 2017 (INDP). Data for 2016 are not available.

There is also a drop in the catch of small pelagics, with a reduction around 75% (Figure 15).

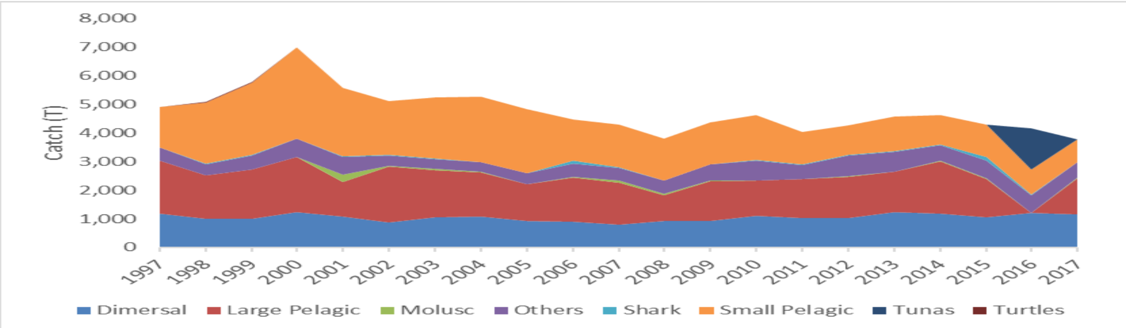
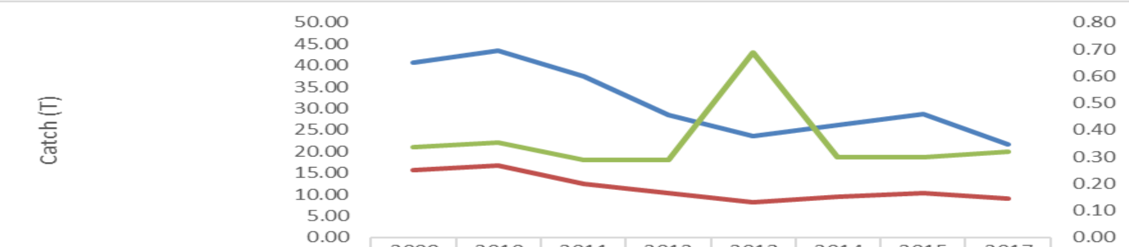


Figure 15 - Share of the different group of species on catch of artisanal fishery in Cabo Verde, from 1997 to 2017 (INDP)

The average catch, per vessels and per fishermen, has also been decreasing, but catches per days at seas has remained stable except for the year 2013 (Figure 16).



	2009	2010	2011	2012	2013	2014	2015	2017
Sum of CPUE (Vessel)	40.60	43.46	37.46	28.54	23.50	26.10	28.72	21.63
Sum of CPUE (Fishermen)	15.73	16.77	12.48	10.42	8.25	9.43	10.33	9.13
Sum of CPUE (Days at sea)	0.34	0.35	0.29	0.29	0.69	0.30	0.30	0.32

Figure 16 – Artisanal CPUE trends in Cabo Verde, from 2009 to 2017 (INDP). No data are available for 2016.

Details on catches for the different islands are shown in Appendix 2 and CPUE in Appendix 3, all having different characteristics with regards to the artisanal fisheries:

(i) **Santo Antão –** gill net has a good share in the fishing effort, after hand line, and has a similar value to diving, beach seiner and seiner. Effort has been decreasing in recent years, with the lowest value in 2013, as well as catches in the last decade.

(ii) **São Vicente -** is the island where the fishing industry is the most important. Effort has been oscillating and is dominated by hand line. Catch in some years is dominated by seiner, but, composed only by hand line in 2017. Catch of groups of others have been increasing since 2002, but, in total catch are decreasing.

(iii) **Santiago -** effort is dominated by hand line, with the gill net in second position, and it is decreasing, with the three lowest values in the last ten years. Share of the gill net in catches is similar to hand line in some years but has been decreasing since 2000. Catch of demersal has been increased in the last decade, but the small pelagics are dominating in overall share.

(iv) **Sal –**hand line is dominant in effort and catch share in most years, with some years being also dominated by seiners. There are some oscillations in the total catch, which is decreasing for small pelagics. Large pelagic catches have remained relatively stable or even slightly increasing in recent years.

(v) **Boavista -** for a long time the island was totally dependent on artisanal fishery with the first semi-industrial vessels appearing in the last 4 years. Fishing effort on artisanal fisheries is mostly based on hand line. Catches has been increasing for all groups of fish, especially for demersal and small pelagic species.

(vi) **São Nicolau –** effort has been increasing over the last decade, with hand line as the dominating gear. The main group of fish caught has been large pelagics, except for 2013. Small pelagics have almost disappeared and the demersal tended to increase slightly in the last 5 years.

(vii) **Brava –** hand line is the dominant gear and has an almost non-existent semi-industrial fishery. Catches have been declining since 2002, despite its increasing in the years before. The catch is dominated by demersals and large pelagics.

Fogo –effort has been decreasing over the years and the gear with the largest share in catch is hand line. Catches have been increasing for the last 10 years. Catch composition has changed considerably over the past 15 years, with "others" now with an important share of the total catch

(viii) **Maio –**hand line is the unique gear used and catch is dominated by large pelagics as well as demersal, with a slight reduction since 2002. In the last 12 years the proportion of small pelagics and other groups have been increasing.

4.4 Main target species

Although estimates suggest the total production potential of the fish stocks around Cabo Verde to be 36,000 and 44,000 tons, 25,000 to 30,000 tons of this estimation is tuna, of which around 70% is made up of stocks that the artisanal fleet can hardly exploit (WB, 2008). Besides this, there are other important marine living resources, including deep-water resources, such as cephalopods, conch-goat, barnacles, algae and other molluscs (MTID, 2013). Also, there are some yet to be explored, but most of these species are thought to be out of reach for the artisanal fleet.

In 2012 effort was excessive, requiring care in terms of management. The fundamental problem was economic inefficiency due to inadequate property rights (Evora, 2016).

Below, we focus on each one of the main groups, small pelagics, demersals, and large pelagics, and the same representative species for each one of them, as indicators of the stock of the group they represent. Below representative species will be, from now on, called target species.

4.4.1 Small pelagics

Historical data shows that most of the small pelagics are caught with seiners, with the gill net in the second position. However, this has changed during the last years, with a negative trend of catch by seiner and in gill net, slightly increasing trends in catch by hand line, from 2011.

In 1997, mackerel scad represented 55% of the total catch among the small pelagics, but ten years later it was only about 37%, and in 2017 it almost disappeared. Blackspot picarel represented 34% of catches in 2017. The bigeye scad has always assumed a middle position, representing 16% of the catch on small pelagic in 2017.

(i) **Mackerel scad (*Decapterus macarellus*) -** is one of the main components of the diet for a significant part of the population in Cabo Verde, because of its nutritional value and, more importantly low price. There is a general opinion among the fishermen that its abundance has been decreasing, and improvement in the fishing, such as bigger vessels, introduction of echosounders and searching for greater distances for fishing grounds, have been implemented to try to keep level of catch (INDP, 2008).

Based on data from the period between 1989 and 2009, MSY was estimated around 2,500 tons, but the resource has been subject to pressures and overfished for almost all this period. The fishing grounds for artisanal fishery have remained the same over time (DeAlteris, 2012). Therefore, it was recommended that for the next three years total national landings be limited to 1,000 tons annually and then slowly increased, ultimately reaching the estimated MSY or 2,700 tons annually.

Catch of mackerel scad in artisanal fishery decreased from 1,000 tons in 1998 to almost 0.1 ton in 2017. The total catch also shows decreasing trend in the last decade (Figure 17).

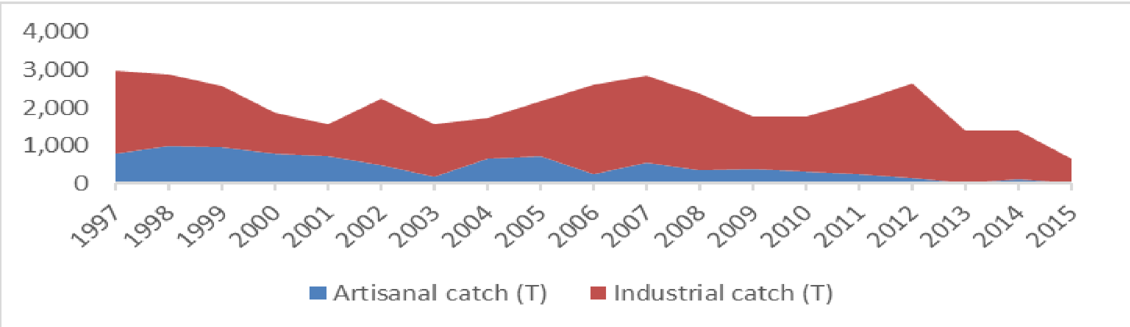


Figure 17 – Catch (T) of mackerel scad in Cabo Verde, from 1997 to 2015 (INDP)

The individual yearly average on total length (L) of fish sampled in local market creased from less than 27 to more than 30 cm, from 2004 to 2016 (Figure 18).

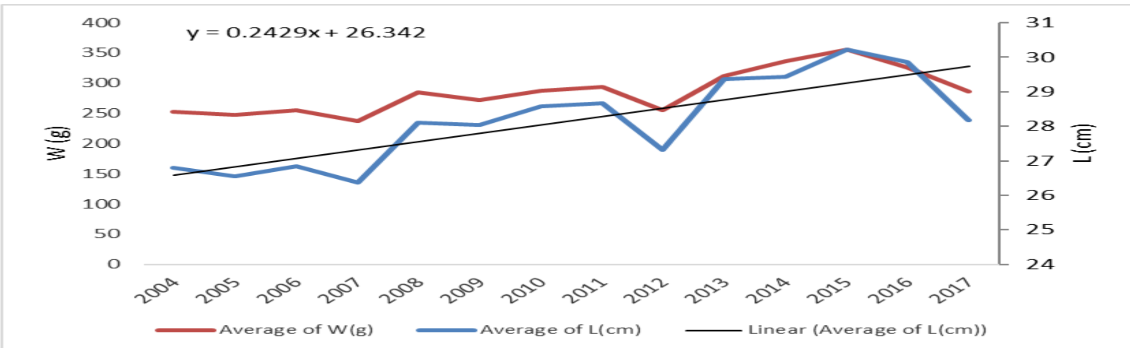


Figure 18 – Trends on average, of total length (L, cm) and total body weight (W, g), of mackerel scad in Cabo Verde, from 2004 to 2017 (INDP)

(ii) **Bigeye scad (*Selar crumenophthalmus*) -** is a very important species, both in a social and economic context. It is the main alternative species during the closed season in summer for mackerel scad, which has been implemented since 2008 (INDP, 2008).

Assessments of the stock status in Cape Verdean waters show that this species was fully exploited, and that landings should be restricted to about 1,000 tons, in order to maintain the stock at productive levels (DeAlteris, 2012).

Catch increased in the first decade of the study period, followed by a progressive reduction, to the initial level, at the end of the second decade (Figure 19).

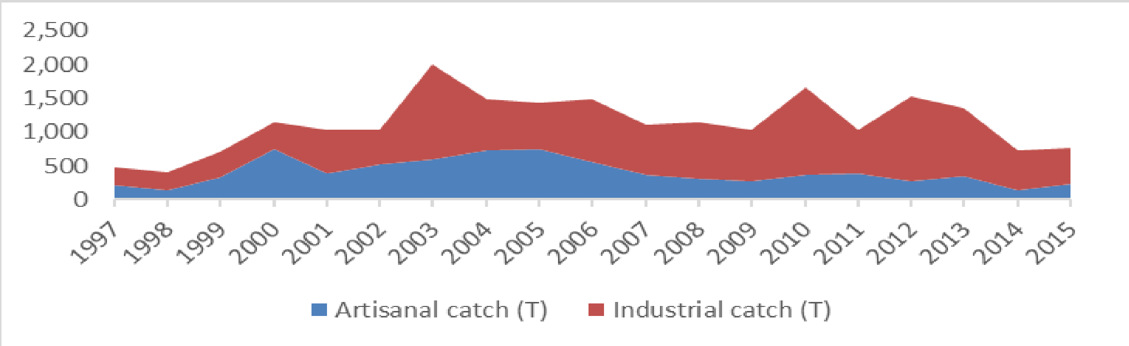


Figure 19 - Catch (T) of bigeye scad in Cabo Verde, from 1997 to 2015 (INDP)

Individual length and weight have increased considerably since 2004 (Figure 20).

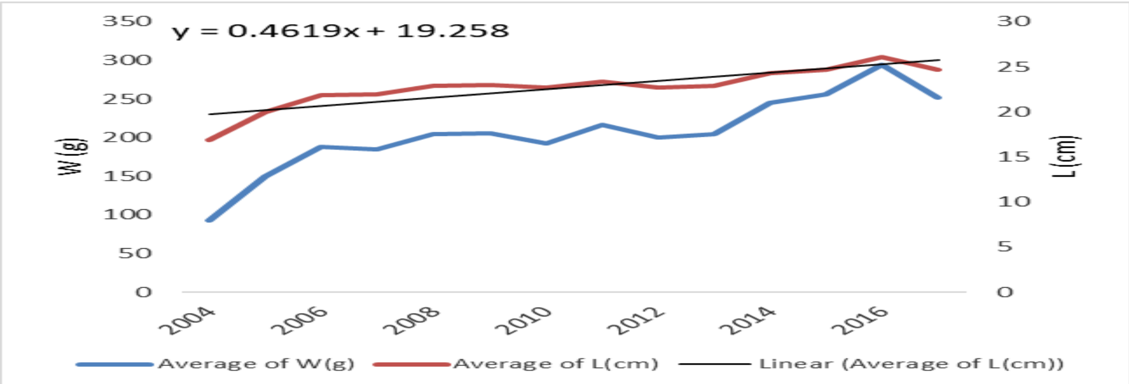


Figure 20 - Average, of total length (L, cm) and total body weight (W, g), of bigeye scad in Cabo Verde, from 2004 to 2016 (INDP)

(iii) **Blackspot picarel (*Spicara melanurur*) -** is also important, both socially and economically, representing the main alternative to mackerel scad and bigeye scad, receiving equivalent or even lower prices. The relative importance of this species has been increasing, as its part in the small pelagic catch has increased significantly in the last decade, compared to the mackerel scad and bigeye scad.

CPUE data suggest a sustainable catch at the current biomass level of 300 tons and that no further expansion of the fishery should be considered, until more data is available on life history (DeAlteris, 2012).

Catch has been decreasing since 2003 (Figure 21) and individual length shows a growing trend (Figure 22).

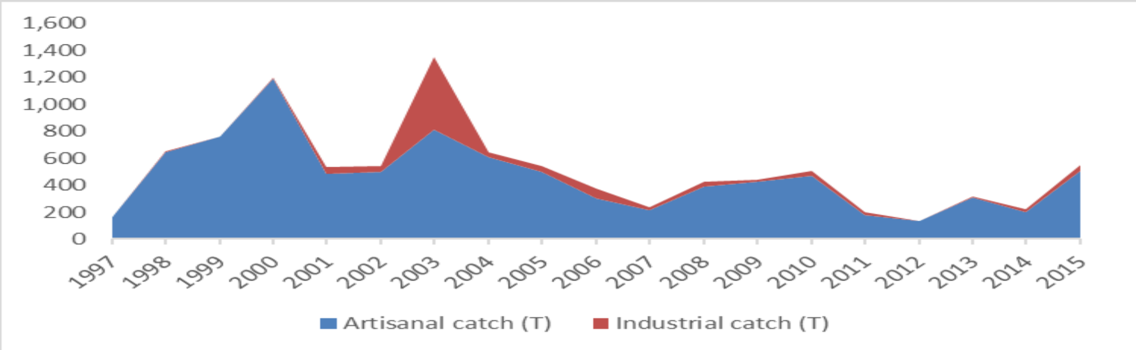


Figure 21 - Catch (T) of blackspot picarel in Cabo Verde, from 1997 to 2015 (INDP)

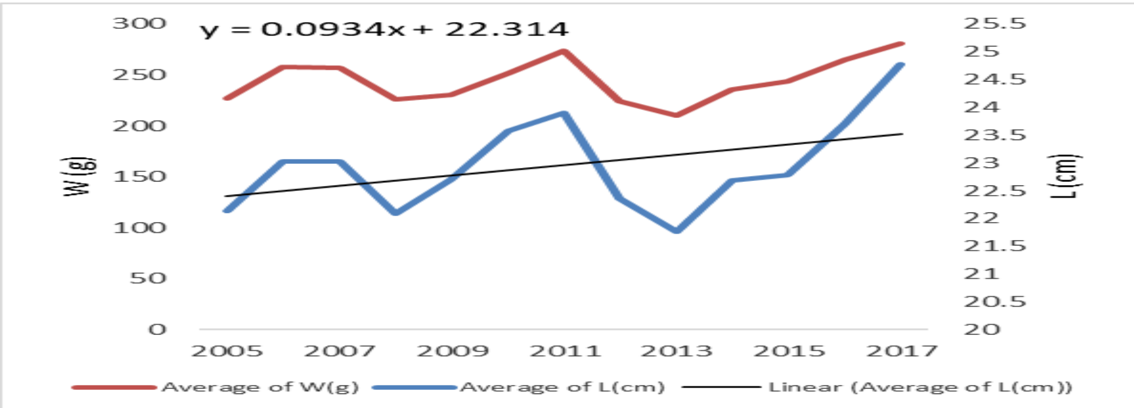


Figure 22 - Average, on total length (L, cm) and total body weight (W, g), of blackspot picarel in Cabo Verde, from 2004 to 2017 (INDP)

4.4.2 Demersal species

Demersal fish are almost all caught by hand line in the artisanal fishery 94%, followed by gill net that represented just 5% of the demersal total catch in 2017.

