



REPORT

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Peruvian mahi mahi fishery (*Coryphaena hippurus*) characterization and analysis of the supply chain

Author´s Note:

This document is the result of a field work carried out between January and April 2015, which has been reviewed and updated accordingly.

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LIST OF ACRONYMS

- ASS: Subtropical Surface Water
- CHD: Direct Human Consumption
- DICAPI: General Directorate of Captaincy and Coastguards
- DIREPRO: Regional Directorate of Production
- DPA: Artisanal Fish Landing Site
- FAO: Food and Agriculture Organization of the United Nations
- FIP: Fishery Improvement Project
- FOB: Free on board
- I-CENPAR: First National Census of Artisanal Fishing in the Maritime Sector
- IMARPE: Peruvian Institute of the Sea
- IUU: Illegal, Unreported and Unregulated
- Kg: Kilogram
- FL: Fork length
- MINAM: Ministry of the Environment of Peru
- nm: Nautical miles
- NOAA: National Oceanic and Atmospheric Administration
- OIT: International Labor Organization
- OSPA: Social Organization of Artisanal Fishermen

LIST OF ACRONYMS

- OZOPRO: Production Field Office
- PRODUCE: Ministry of Production
- PROMPERU: Peru Exports and Tourism Promotion Board
- RM: Ministerial Resolution
- SANIPES: National Fish Health Agency
- SEPA: Artisanal Fishing Extension Service
- SFI: Smart Fishing Initiative
- SUNARP: National Superintendency of Public Records of Peru
- SUNAT: National Superintendency of Tax Administration
- t: Metric ton

SUMMARY

The mahi mahi (*Coryphaena hippurus*) is an opportunistic, broad-spread, high-fertility predator characterized by its fast growth and maturity cycle (Palko et al., 1982; Oxenford et al., 1999; Solano-

Sare et al. Al., 2008, FAO, 2015). Between 2010 and 2014, Peru has maintained annual landings that correspond to 50% of the worldwide total (FAO, 2017). In 2016, national exports amounted to 82 million dollars FOB, with the United States buying more than 80% (SUNAT, 2017). Although the mahi mahi fishery is of utmost importance, it does not have a Fishery Regulation, but it does have some management measures. However, such regulations are not enough to guarantee a long-term sustainability.

Between January and April 2015, the links of the supply chain of the mahi mahi fishery and their interactions were characterized and analyzed using secondary information and primary information, through surveys to the main stakeholders in the fishery sector. In that sense, it was concluded that the traceability is deficient. In the domestic market there are no benefits for fishermen who work formally, sustainably and with adequate sanitary measures. On the other hand, in the international market we found that the value of the Peruvian mahi mahi is below compared to the one exported by other countries, due to health aspects and inadequate technical characteristics. It is very important to improve fisheries management, to generate economic incentives for formalization, to curb the increase in excessive fishing effort, to improve the monitoring, control and inspection processes to guarantee sustainability, traceability and quality, as well as the economic development of the stakeholders involved in the supply chain.

I. INTRODUCTION

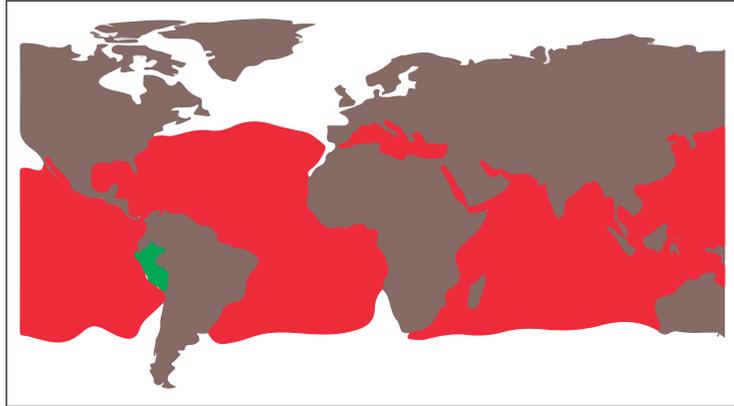


The mahi mahi (*Coryphaena hippurus*) is an epipelagic species of fast swimming, distributed worldwide (**Figure 1**) in tropical and subtropical waters in the Pacific, Atlantic and Indian Ocean, and in the Mediterranean Sea (Palko et al., 1982, Collete, 1999, FAO, 2015). This species lives in waters with temperatures ranging between 21 and 30°C (FAO, 2015), and may also be found in oceanic or coastal waters (FAO, 1994; Collete, 1999; Solano et al., 2008).