In terms of species composition, the catch data in 2017 is dominated by grouper, moray eels, and amberjack, with the share of 23%, 12% and 12%, respectively, meaning that they represent almost half of artisanal fleet's total demersal catch.

(iv) **Grouper (*Cephalopholis taeniops*) -** unlike the small pelagic above mentioned, the importance of groupers is linked to high commercial value and market opportunities.

An assessment of stock status of grouper in Cape Verdean waters indicated that the stock was fully exploited and estimated that the sustainable level of catch was around 75 tonnes (Tariche et al. 2012). DeAlteris (2014) suggested that a minimum size limit of 30 cm should be introduced, and fishing mortality should be reduced overall, to safeguard and increase the spawning stock.

Catch of grouper has remained more or less staible since 1997 (Figure 23), while average size has increased since 2003 (Figure 24).

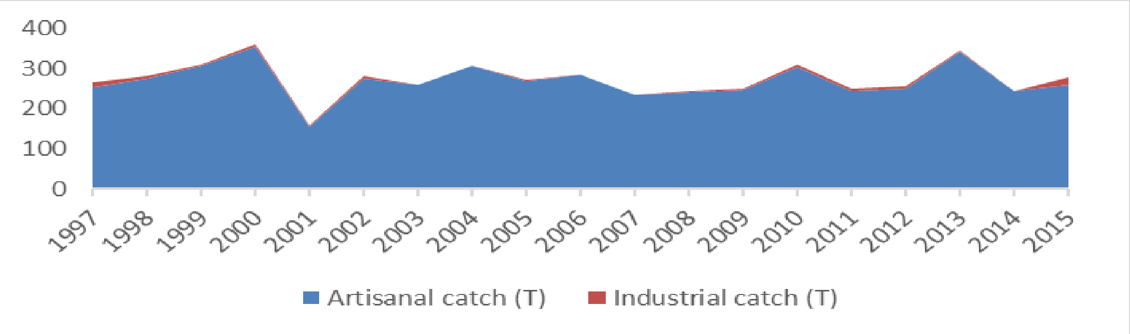


Figure 23 - Catch (T) of grouper in Cabo Verde, from 1997 to 2015 (INDP)

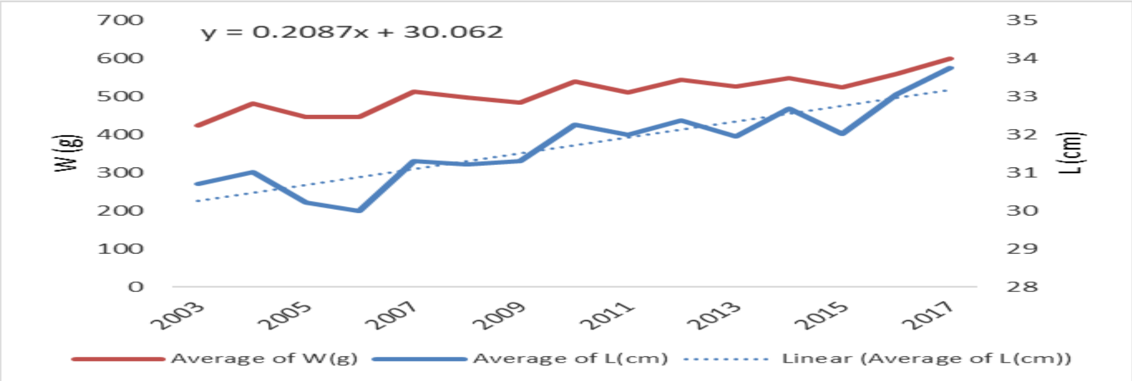


Figure 24 - Average, of total length (L, cm) and total body weight (W, g), of grouper in Cabo Verde, from 2005 to 2017 (INDP)

(v) **Moray eels (*Moreana sp.*) -** due to high demand, especially during traditional festivities, this is a high-value species. Catches are slightly increasing since 2007 (Figure 25).

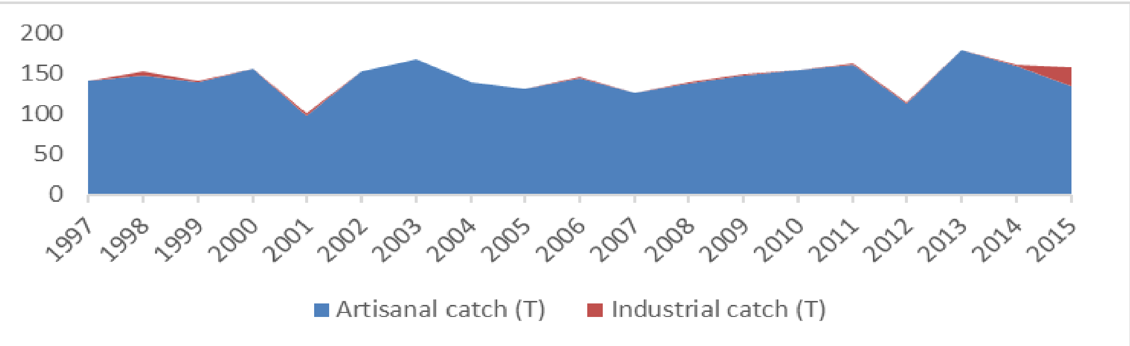


Figure 25 - Catch (T) of moray eels in Cabo Verde, from 1997 to 2017 (INDP)

(vi) **Amberjacks (*Seriola sp.*) –** it is often bought by restaurants, paying a high price. Estimations by FAO (2009), using the Schaefer dynamic production model, derived no clear-cut conclusions on the state of the stock, however, it was recommended to adopt a precautionary approach and that an analysis of the data on the abundance index series (CPUE) should be tried.

Catch data shows a significant increase in the artisanal catch, responsible for the total catch since 2013 (Figure 26).

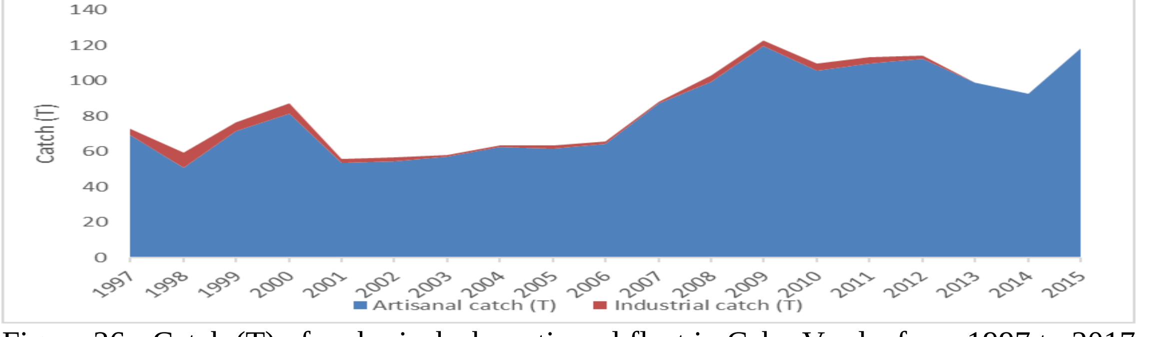


Figure 26 - Catch (T) of amberjacks by artisanal fleet in Cabo Verde, from 1997 to 2017 INDP)

4.4.3 Large pelagics

The large pelagics are almost all caught by hand line in the artisanal fishery in Cabo Verde. During the study period, two species have been dominating the catch, yellowfin tuna, representing 70% of the total catch of large pelagic and Wahoo, with about 25%.

(vii) **Yellowfin tuna (*Thunnus albacares*) -** is one of the most important species for the fishing industry in Cabo Verde. The potential of this fishery is estimated to be very high and the market opportunity is diversified, i.e. local market, restaurants, hotels, and processing plants. There is an open competition among sellers and buyers and prices are high.

As in all tuna and tuna-like species, the stock assessment and management are performed by ICCAT. The most recent analysis, in 2010, indicates overfishing but annual catches in 2012-2014 were below the estimated MSY. Nevertheless, there is concern with regards to Fish Aggregation Devices (FAD)-related mortality of small individuals.

Catch of yellowfin tuna has been fluctuating during the study period, with the lowest value recorded in 2008 (Figure 27).

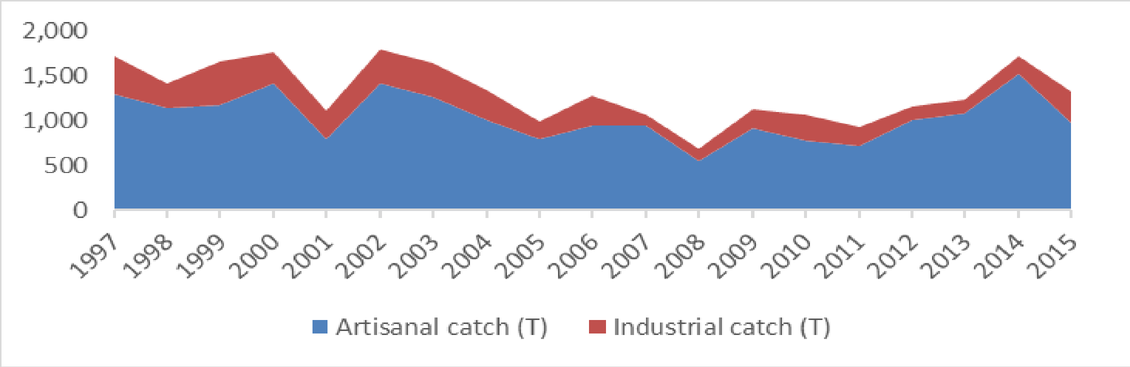


Figure 27 - Catch (T) of yellowfin tuna in Cabo Verde, from 1997 to 2017 (INDP)

The national data on catch are different from those provided by ICCAT (see Appendix 4 - rr) and FAO (see Appendix 4 - ss).

(viii) **Wahoo (*Acanthocybium solandri*) -** is a target species in both commercial and recreational fisheries in Cabo Verde. Usually dried and used in traditional cuisine, the commercial value can be very high, especially in the main markets.

There is no evidence of more than a single shared stock of wahoo in the WCA, and genetic studies suggest that stock boundaries may extend beyond this region. However, this remains unclear and more comprehensive analysis of stock structure for the entire Atlantic are needed for a stock assessment and management (Oxenford et al., 2003).

National catch in the study period is decreasing since 2012 (Figure 28), with similar values than data catch provided by ICCAT (see Appendix 4 - tt) and FAO (see Appendix 4 - uu).

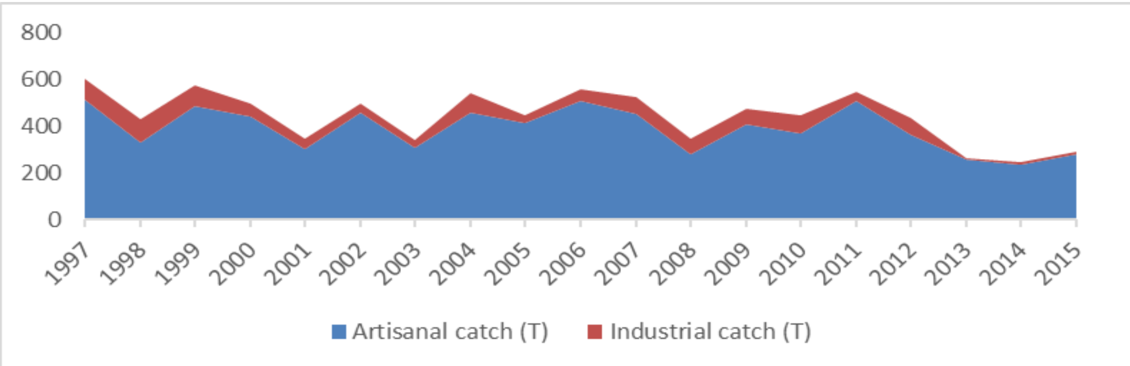


Figure 28 - Catch (T) of wahoo in Cabo Verde, from 1997 to 2017 (INDP)

5 ECONOMIC ASPECTS OF THE ARTISANAL FISHING IN CABO VERDE

To analyse the artisanal fisheries economy in Cabo Verde, data on income from seven of the main representative species, from 2009 to 2017, were used as indicators, excluding here the amberjack, due to its low representativity in the different islands and no accurate data on price. Together, they represent 97% of the changes to the total catch, so it is assumed that they have the same influence on total income.

Analysing the impact of the catch of the different species on the total revenue, the data indicates that yellowfin tuna is the one with the highest influence, followed from far by moray eels, with a weak relationship between its catch and total revenue (see Appendix 4 – c and d). In general, the influence of target species catches in the total revenue is not so high as could be expected, with no significant relationship between them.

In general, there is also no significant impact of the size of catch on the price, but it is possible to identify some negative relationship: mackerel scad and bigeye scad (in São Vicente and Santo Antão Islands), wahoo (São Vicente Island), grouper (in Santo Antão Island), and yellowfin tuna (in São Vicente Islands) (see Appendix 5 – a, b, e, f, g, h and i).

Yellowfin tuna is the target species that contributes the most to income in artisanal fishery in Cabo Verde (Figure 29).

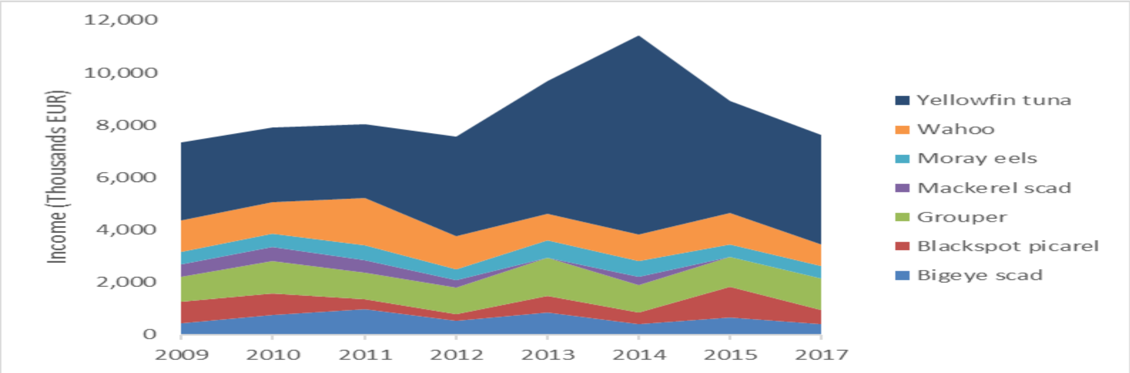


Figure 29 – Income of the different target species in Cabo Verde, from artisanal fishing between 2009 and 2017. Data were not available for 2016

Annual incomes from artisanal fisheries vary considerably between years, but strong decreasing trends can be seen for Sao Vicente and Santo Antão Islands (see Table 7).

Table 7 – Artisanal fishery yearly total incomes, in EUR, for the different island of Cabo Verde, from 2009 to 2017

Year	Santo Antão	São Vicente	Santiago	Sal	Boavista	São Nicolau	Brava	Fogo	Maio	Average
2009	819,079	674,016	2,075,384	548,025	624,568	1,071,312	600,817	222,928	713,676	**816,645**
2010	794,300	460,823	2,028,067	875,957	1,075,429	1,178,615	625,492	253,816	624,077	**879,619**
2011	453,868	330,173	2,241,559	716,669	964,670	1,245,797	640,535	254,290	1,200,780	**894,260**
2012	705,573	355,439	2,064,640	448,457	878,343	976,352	628,849	210,421	1,298,812	**840,765**
2013	545,194	352,040	5,496,271	431,861	728,350	455,085	326,981	318,559	1,045,567	**1,077,768**
2014	437,428	440,157	5,680,320	590,331	1,093,088	1,371,128	647,117	331,903	835,889	**1,269,707**
2015	587,240	393,080	2,481,655	563,246	1,034,217	1,439,675	767,563	419,840	1,249,042	**992,840**
2017	369,364	292,158	2,006,710	854,313	1,095,181	1,480,603	424,676	442,044	669,105	**848,239**
Average	**589,006**	**412,236**	**3,009,326**	**628,607**	**936,731**	**1,152,321**	**582,754**	**306,725**	**954,618**	**952,480**

In 2017, income for artisanal vessels of São Vicente, Santo Antão, Fogo, Santiago, Brava and Sal Island was under the national average, and vessels from São Nicolau Island recorded values double above the average. Vessels in Fogo Island recorded losses in 2011 and 2012 (see Table 8).

Table 8 - Artisanal fisheries yearly income, in EUR, per vessel in the different islands, from 2009 to 2017

Years	Santo Antão	São Vicente	Santiago	Sal	Boavista	São Nicolau	Brava	Fogo	Maio	Average
2009	778	608	638	780	2,010	3,076	1,254	45	1,697	**1,210**
2010	648	257	558	1,371	3,683	3,373	1,282	12	1,085	**1,363**
2011	419	190	399	995	3,277	2,608	737	-74	2,456	**1,223**
2012	418	217	304	439	1,432	2,333	1,288	-65	2,529	**988**
2013	426	445	1,465	506	1,217	1,093	695	304	2,598	**972**
2014	221	431	1,442	678	1,918	3,527	1,482	85	1,613	**1,266**
2015	393	238	445	590	1,770	3,717	1,806	195	2,746	**1,322**
2017	310	109	435	945	1,963	3,167	863	268	1,108	**1,019**
Average	**452**	**312**	**710**	**788**	**2,159**	**2,862**	**1,176**	**96**	**1,979**	**1,170**

The average monthly salary per fishermen in the different islands shows similar patterns as income per vessels. Sao Vicente Island in the last position in this ranking, for the year 2017, with an average monthly salary of only 9 EUR. Santo Antão, Fogo Santiago, Sal and Brava Islands are also below the national average. In the same year, Sao Nicolau Islands presented the best performance and, together with, Maio and Boavista Islands, they complete the group that is above the national average (see Table 9).

Table 9 – Artisanal fisheries fishermen's monthly salary, in EUR, in the different islands, from 2009 to 2017

Years	Santo Antão	São Vicente	Santiago	Sal	Boavista	São Nicolau	Brava	Fogo	Maio	Average
2009	117	100	93	73	200	328	121	6	153	**132**
2010	97	42	81	128	366	360	123	2	98	**144**
2011	45	19	56	97	287	290	98	-8	228	**124**
2012	41	19	39	38	131	199	115	-7	232	**90**
2013	41	39	190	43	111	93	62	34	238	**95**
2014	21	38	187	58	175	301	133	10	148	**119**
2015	38	21	58	50	162	317	161	22	252	**120**
2017	30	9	56	80	179	268	76	28	102	**92**
Average	**54**	**36**	**95**	**71**	**201**	**269**	**111**	**11**	**181**	**114**

The different islands have different economic dynamics in the period of this study:

(i) **Santo Antão -** the target species have a very high share of the total artisanal catch in Santo Antão Island, 87% on average, where their income evidences a decreasing trend, with special attention for bigeye scad and mackerel scad, whose contribution has disappeared in recent years (Figure 30).

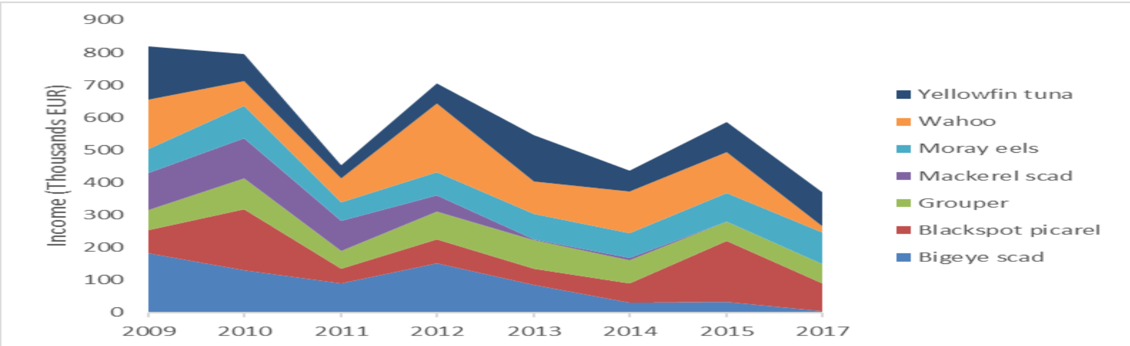


Figure 30 – Income trends from target species on artisanal fishery in Santo Antão Island, from 2009 to 2017. No data is available for 2016.

(ii) **São Vicente -** target species have a very high contribution for the total catch, about 93% of it, on average. There are only two species with increasing incomes in the last years, moray eels and grouper. A part of them, only wahoo and yellowfin tuna appear in the contribution for the last years. The contribution of the small pelagic representative incomes disappeared in recent years (Figure 31).

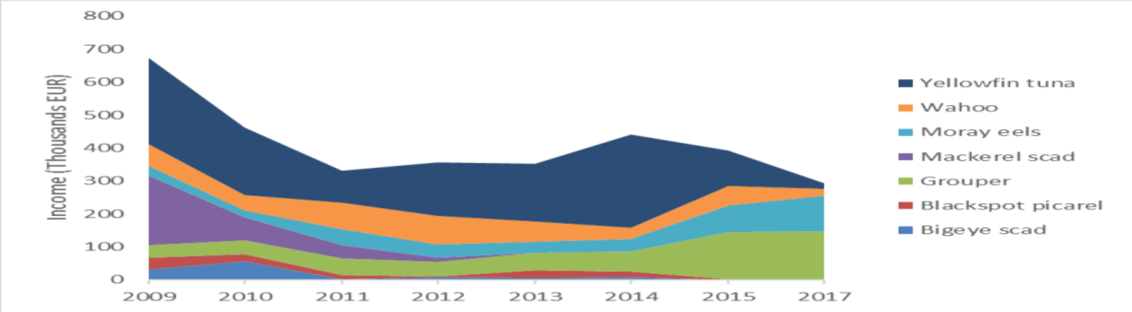


Figure 31 – Income trends from target species on artisanal fishery in São Vicente Island, from 2009 to 2017. No data is available for 2016.

(iii) **Santiago -** the income from target species, that represents around 82% of the overall catch, on average, is stable, but has been decreasing in the last 4 years, after its maximum years of 2012 and 2013. The yellowfin tuna is the species with the largest contribution, with blackspot picarel and grouper also having a good share (Figure 32).

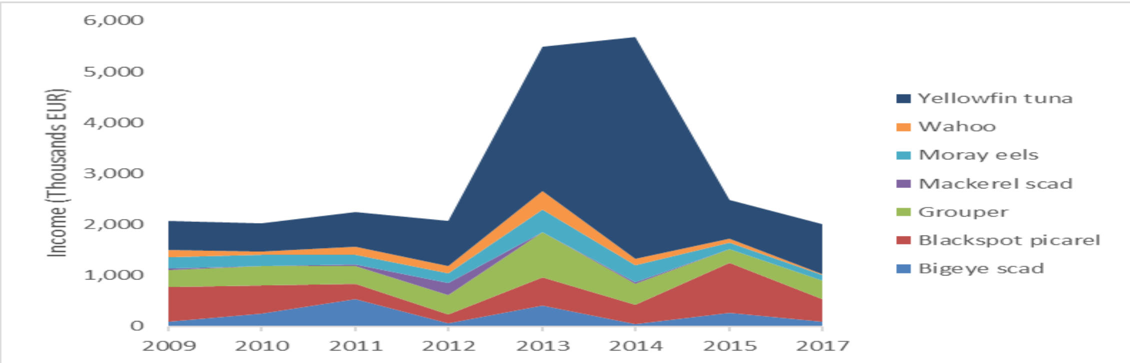


Figure 32 – Income trends from target species on artisanal fishery in Santiago Island, from 2009 to 2017. No data is available for 2016.

(iv) **Sal -** the target species on the total catch is also not so high, 23%, on average. The general income from them are increasing, after recovering from its lowest point in 2013, with a very good contribution from yellowfin tuna and grouper, in recent years, with moray eels presenting the second largest share (Figure 33).

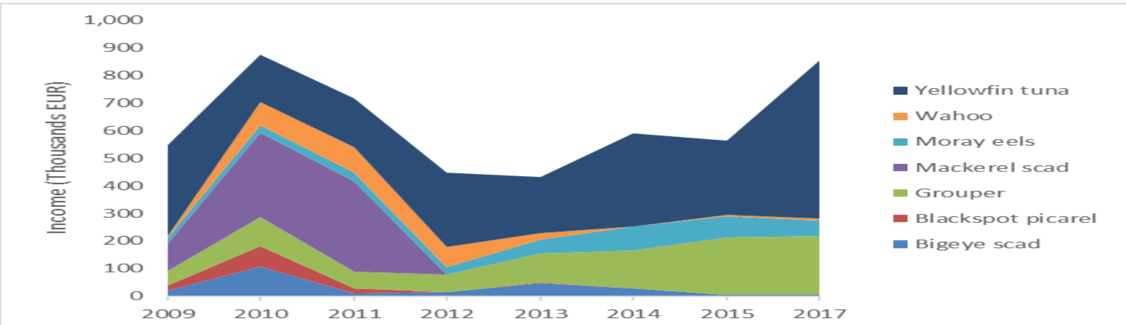


Figure 33 – Income from target species on artisanal fishery in Sal Island, from 2009 to 2017. No data is available for 2016.

(v) **Boavista -** income from target species, that represents around 90% of the total catch, is increasing. The species with the highest contribution is the yellowfin tuna, bigeye scad and grouper and the top performance was recorded in 2014, with an important, but unique, contribution of mackerel scad (Figure 34).

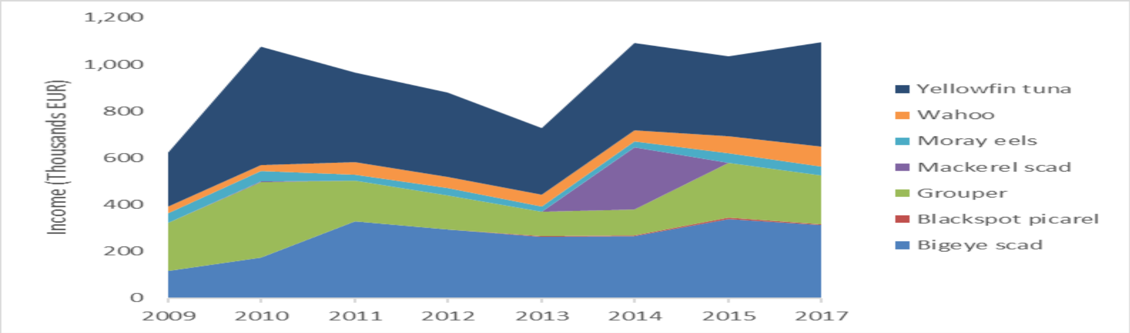


Figure 34 - Income from target species on artisanal fishery in Boavista Island, from 2009 to 2017. No data is available for 2016.

(vi) **São Nicolau -** with a contribution around 94% of the total catch, the target species represent most of the share. Despite the very low income in 2013, in general, it is increasing, even if it is at a low yearly rate. The yellowfin tuna and wahoo are the two species with the largest share in the income, followed by grouper. There are no incomes from Mackerel scad and bigeye scad (Figure 35).

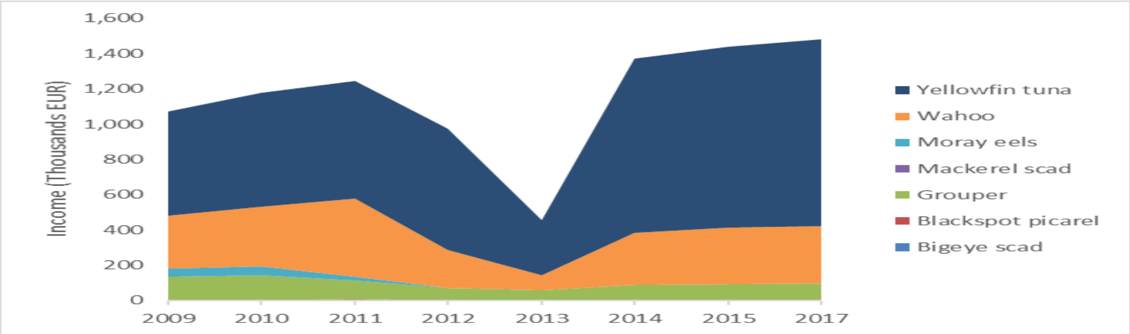


Figure 35 – Income trends from target species on artisanal fishery in São Nicolau Island, from 2009 to 2017. No data is available for 2016.

(vii) **Brava -** the impact of the target species in total catches is very strong, representing, on average, 94%. Their total income has been slightly decreasing in the last years and it is mostly composed of income from large pelagic, with a good contribution of grouper also (Figure 36).

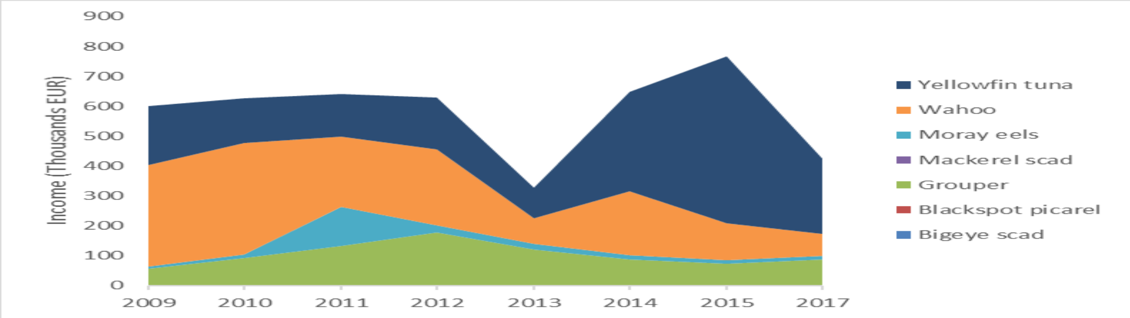


Figure 36– Income from target species on artisanal fishery in Brava Island, from 2009 to 2017. No data is available for 2016.

(viii) **Fogo** – here the target species represent the lion's share of the total catch, representing, on average, 70%. The incomes are growing and the species that mostly contributed to the good performance are the large pelagic (Figure 37).

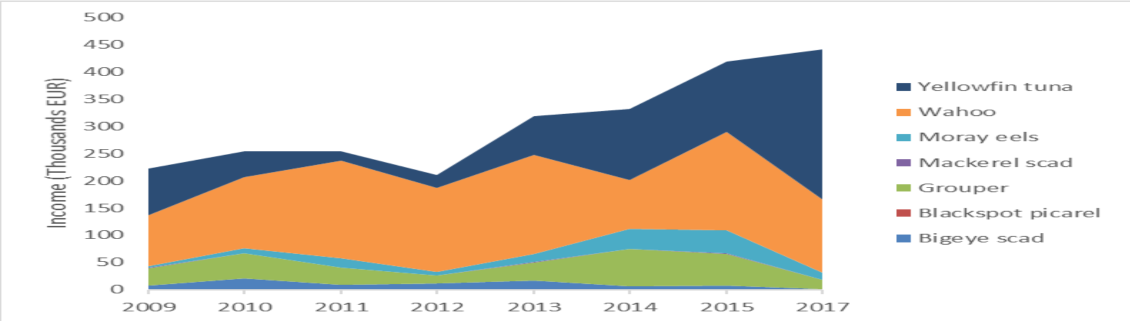


Figure 37 – Income from target species on artisanal fishery in Fogo Island, from 2009 to 2017. No data is available for 2016.

(ix) **Maio** - the target species part of the total catch only represents 8% of it, on average. Incomes have been generally stable in the study period, although with some fluctuations. This stability is due to the great economic contribution from yellowfin tuna, and, recently, growing trends from the wahoo's income contribution (Figure 38).

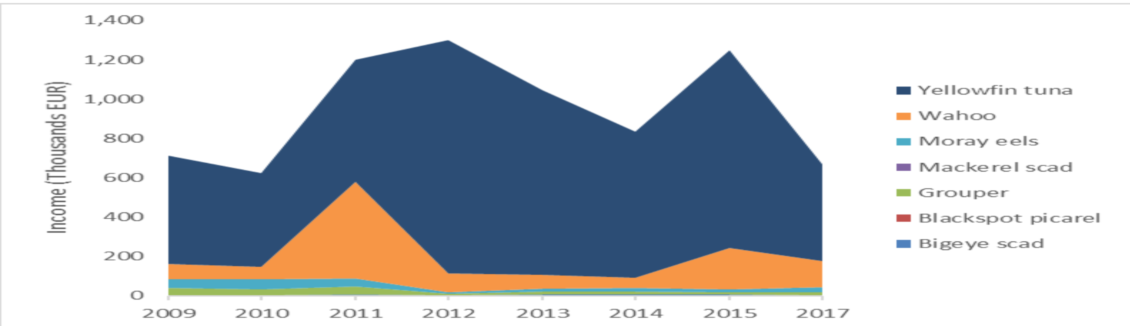


Figure 38 – Income from target species on artisanal fishery in Maio Island, from 2009 to 2017. No data is available for 2016.

6 OPTIMAL EFFORT, MSY AND MEY

Estimation of optimal level of effort on MEY and MSY is identified as a key point to design a management strategy to improve the profitability of this fishery. Therefore, in order to elaborate recommendations for the artisanal fisheries management, E(MEY) and E(MSY) are estimated for each island, and national total, using the parameters a and b and R^2, estimated by linear regression on CPUE ant effort (see Table 10).

Table 10 – Estimated parameters, a, b and R^2, for each island and total national

	Santo Antão	São Vicente	Santiago	Sal	Boavista	São Nicolau	Brava	Fogo	Maio	National
a (Intercept)	-0.000003	-0.000004	-0.000001	-0.000002	-0.000006	-0.000004	-0.000004	-0.000010	-0.000002	-0.0000005
b (Declive)	0.073	0.089	0.089	0.056	0.052	0.089	0.065	0.163	0.077	0.0978
R^2	0.31	0.52	0.52	0.33	0.04	0.52	0.88	0.84	0.81	0.8867

The estimated values for E(MSY), similar to estimated values calculated for E(MEY), by days at sea (from which are calculated the correspondent number of vessels, based on the average days at sea per vessels in each island, as explained in the point 3.4 above), are shown in Table 11.

Table 11 – Adjustments of number of vessels to the effort on MSY

	Santo Antão	São Vicente	Santiago	Sal	Boavista	São Nicolau	Brava	Fogo	Maio	Cabo Verde
E(MSY) (Days at sea)	12,117	11,138	44,350	13,950	4,333	11,138	8,063	8,150	19,250	**132,488**
N. of Vessels on E(MSY)	146	115	508	245	55	115	141	89	69	**1,483**
Present N. Vessels	156	162	581	216	136	142	129	207	98	**1,827**
Adjustment need	**-7%**	**-29%**	**-13%**	**14%**	**-60%**	**-19%**	**9%**	**-57%**	**-30%**	**-19%**

In general, for a part of Sal and Brava Islands, the effort should be reduced in order to reach the maximum sustainable yield, with the most significant reduction needed identified for Boavista Island. The average reduction, in order to optimise the effort to sustainable levels is different when the E(MEY) is estimated using the total national data, around 1,064, which would mean a reduction around 42% on the fleet.

7 SENSITIVITY ANALYSIS

The E(MEY), estimated in section 6, and corresponding catch and CPUE, are used here as reference, to analyse the sensitivity of CPUE (Figure 39) and catch (Figure 40) to changes on the national effort in a range of -/+30%.

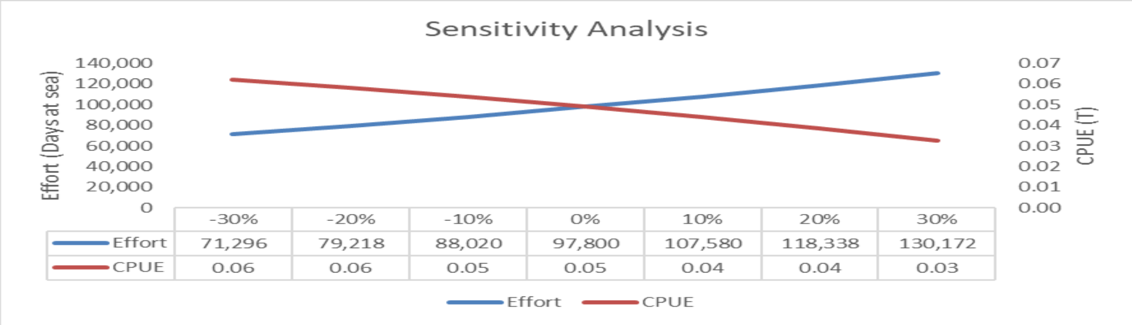


Figure 39 – Cabo Verde estimated CPUE on different levels of effort

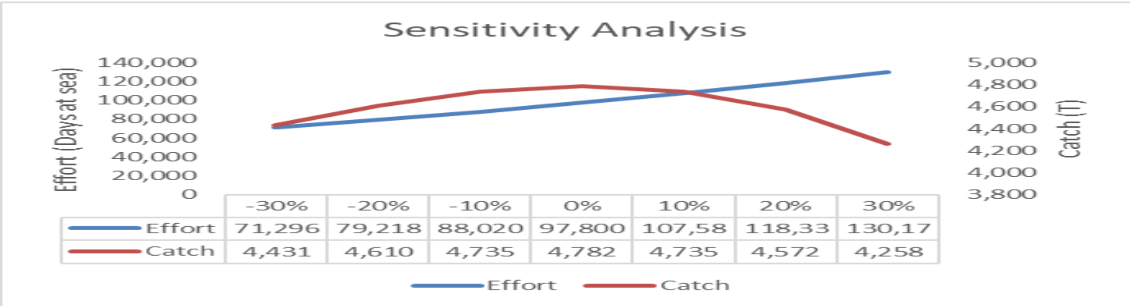


Figure 40 – Cabo Verde estimated catch on different levels of effort

This is similar among all the different islands (see Appendix 6), except for Fogo Island, that responds positively to the increase in effort in the first stages (Figures 41 and 42).

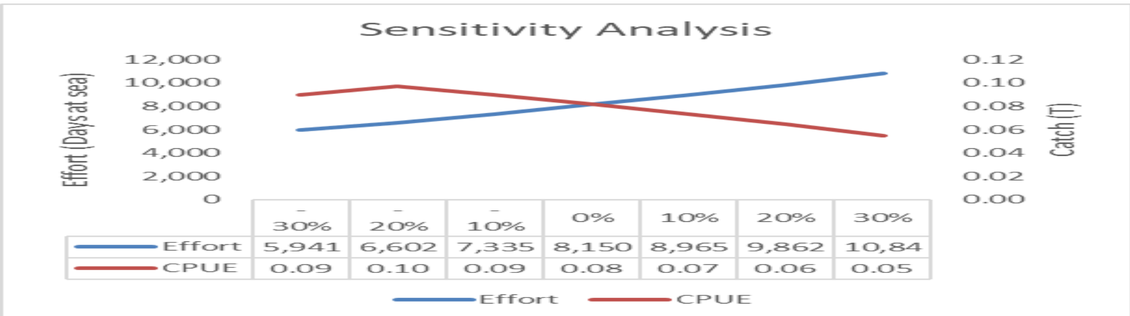


Figure 41 – Fogo Island estimated CPUE on different levels of effort

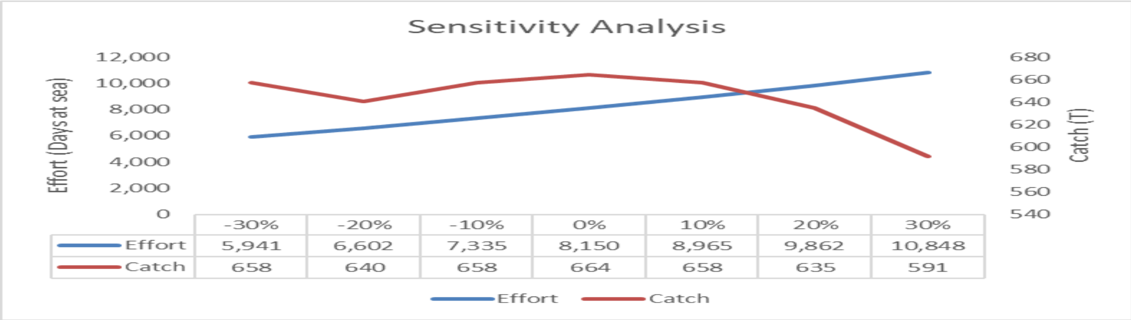


Figure 42 - Fogo Island estimated catch on different levels of effort

8 DISCUSSION

In this section we discuss the main results, comparing them with results from other studies.

8.1 Data used

The description of Artisanal Fishery highlights its important contribution to development of the islands, especially jobs and food security. In this field, the big difference between the FAO and DGRM’s estimations in national consumption can be explained by the different situation in the years used as reference.

In 2002 Cabo Verde could not export to the Union European, so all the national production and imports were counted as national consumption.

Using the estimated data on production from FAO, 199,000 tons, and ICCAT, 226,25.28 tons, and the data on imports, 7,704.77 tons, and exports, 24,268.783 tons, from ACOPESCA (Competent Authority for Fisheries Products) and population data from INE, we estimate the national consumption to be around 6% and 11%, respectively for the year 2016. It is impossible to compare this value to national statistics because there the catch numbers are equal to exports.

The differences between the different catch statistics can be partially explained by the different sources and different interpretations on what is national production, with INDP not including the catch of the chartered fishing vessels in their statistics.

Also, we find some other problems with the available data, most of them linked to fishing effort estimation, and at least three of them can be crucial to increase the marginal errors, mainly:

(i) It assumes that every vessel has the same catch capacity, ignoring the differences that different fishing gear, engines and size can have.

(ii) On vessels with two or more fishing gears, there is double counting when estimating the total effort.

(iii) The survey is done with an interval of five years which forces us to assume no changes in the data on vessels and fishermen between the intervals.

8.2 Management system

The fact that access is being controlled by the use and issuance of fishing licences, indicates that the artisanal fishery in Cabo Verde is not an open-access fishery. However, there are still problems to controlling the access, and those problems are directly linked to the situation of being an archipelago, which increases the MCS cost and makes it virtually impossible to efficiently control entry into the fisheries using licenses.

The number of fishing licences had a strong impact on the introduction of the national inspection body in 2012, surveying all the unloading ports and fishing grounds at sea, it increases to its maximum in 2014, having a second impulse after 2016, probably caused by the elimination of the license fees (Figure 43).

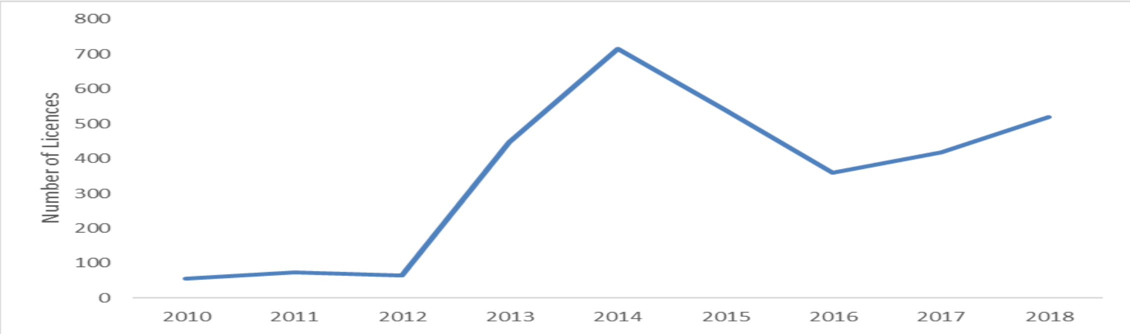


Figure 43 – Artisanal fishing licence on Cabo Verde from 2010 to 2018 (Source: DGRM)

Also, the Dispatch Number 02 of 2015, that should have established a limit on the number of vessels on each island per year, seems no to be followed, as the number of vessels is still increasing. Here we call special attention to the donations of boats, that is when boats are being given to fishers, representing 7% of the overall new acquisitions. Coincidence or not, it is a fact that the numbers tend to increase in election years, being highest in 2011 and 2012, the years of governmental and local elections, respectively (Figure 44).

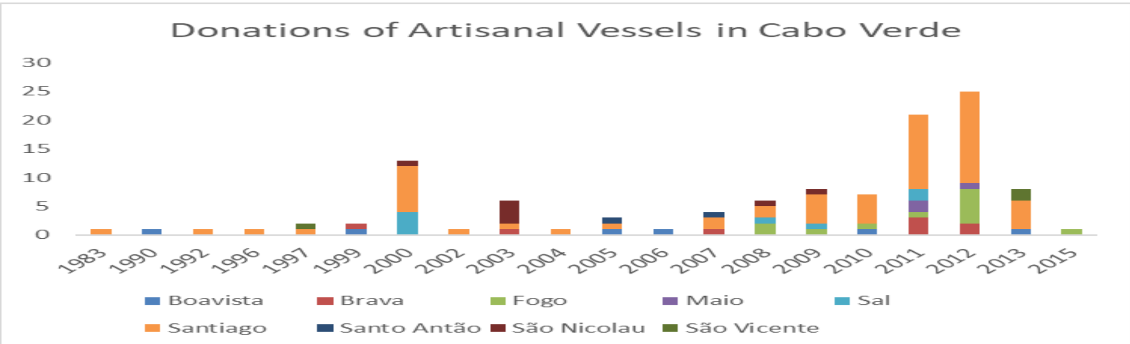


Figure 44 – Trends of the donations of artisanal vessels in Cabo Verde

8.3 Legal framework

The registration of artisanal vessels is regulated by a combination of rules regarding safety and fishing. But, on the other hand, it also restrains owners who want to improve vessel capacity.

For safety reasons, they cannot fish in fishing grounds from which they cannot see the land. However, if they improve on the vessel capacity, in order to get this permission, such as a cabin with navigation equipment, regardless of their size, they become non-eligible for the artisanal categorisation, with all the increase in costs that this implies.

When looking into the current two-year Fishery Management Plans, there are two points that call for attention:

(i) Grouper, *Cephalopholis taeniops*, is mostly caught by hand line. So, if we consider that this is a species that lives among rocks, at significant depths, and the morphology of its mouth, the selectivity of this gear decreases dramatically. Therefore, fishers find it difficult to adhere to limits on catch sizes set at 27 cm for total length.

(ii) There is also a minimal catch size established for *Lithognathus mormyrus*, of 27 cm of furcal length, and for blackspot picarel, *Spicara melanurus*, 17 cm of furcal length, which is a difference of 10 cm for two species with similar morphology and mostly caught by same fishing gear, gill nets, which furthermore have a minimal limit of 0,03 cm for mesh size.

8.4 Fishing gear

The prevalence of the hand line among the other fishing gear could be wrongly understood as good news for the resources, as its catchability is usually lower than for many other gears. However, if we consider the limited fishing ground and limited demersal species, both with regards to quantity and diversity, and the weak capacity to compete for the large pelagics, this reduces greatly the profitability of the fishery.

Seiner is in second position with 14% of the total catch. However, the incomes associated with its target species is not so high as those associated with hand line. Also, they are the species with the most significant reduction indicators.

8.5 The main target species

The data, in general, confirms concerns that others have expressed about the need for management reforms to combat negative trends in many of the main stocks of target species (see e.g. Evora, 2016). This is especially true for small pelagics.

The more delicate case is the small pelagics, especially mackerel scad, where reduction is dramatic in the artisanal catch, and in total catch, and the increasing trends of individual size, as well as the other two representative species of small pelagic, bigeye and blackspot picarel. Growth in fish is highly variable depending on food availability and environmental conditions (Hamre et al., 2014). So, the results can be read as a result of a reductions of competitivity, in the stock and/or between the stock and other stock of small pelagic.

It could also be a consequence of the closed season and the setting of minimal catch sizes, in case of mackerel scad, but the increasing trend started before this was first established, in 2008. This requires further study.

Among the demersals representative species, the grouper's sustainable catch has been excessive, and it shows an increasing trend on individual size, in opposition to a slight tendency towards reduction in the catch. Morays eels and amberjack are still growing, but, in both cases, more data is needed to have a clearer idea on the state of their stocks.

The decreasing in the catch of wahoo can indicate a reduction in the available biomass, but more data is needed to support such a thesis.

8.6 Catch and economic indicators

The total catch, catch of target species and economic indicators are very different and specific from one island to another and from the global analysis:

(i) **Cabo Verde –** the diversification of effort and on shares on catch are decreasing, increasing the dependency on the hand line and its main target species, demersals and large pelagics, where catch has been stable. Small pelagics, especially mackerel scad and bigeye scad, are responsible for the reduction in the total catch, as well as CPUE. The slightly increasing trend in the other groups, might be interpreted as a tendency to change traditional species caught due to their reduced availability.

The catch of target species is a good indicator of economic performance, which is decreasing in most of the islands. Yellowfin tuna generates the highest incomes. The fishing effort, above the estimated MEY, requires some precautions and needs to be reduced, in order to improve the profitability, especially, for the fishermen, with a salary under the basic salary established on 117 EUR per month.

(ii) **Santo Antão –** this is the island where we see the most diverse pattern of artisanal effort. Even so, the total catch keeps decreasing, probably because of the decreasing of the seiner effort and catch, reflected in the drop of the catch of two of the small pelagic representative-species, mackerel scad and bigeye scad.

The target species explain decreasing incomes, especially from mackerel scad and bigeye scad. Consequently, income per vessel and salaries are decreasing, which calls for an adjustment in the number of vessels of 93% of the present number.

(iii) **São Vicente –** also with a very good diversity on effort and catch of artisanal fishery, still representing the most dramatic drop on total and specific catch, even maintaining high levels of effort, and mackerel scad is the determinant for that. The increase in catch of the species of other groups, the most significant among the islands, is also an indicator of the very bad performance of traditional stocks exploited.

Also, here, the target species are identified as good indicators of economic performance, overall decreasing, with a shifting in the contributions, from small pelagics to demersals and large pelagics.

Incomes per vessel are also decreasing, as well as salary, around 31% of the national basic. These are indicators of the low profitability of the activity and, in order to achieve sustainability, number of vessels should be reduced to 71% of the present number.

(iv) **Santiago -** the diversity on the effort and catch is even more apparent in Santiago Island, where gill net has a good share of the total, as well as seiner and hand line. It also represents the second more expressive in the semi-industrial fishery, most of it concentrated in the main town. Far-distant-communities are more dependent on the artisanal catches.

The blackspot picarel has the largest historical catches among the different islands, in opposition to mackerel scad, contradicting most of the other islands. The diversification, of fishing gear and target species, seems to explain the maintaining of the level of catch. The two maximums in 2000 and 2013 are due to high level of catch of blackspot picarel and yellowfin tuna, respectively.

The incomes seem stable, except for the high level of income from yellowfin tuna in 2013 and 2014, but salaries and income per vessels are still very low, probably since the number of vessels is 13% above the estimated number on MEY.

(v) **Sal –** this island is not so dependent on the artisanal fisheries, with the semi-industrial fishery also playing an important role. Also, the artisanal fishery presents a good share of the catch for seiner, even with the dominancy of hand line on the effort. This may explain why, even with a little decreasing effort, catches are still increasing.

The increase in incomes is explained by income from the species with high market values, yellowfin tuna, grouper, and moray eels, that appeared as alternatives to mackerel scad. This gives marginal space to increase on the effort, but, in opposition, the salaries bring some precautions and actions are needed to increase it, at least to the national basic level. This is very important as this is one of the islands with the highest costs of living.

(vi) **Boavista –** the fishing effort, mostly based on hand line, and the limited semi-industrial fleet, explains the strong dependency of this island on the artisanal fisheries to supply animal protein. This fishery seems to be in expansion with incomes still growing, especially from yellowfin tuna, bigeye scad and grouper, which are the main income sources.

It is the second island with the best salary per fishermen, considered to be acceptable according to national standards. Even so, estimated MEY indicates that effort should be reduced, or the profitability will soon be threatened.

(vii) **São Nicolau –** despite its strong tradition on semi-industrial fishery this island is also very dependent on artisanal products, especially in the far-distance communities.

Hand line is the unique fishing gear providing fish in the last decade and this can explain the disappearance of small pelagics, normally cough with seiner, that also disappeared from effort composition, probably due to the lack of economic rentability.

Target species are good indicators here of economic performance, with a very high share of total catch. Their income is increasing, and the highest contribution is from yellowfin tuna, followed by wahoo and grouper, justifying the reason why the island presents the highest income per vessel and the highest salary.

Even so, there is a need to reduce the number of vessels to 81% of the present number, in order to achieve the MEY.

(viii) **Brava** – the island indicates strong dependency on artisanal fishery, with total catch declining. Target species are good indicators of economic performance, with income being mostly supported by yellowfin tuna, grouper and wahoo, which decreasing trend bring some concerns. The low salary in 2017 is also a concern, which could possibly be solved by the adjustment of the effort to the MEY level.

(ix) **Fogo** – the strong dependence on artisanal fishery to provide fish is also present here. The general decrease in the target species, in opposition to the increase of the catch of species on the other groups, may indicate a shifting caused by the reduction of those traditionally most important, in this case, the small pelagic.

The target species importance here is not so great but can also help to understand the economic dynamics. The incomes are still growing, probably due to the shifting to species with high commercial value, large pelagics. Even so, effort should be largely reduced, or at least maintained, to adjust to the estimated MEY, to avoid a future decline of profitability and, most importantly, improve the salaries, estimated to be the lowest, on average.

(x) **Maio** – also, here, the strong dependence on artisanal fishery to provide fish is noted. The catch of the less important species is increasing, as well as the total catch.

Most of the incomes come from yellowfin tuna, above 70%. This is the island where the target species has the smallest share on total catch, which gives rise to caution when interpreting the results based on their catches. The results point to a salary level which is under the national basic level and we estimate that the fleet must be reduced around 30%.

8.7 Economic viability of artisanal fishery in Cabo Verde

Fisheries bioeconomic theory and models can be helpful in the development of good fisheries management policies. Bioeconomic models integrate simple biological models with basic economic models that consider fishers' behaviour (as well as taking into consideration, space, time, and uncertainty). Such models can be used to show how a fishery will likely operate given the endogenous, but interdependent, changes in fleet and stock sizes (Anderson & Seijo, 2010).

Our results provide strong evidence that the artisanal fishing in Cabo Verde is rapidly endangering its economic viability:

(i) The availability of small pelagics, normally responsible for the largest catches and, consequently, large share on the income, are generally going down.

(ii) The catch of demersals is stable, but being caught above the recommended levels, which leads us to the question when they will support actual level of effort, or even continuously increasing on it.

(iii) The large pelagics still uphold good income levels and have the largest catch potential but getting into this fishery is becoming harder and harder over the years, due to unequal competition with other national and foreign fleets.

(iv) Effort levels are generally above the estimated levels for MEY.

(v) Salaries in six of the nine inhabited islands, and even the national average, are less than the basic salary in Cabo Verde.

If we add to this the weak capacity to invest in new technology, to improve the catch capacity, and the strong dependence on one fishing gear and, consequently, short range of target species and fishing ground, we conclude that the associated risks to the economic viability are very high and the fishery is not profitable anymore. The situation will only get worse unless urgent management tools are implemented.

8.8 Means to increase the economic viability of the artisanal fleet

Maximum economic yield (MEY) and maximum sustainable yield (MSY) represent different fisheries objectives in fisheries management, but are both crucial points to identify, in order to achieve overall goals in the industry, that should be biological sustainability and social and economic benefits (Habib at al, 2014).

Achieving this in artisanal fishery in Cabo Verde would maximise the benefits to communities, to the general population and to the economy of the country.

It is not reasonable to think that there is a solution with one action or without deep reflexion on changes that should be implemented in the current management system, which is considered to be controlled, but in fact, acts like an open access, as showed by the results of this study.

In this sense, we identify and suggest nine measures that could help to improve on the overall management and move the fisheries towards more biological, economic and social sustainability:

(i) **Limit the level of effort –** for some time, the construction of new artisanal vessels could be banned, which would stabilise the current number of vessels. Mechanisms should be introduced that, in the medium term, reduce the number of vessels, aiming for effort levels which yield MEY.

(ii) **Revision of legal framework –** the current classification of the fleet could be changed by creating a category of a small-scale fleet. This new category would include all the current artisanal vessels and part of semi-industrial fleet, i.e. those vessels under 12 meters in total length. This would create incentives for artisanal vessel owners to invest in upgrading their vessels, without the “risk” of being considered “non-eligible” for the artisanal category and thereby increase operational costs. This would also benefit the smallest semi-industrial fleet and improve their incomes as they would have improved vessels. Also, the traditional coastal target species could benefit, as this might result in a reduction in fishing pressures.

(iii) Real-time management – the marine ecosystem dynamics in Cabo Verde are very fast. So, in order to put in place measures that effectively can protect the biodiversity and management system it is necessary to create mechanisms that monitor them in real-time. To make this possible, statistics and biological parameters must be accurate and collected and evaluated continuously, producing real-time advice to fisheries managers.

(iv) Local management – this study indicates that the biodynamics for the different islands are very different from each other, suggesting also possibly, complete, or partially, separated stocks. Thus, their evaluation and management should be done by keeping this in mind, that is by islands or by groups of islands.

(v) Extension network – a creation of a team, spread to the different islands and well-coordinated, could ease communication between communities and administration, and would ease a permanent dialogue, making the communities feel themselves part of the system and part of the decision making. This could also create increased understanding of the measures put in place and, finally, increase compliance with the law and regulations. This would also allow for closer collaboration between different communities to create alternative economic activities for those who decide to abandon the fishing activity.

(vi) **One decision centre–** concentrating the decision making in one single institution, including coordination of workload, local management coordination, licensing, and authorisation for new vessels to enter the fishing would ease the coordination and communication flow in the management as a whole.

(vii) **Financial support –** among the artisanal fishermen there reigns the feeling that foreign fleets negatively affect the catch of large pelagics, both direct and indirectly. A study could be conducted to evaluate the level of this impact and convert it into financial compensation schemes to be used to create an economic fund to support the development of the artisanal fleet, with improvements on the capacities to explore further fishing grounds and different target species. The government could also contribute to such a fund to increase national food security, employment and fighting against poverty.

(viii) **Control, Monitoring and Surveillance –** this is the key overall point. Without a good, independent and transparent system to control the fishing activity and guarantee the compliance with legislation, assuring the good and fair competitivity among the operators, avoid the unfair competition of other fleets, industrial and foreign, none of the previous actions would produce the expected results, and will be a waste of time and money.

Eventually, the reforms suggested above could lead to an introduction of a quota-system. That could eventually establish conditions to the durable and responsible exploitation of the marine resources, maximising economic and social benefits and thereby the overall development of the country.

These suggestions could possibly alleviate some of the challenges faced by the artisanal fisheries in Cabo Verde. How and to what extent they may do so is an area for future work.

9 FINAL COMMENTS

This study uses some restricting assumptions to achieve the results needed, because of the lack of some crucial data, like prices of the different species on the different islands, which normally increase the marginal error, thus, cautions are recommended in their interpretation or use outside this context.

Also, the present study considers a scenario where the business is well managed, with the vessel's owner perfectly conscious of the need to amortise the capital invested, and that this should be debited from income as a cost, before the sharing. But this does not happen in most of the cases and also the share system is not standardised, as assumed here.

However, this study has estimated E(MEY) for artisanal fishery in Cabo Verde, for the different islands, which has not been done before. We believe that these estimates should be considered, especially if the precautionary approach is to be used in the fisheries management as established in the Code of Conduct for a Responsible Fisheries.

Furthermore, we recommend that, in the future, data on price should be collected in all the different islands, in order to update this study and minimise the possible errors associated with its estimations, possibly also testing different depreciation rates and individual share systems in the different islands.

A good flow on the available data in the different institutions of the fisheries sector would also help with more specific analysis and gaining more accurate results.

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APPENDICES

APPENDIX 1 – Catch by different gears of the artisanal fleets (shares of total catch)

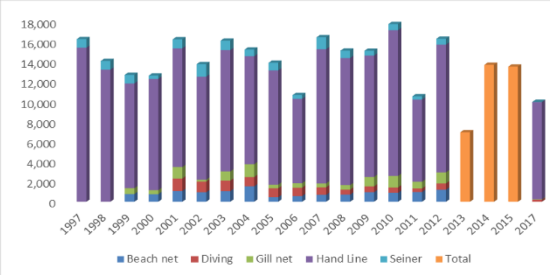


Figure a – Catch by different gears in Santo Antão Island, by days at sea, from 1997 to 2017 (INDP)

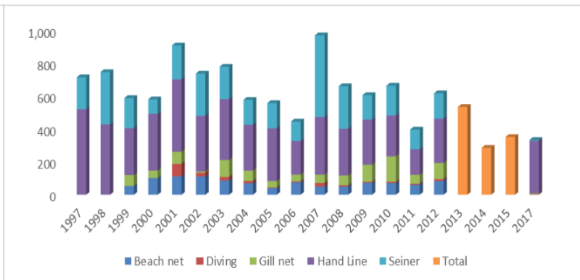


Figure b - Catch by different gears in Santo Antão Island, from 1997 to 2017 (INDP)

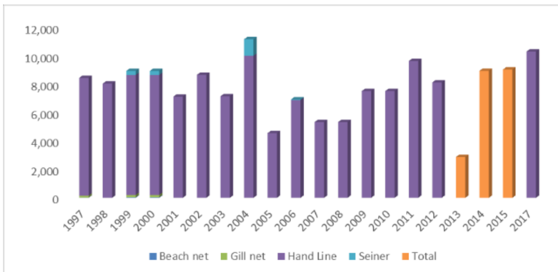


Figure c - Catch by different gears in Sao Nicolau Island, by days at sea, from 1997 to 2017 (INDP)

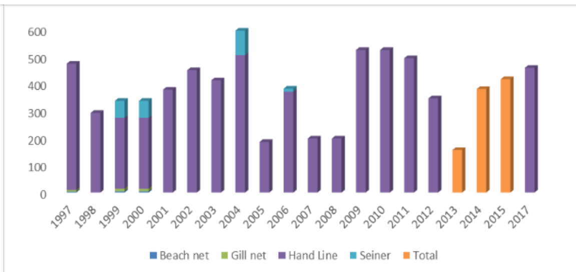


Figure d - Catch by different gears in Sao Nicolau Island, from 1997 to 2017 (INDP)

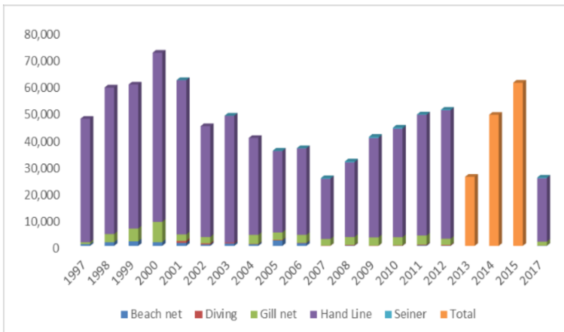


Figure e – Catch by different gears in Santiago Island, by days at sea, from 1997 to 2017 (INDP)

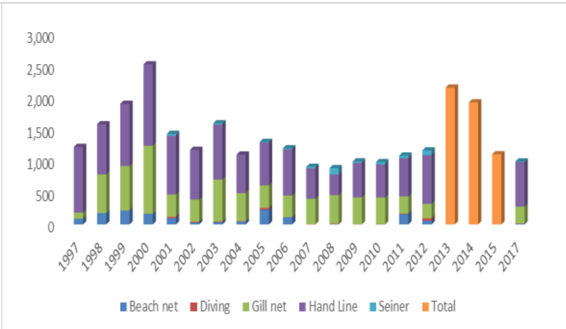


Figure f - Catch by different gears in Santiago Island, from 1997 to 2017 (INDP)

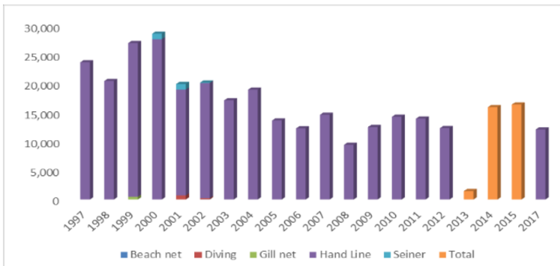


Figure ss - Catch by different gears in Sal Island, by days at sea, from 1997 to 2017 (INDP)

Figure tt - Catch by different gears in Sal Island, from 1997 to 2017 (INDP)

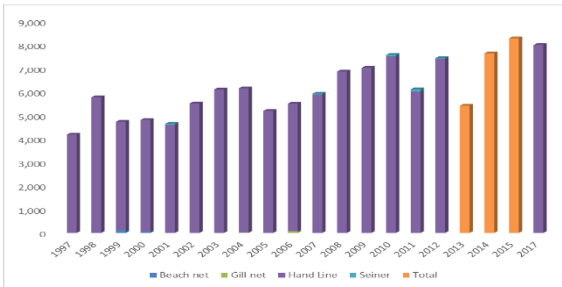


Figure i - Catch by different gears in Boavista Island, by days at sea, from 1997 to 2017 (INDP)

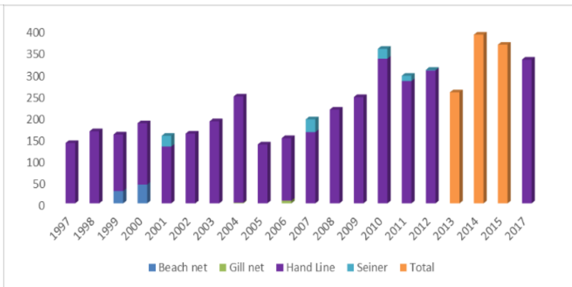


Figure j - Catch by different gears in Boavista Island, from 1997 to 2017 (INDP)

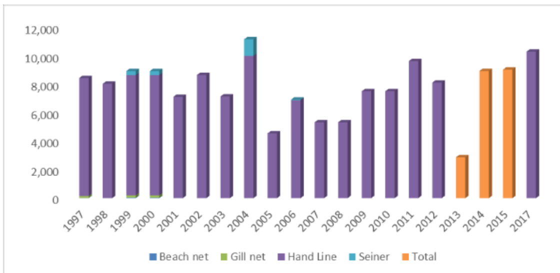


Figure k - Catch by different gears in Sao Nicolau Island, by days at sea, from 1997 to 2017 (INDP)

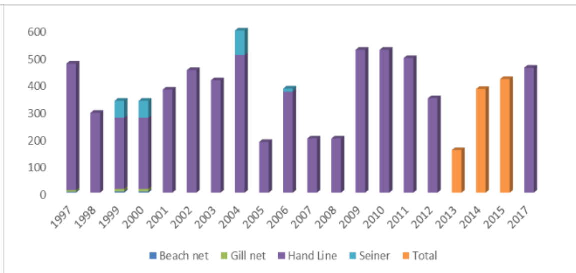


Figure l - Catch by different gears in Sao Nicolau Island, from 1997 to 2017 (INDP)

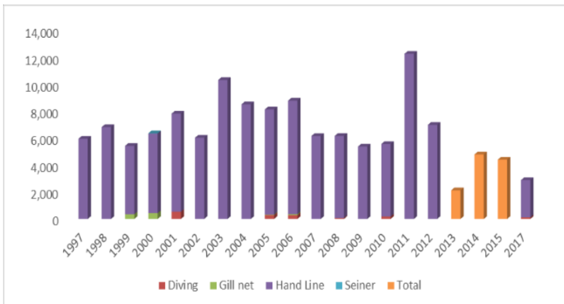


Figure m - Catch by different gears in Brava Island, by days at sea, from 1997 to 2017 (INDP)

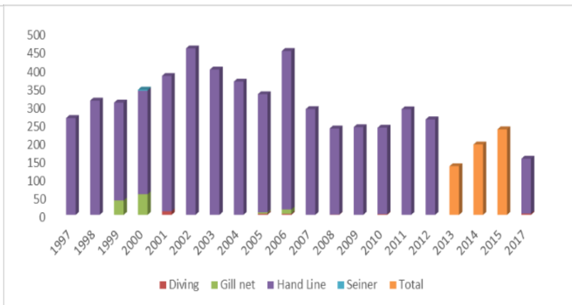


Figure n - Catch by different gears in Brava Island, from 1997 to 2017 (INDP)

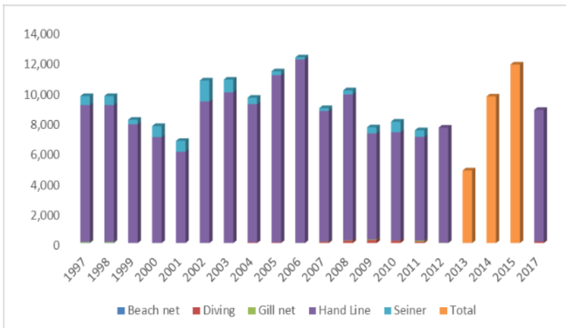


Figure o - Catch by different gears in Fogo Island, by days at sea, from 1997 to 2017 (INDP)

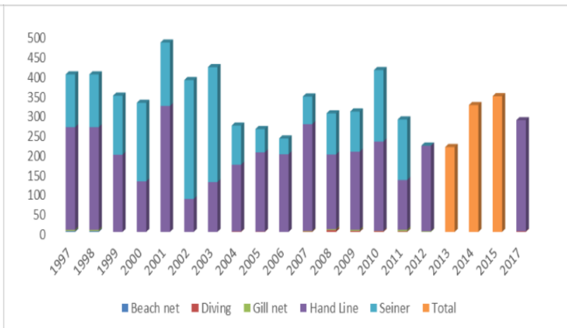


Figure p - Catch by different gears in Fogo Island, from 1997 to 2017 (INDP)

APPENDIX 2 – Catch by artisanal fleets (Catch of species groups and target species)

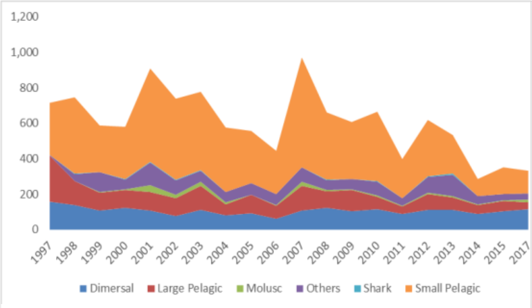


Figure q - Share of the different group of species on catch composition of artisanal fishery, in Santo Antão Island, from 1997 to 2017 (INDP)

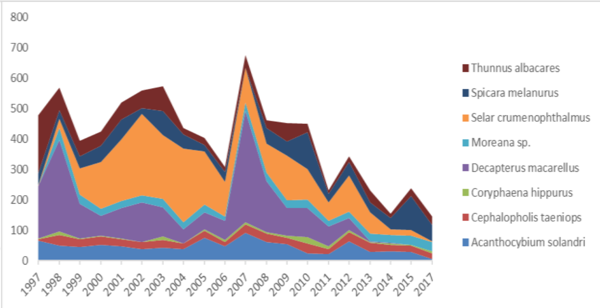


Figure r – Catch of the representative species on artisanal fishery in Santo Antão Island, from 1997 to 2017 (INDP)

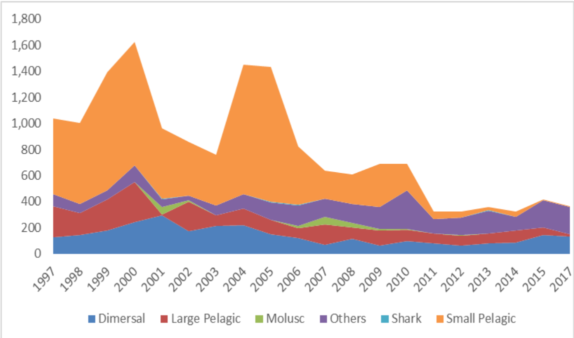


Figure s – Share of the different group of species on catch composition of artisanal fishery, in Sao Vicente Island, from 1997 to 2017 (INDP)

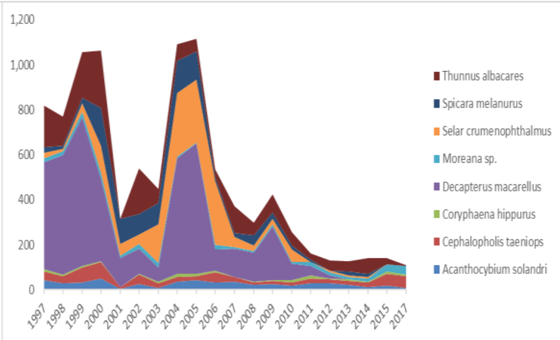


Figure t – Catch of the representative species on artisanal fishery in São Vicente Island, from 1997 to 2017 (INDP)

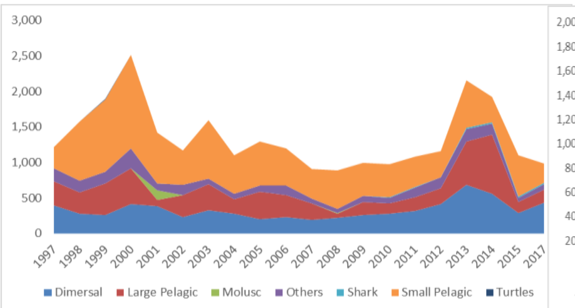


Figure u - Share of the different group of species on catch composition of artisanal fishery, in Santiago Island, from 1997 to 2017 (INDP)

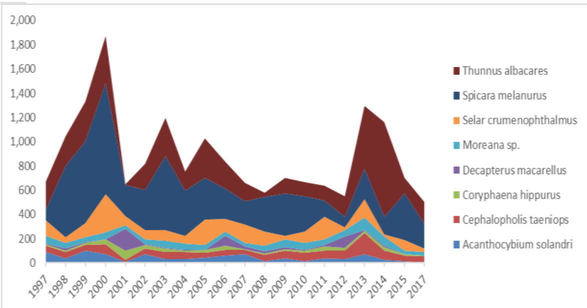


Figure v – Catch of the representative species on artisanal fishery in Santiago Island, from 1997 to 2017 (INDP)

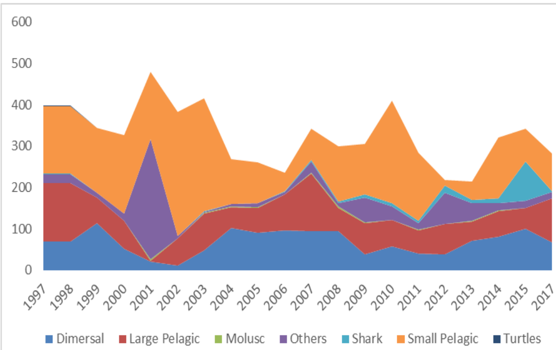


Figure w - Share of the different group of species on catch composition of artisanal fishery, in Sal Island, from 1997 to 2017 (INDP)

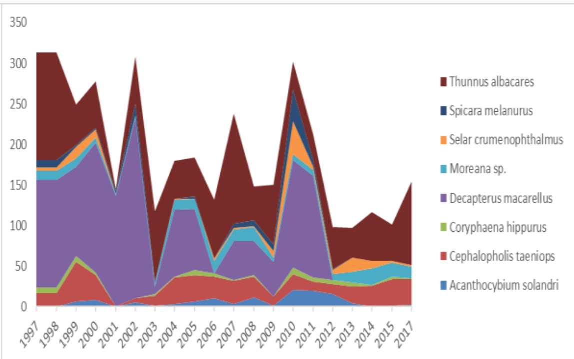


Figure y - Catch of the representative species on artisanal fishery in Sal Island, from 1997 to 2017 (INDP)

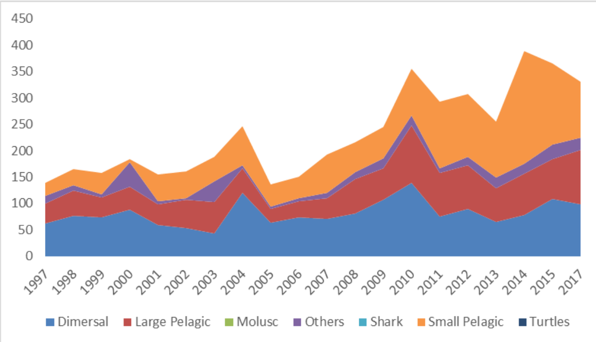


Figure z – Share of the different group of species on catch composition of artisanal fishery, in Boavista Island, from 1997 to 2017 (INDP)

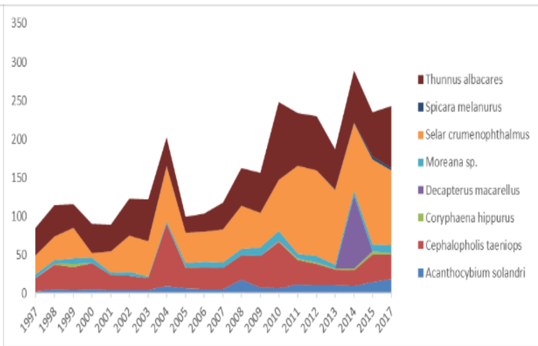


Figure aa – Catch of the representative species on artisanal fishery in Boavista Island, from 1997 to 2017 (INDP)

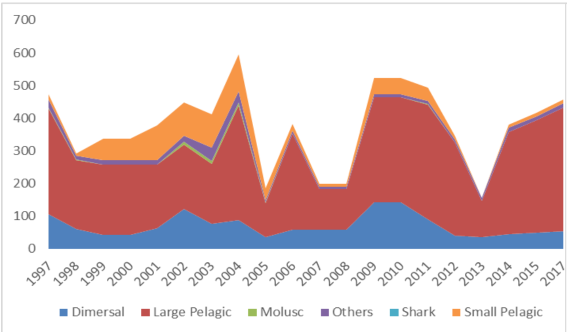


Figure bb - Share of the different group of species on catch composition of artisanal fishery, in Sao Nicolau Island, from 1997 to 2017 (INDP)

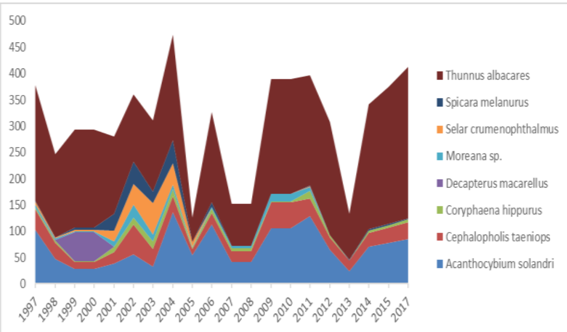


Figure ccuu – Catch of the representative species on artisanal fishery in Sao Nicolau Island, from 1997 to 2017 (INDP)

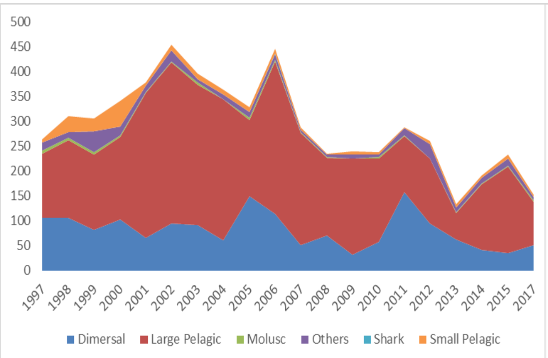


Figure dd - Share of the different group of species on catch composition of artisanal fishery, in Brava Island, from 1997 to 2017 (INDP)

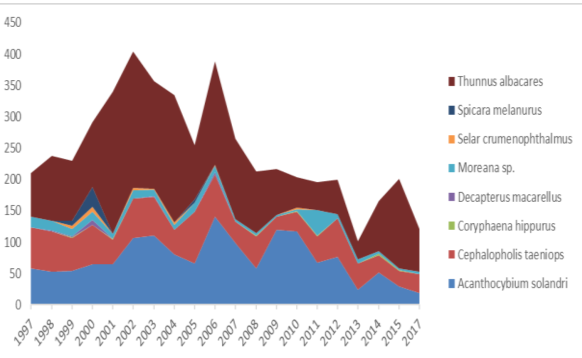


Figure ee – Catch of the representative species on artisanal fishery in Brava Island, from 1997 to 2017 (INDP)

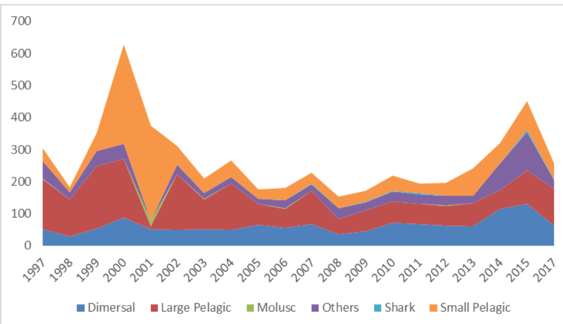


Figure ff - Share of the different group of species on catch composition of artisanal fishery, in Fogo Island, from 1997 to 2017 (INDP)

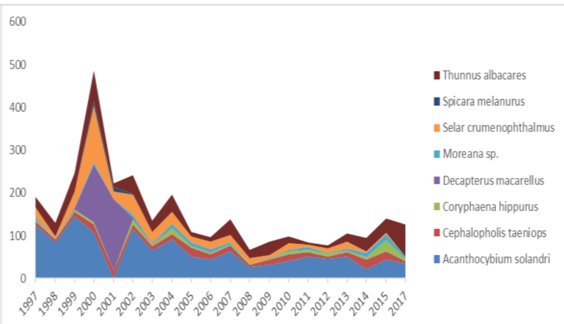


Figure gg – Catch of the representative species on artisanal fishery in Fogo Island, from 1997 to 2017 (INDP)

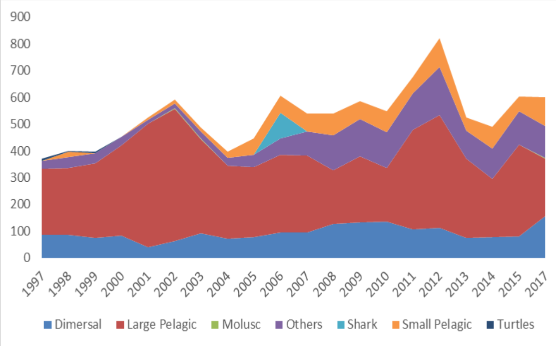


Figure hh - Share of the different group of species on catch composition of artisanal fishery, in Maio Island, from 1997 to 2017 (INDP)

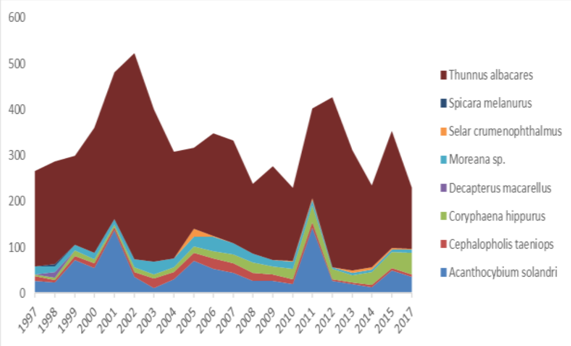
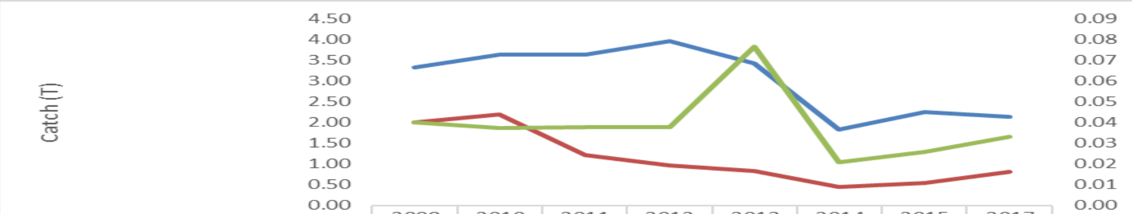


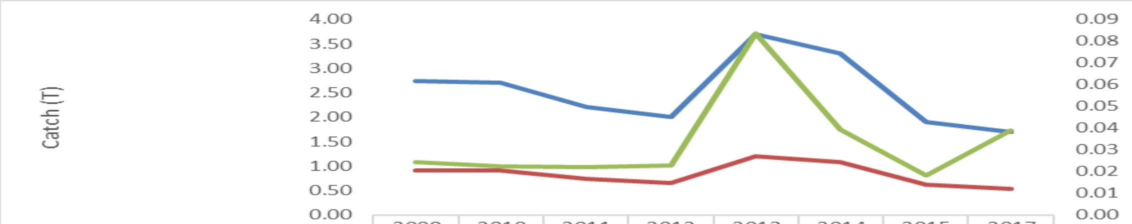
Figure ii – Catch of the representative species on artisanal fishery in Maio Island, from 1997 to 2017 (INDP)

APPENDIX 3 – CPUE by artisanal fleets



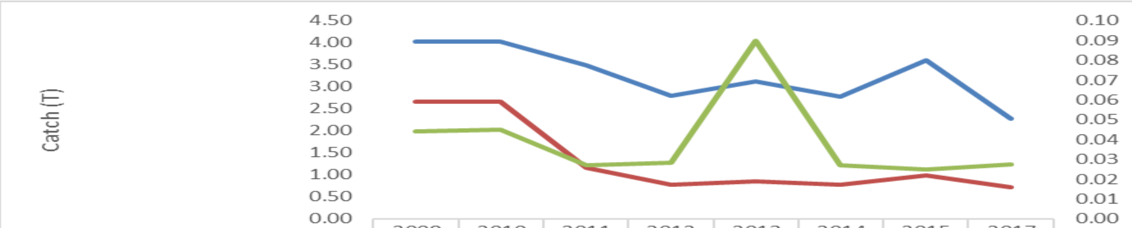
	2009	2010	2011	2012	2013	2014	2015	2017
Sum of CPUE (Vessel)	3.33	3.65	3.65	3.96	3.42	1.83	2.25	2.14
Sum of CPUE (Fishermen)	2.00	2.19	1.22	0.97	0.83	0.45	0.55	0.81
Sum of CPUE (Days at sea)	0.04	0.04	0.04	0.04	0.08	0.02	0.03	0.03

Figure jj – Trends of CPUE on catch of artisanal fishery in Santo Antão Island, from 1997 to 2017 (INDP)



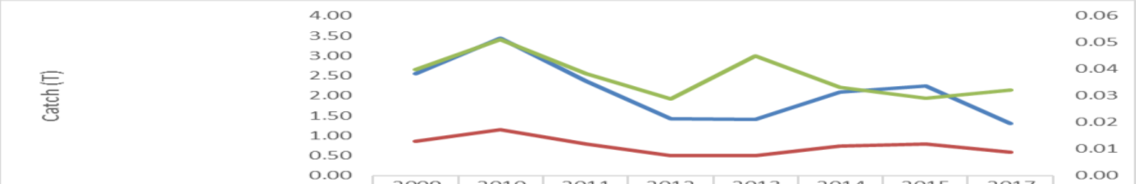
	2009	2010	2011	2012	2013	2014	2015	2017
Sum of CPUE (Vessel)	2.74	2.71	2.22	2.00	3.71	3.30	1.90	1.70
Sum of CPUE (Fishermen)	0.91	0.90	0.73	0.65	1.20	1.07	0.61	0.53
Sum of CPUE (Days at sea)	0.02	0.02	0.02	0.02	0.08	0.04	0.02	0.04

Figure kk - Trends of CPUE on catch of artisanal fishery in São Vicente Island, from 1997 to 2017 (INDP)



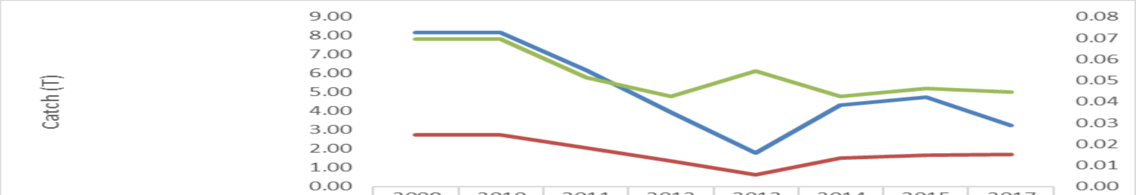
	2009	2010	2011	2012	2013	2014	2015	2017
Sum of CPUE (Vessel)	4.02	4.03	3.49	2.80	3.12	2.78	3.60	2.27
Sum of CPUE (Fishermen)	2.65	2.65	1.16	0.77	0.86	0.77	0.99	0.71
Sum of CPUE (Days at sea)	0.04	0.04	0.03	0.03	0.09	0.03	0.02	0.03

Figure ll – Trends of CPUE on catch of artisanal fishery in Santiago Island, from 1997 to 2017 (INDP)



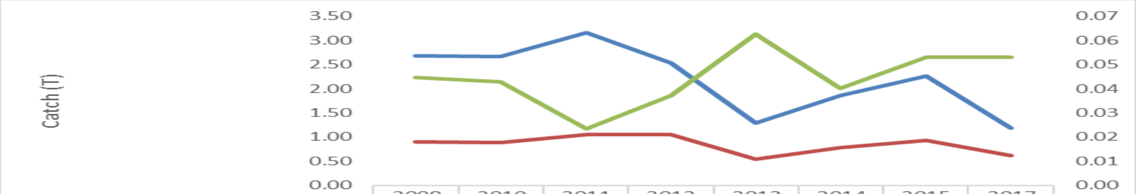
	2009	2010	2011	2012	2013	2014	2015	2017
Sum of CPUE (Vessel)	2.56	3.44	2.37	1.43	1.40	2.10	2.24	1.31
Sum of CPUE (Fishermen)	0.85	1.15	0.79	0.51	0.50	0.75	0.79	0.59
Sum of CPUE (Days at sea)	0.04	0.05	0.04	0.03	0.04	0.03	0.03	0.03

Figure mm - Trends of CPUE on catch of artisanal fishery in Sal Island, from 1997 to 2017 (INDP)



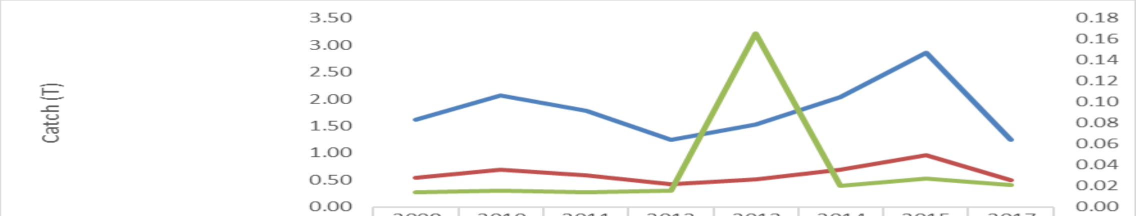
	2009	2010	2011	2012	2013	2014	2015	2017
Sum of CPUE (Vessel)	8.18	8.18	6.17	3.93	1.78	4.32	4.73	3.23
Sum of CPUE (Fishermen)	2.73	2.73	2.06	1.37	0.62	1.51	1.65	1.72
Sum of CPUE (Days at sea)	0.07	0.07	0.05	0.04	0.05	0.04	0.05	0.04

Figure nn - Trends of CPUE on catch of artisanal fishery in São Nicolau Island, from 1997 to 2017 (INDP)



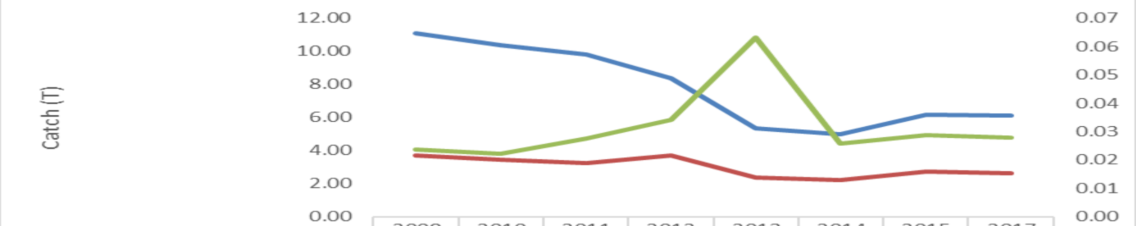
	2009	2010	2011	2012	2013	2014	2015	2017
Sum of CPUE (Vessel)	2.69	2.67	3.17	2.53	1.29	1.86	2.27	1.19
Sum of CPUE (Fishermen)	0.90	0.89	1.06	1.06	0.54	0.78	0.93	0.61
Sum of CPUE (Days at sea)	0.04	0.04	0.02	0.04	0.06	0.04	0.05	0.05

Figure oo - Trends of CPUE on catch of artisanal fishery in Brava Island, from 1997 to 2017 (INDP)



	2009	2010	2011	2012	2013	2014	2015	2017
Sum of CPUE (Vessel)	1.62	2.07	1.78	1.25	1.54	2.05	2.87	1.24
Sum of CPUE (Fishermen)	0.54	0.69	0.59	0.42	0.52	0.69	0.97	0.50
Sum of CPUE (Days at sea)	0.01	0.02	0.01	0.02	0.17	0.02	0.03	0.02

Figure pp - Trends of CPUE on catch of artisanal fishery in Fogo Island, from 1997 to 2017 (INDP)



	2009	2010	2011	2012	2013	2014	2015	2017
Sum of CPUE (Vessel)	11.07	10.36	9.81	8.39	5.37	5.00	6.17	6.13
Sum of CPUE (Fishermen)	3.69	3.45	3.27	3.72	2.38	2.22	2.71	2.62
Sum of CPUE (Days at sea)	0.02	0.02	0.03	0.03	0.06	0.03	0.03	0.03

Figure qq - Trends of CPUE on catch Maio Island, from 1997 to 2017 (INDP)

APPENDIX 4 – Catch of yellowfin tuna and wahoo (Data from ICCAT and FAO)

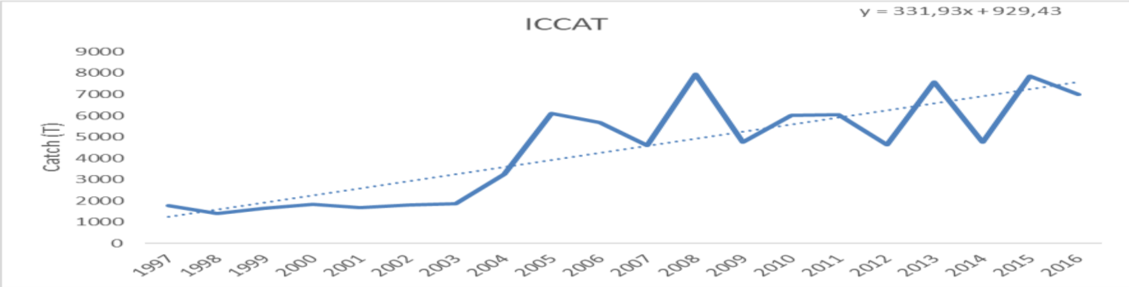


Figure rr – Trends of catch (T) of yellowfin tuna in Cabo Verde, from 1997 to 2017 (ICCAT)

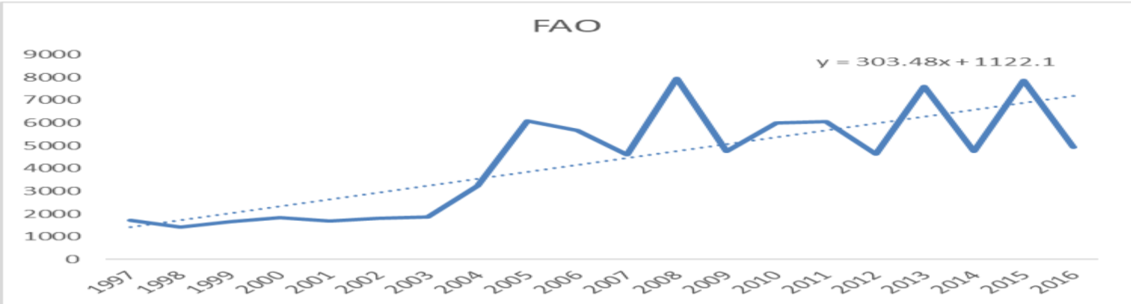


Figure ss - Trends of catch (T) of yellowfin tuna in Cabo Verde, from 1997 to 2016 (FAO)

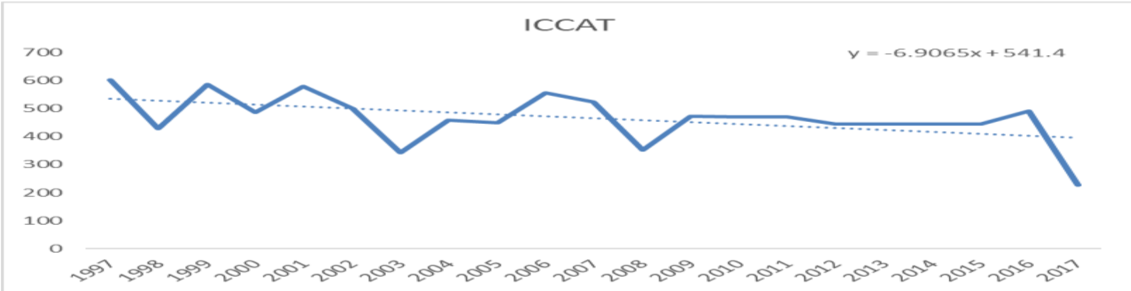


Figure tt - Trends of catch (T) of wahoo tuna in Cabo Verde, from 1997 to 2016 (ICCAT)

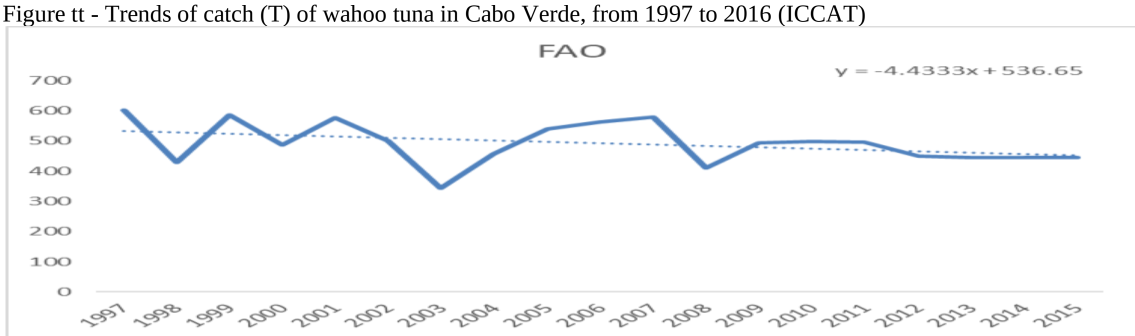


Figure uu - Trends of catch (T) of wahoo tuna in Cabo Verde, from 1997 to 2016 (FAO)

Appendix 5 - Impact of catch of target species in total income and price

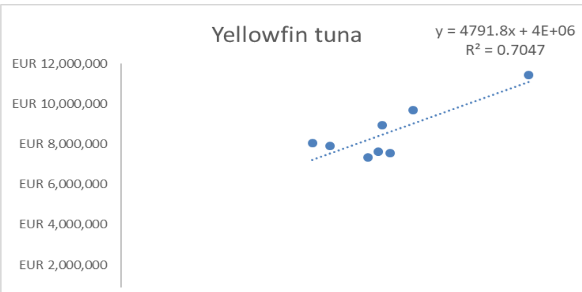


Figure vv – Relationship between catches of target yellowfin tuna and total income

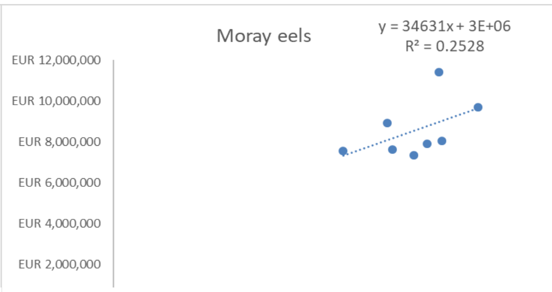


Figure ww - Relationship between catches of moray eels and total income

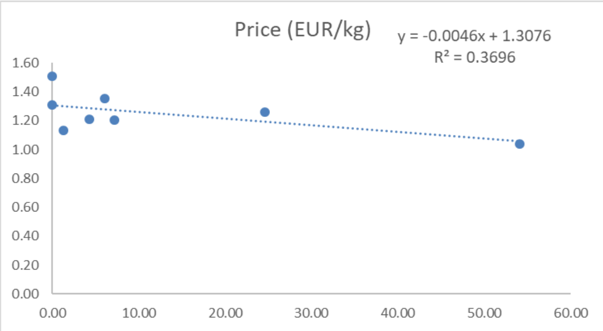


Figure yy – Relationship between catch and price per kg of bigeye scad in Sao Vicente Island

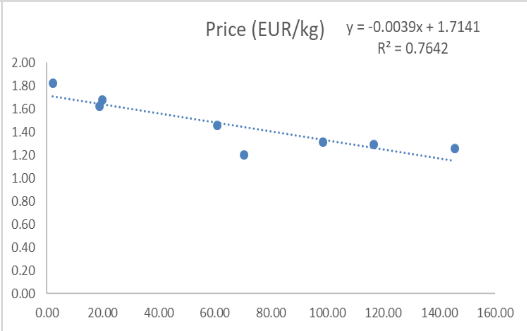


Figure zz – Relationship between catch and price setting of bigeye scad in Santo Antão Island

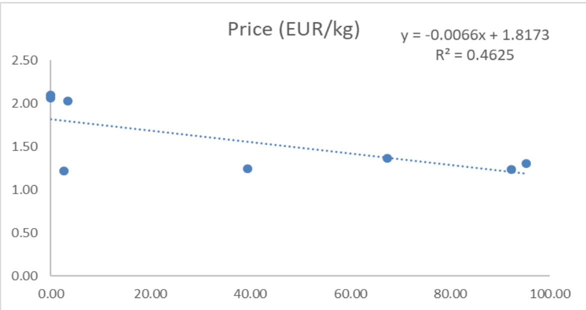


Figure aaa – Relationship between catch and price per kg of mackerel scad in Santo Antão Island

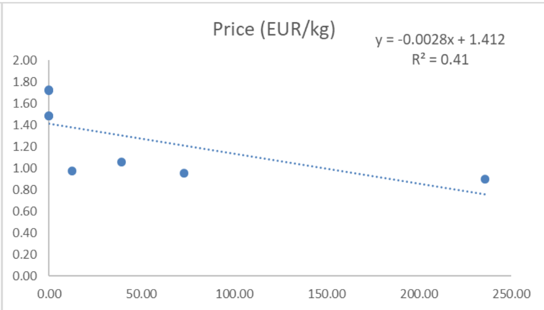


Figure bbb – Relationship between catch and price per kg of mackerel scad in Sao Vicente Island

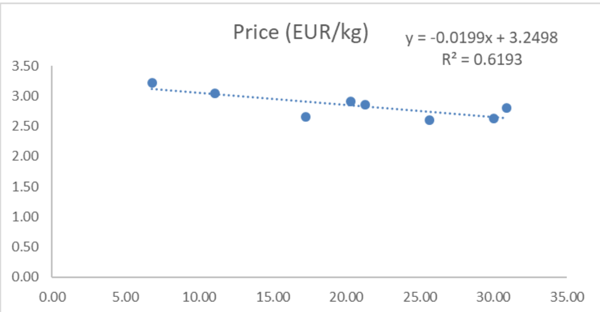


Figure ccc – Relationship between catch and price per kg of wahoo in Sao Vicente Island

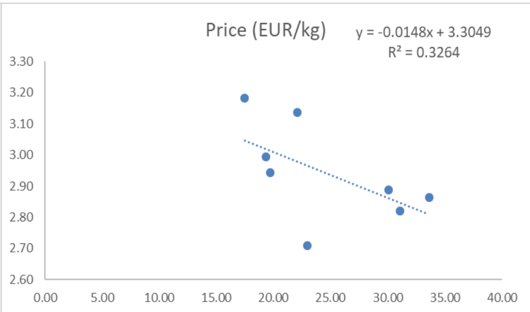


Figure ddd – Relationship between catch and price per kg of grouper in Santo Antão Island

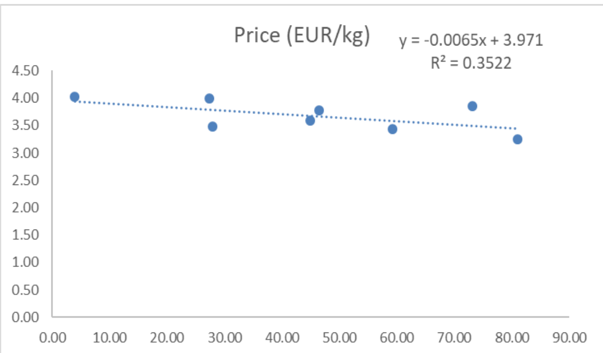


Figure eee – Relationship between catch and price per kg of yellowfin tuna in Sao Vicente Island

APPENDIX 6 – Sensitivity analysis of CPUE and catch for different levels of effort, in a range of -/+30%

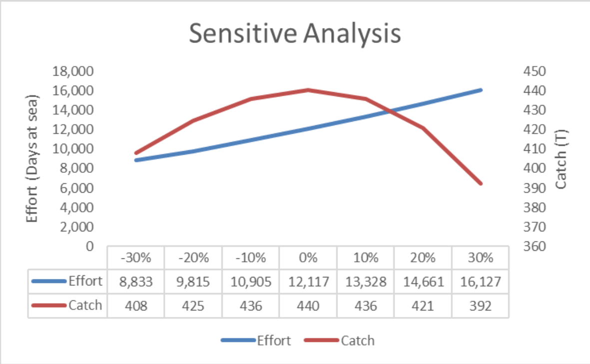


Figure fff – Santo Antão Island estimated catch on different levels of effort

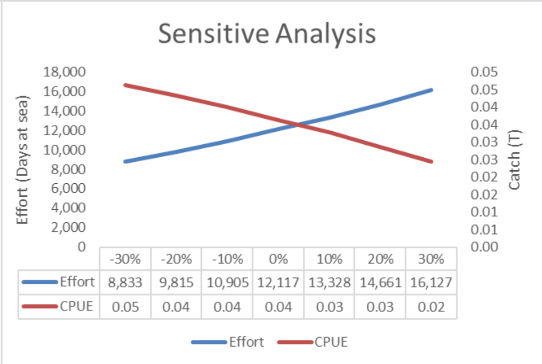


Figure ww - Santo Antão Island estimated CPUE on different levels of effort

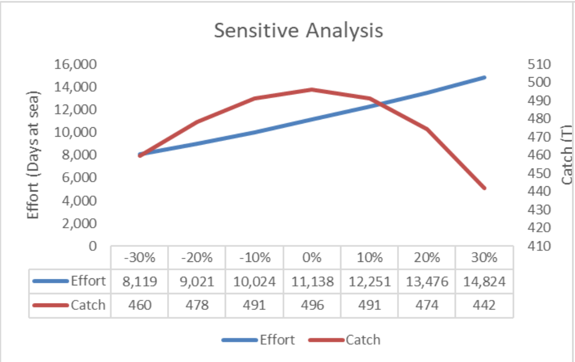


Figure kkk – São Vicente Island estimated catch on different levels of effort

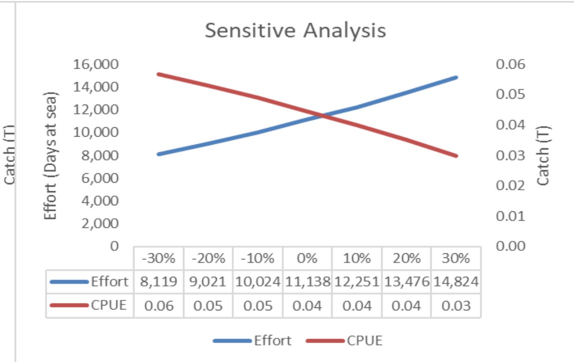


Figure vv – São Vicente Island estimated CPUE on different levels of effort

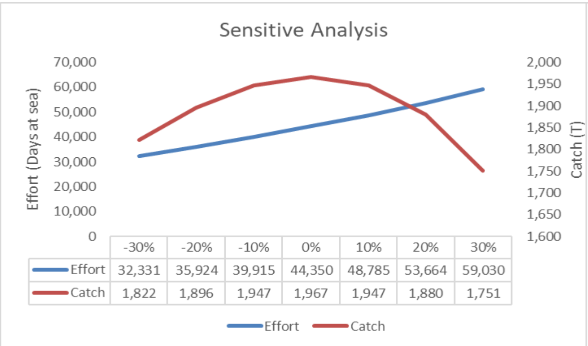


Figure mmm – Santiago Island estimated catch on different levels of effort

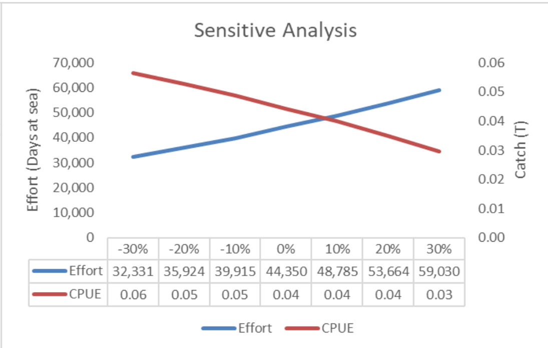


Figure nnn – Santiago Island estimated CPUE on different levels of effort

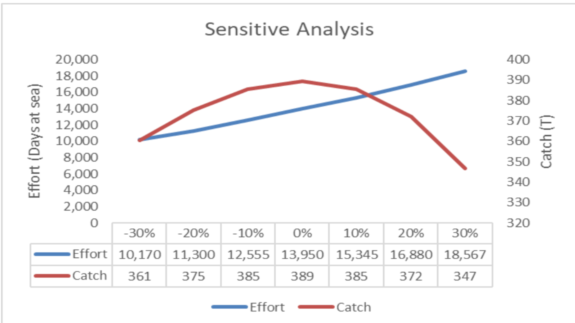


Figure ooo – Sal Island estimated catch on different levels of effort

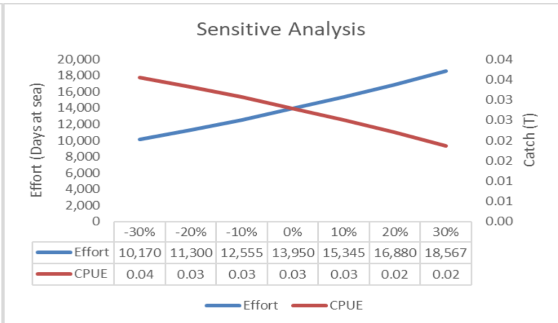


Figure ppp – Sal Island estimated CPUE on different levels of effort

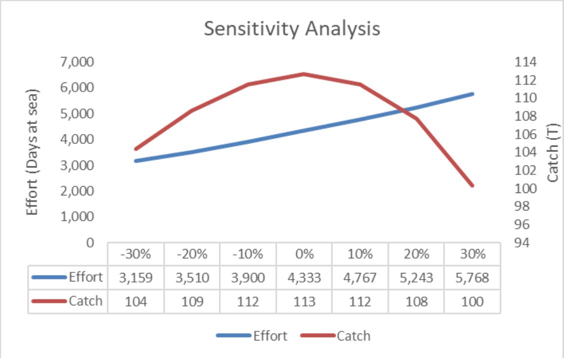


Figure qqq – Boavista Island estimated catch on different levels of effort

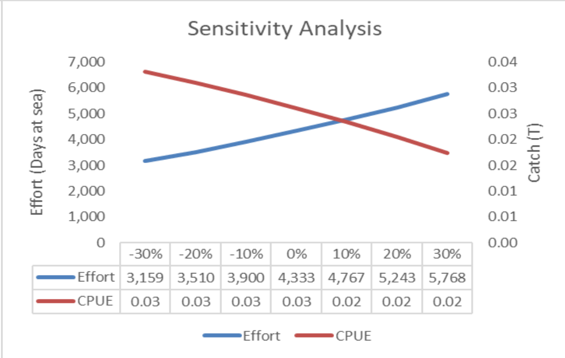


Figure xx – Boavista Island estimated CPUE on different levels of effort

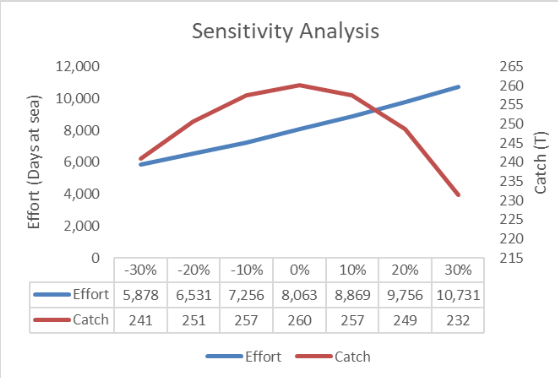


Figure sss – Brava Island estimated catch on different levels of effort

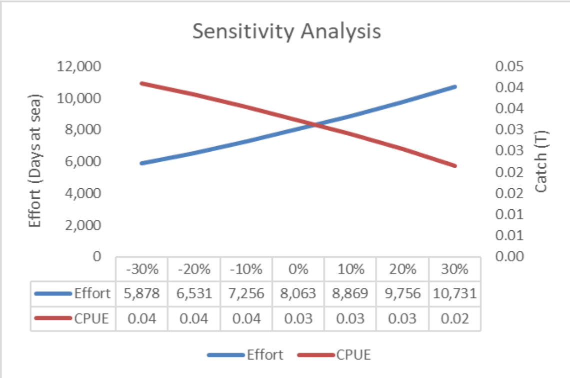


Figure ttt – Brava Island estimated CPUE on different levels of effort

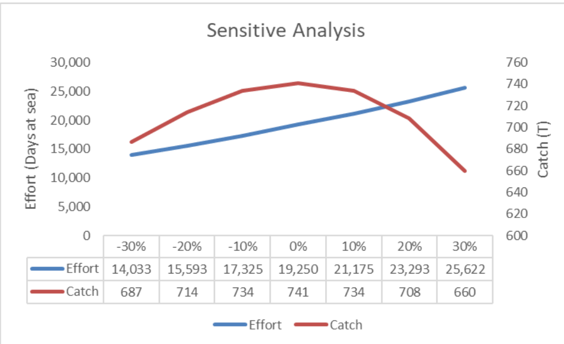


Figure uuu – Maio Island estimated catch on different levels of effort

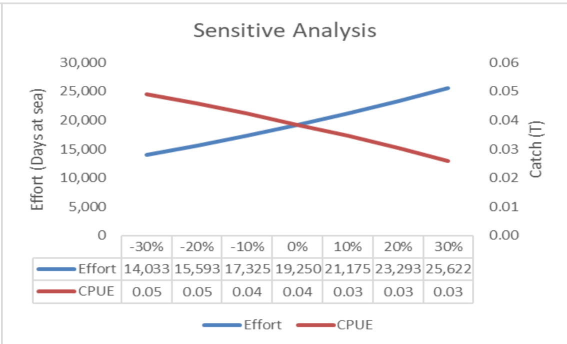


Figure vvv – Maio Island estimated CPUE on different levels of effort