The mahi mahi is an opportunistic and voracious top predator (Palko et al., 1982). It is a fast-growing species (Oxenford, 1999), with an elongated and compressed body (Collete, 1999). They are heterosexual organisms and show sexual dimorphism (the males have a prominent bony bulge in the front of the head), the same that begins to appear at the 40 cm of fork length (FL) (Palko et al., 1982). It is a species of early maturity (Oxenford, 1999) with a high fertility rate, long spawning season and very short lifespan (Palko et al., 1982). It begins its maturity at 35 cm FL, reaching full maturity at 55 cm FL (Palko et al., 1982).

In Peru, the mahi mahi fishery is exclusively for artisanal fishing, which uses vessels of up to 32.6 m³ of hold capacity and mainly manual fishing gear. This artisanal condition has not prevented it from developing a fleet capable of sailing at sea on long-haul voyages. For example, fishing logbooks show catches made beyond 200 nautical miles from the coast, in international waters, on trips that can last for more than 20 days. On the other hand, longline is the most commonly used fishing gear.

Figure 1. Worldwide distribution of the *Coryphaena hippurus*



Source: FAO, 2015

Traceability is defined as the systematic ability to access all or some information related to a food throughout its life cycle (Olsen and Borit, 2013). In the case of seafood, it's from catch to the final consumer (Christensen et al, 2014).

The WWF Smart Fishery Initiative (SFI), in order to promote transparency in the global fisheries sector, considers six basic principles for traceability: (1) Provide essential information, (2) Provision of information occurs along the whole chain (3) Effective monitoring of transformations, (4) Digital information and standardized data formats, (5) To have means of verification and (6) Transparency and public access to information (SFI, 2015).

The **supply chain** is defined as a system that groups the economic stakeholders interrelated by the market and who participate articulately in activities that generate value around a good or service. This includes the phases of provision of inputs, production, conservation, transformation, distribution, marketing and consumption, both in domestic and external markets (Law No. 28846 - Law to Strengthen Supply Chains and Conglomerates).

Illegal fishing is defined as the extractive fishing activity of seafood in Peruvian jurisdictional waters, carried out by national or foreign vessels without authorization or carrying out against legal measures of conservation, management or sustainability. This activity uses prohibited fishing gear, extracting protected species, in forbidden or during closure. This practice does not respect the allowable catch quotas, and does not state or provide false or inaccurate information on the weight and species of the catch (PRODUCE, 2017).

Likewise, the definition of informal fishing has been constructed from the definition of: 1) informal mining and 2) informal economy. The Ministry of the Environment of Peru considers **informal mining** as the activity performed by mining operators who are not legal, those who have started a process of formalization and those who do not operate in prohibited areas or use machinery that does not correspond to their category (MINAM, 2015). While the International Labor Organization defines **informal economy** as the set of economic activities developed by workers and economic units who, both in law and in practice, are insufficiently covered by formal systems or not covered at all. The activities of such people and companies are not covered by the law, which means that they operate outside it; or are not included in practice, which means that, although these people operate within the scope of the law, the law is not applied or fulfilled; or the law itself does not encourage compliance because it is inappropriate, cumbersome or impose excessive costs. (ILO, 2015)

Therefore, for the purposes of this investigation, informal fishing is considered as the activity that is carried out by fishermen who do not have a fishing license, or are in the process of getting one or whose license is not in force. Also, it includes those fishermen whose boats do not have certificate of registration, are in process of obtaining it or are not valid anymore. In all cases, the fishing activity is carried out in the fishing seasons established and respecting the measures of fishing regulations in force. In case fishermen use fraudulent documents, do not respect existing fishing regulations or commit acts of corruption, this activity will be considered as an illegal activity.

It is important to take into account that the difference between the definitions of informal fishing and illegal fishing in some cases may be ambiguous and therefore it is recommended to go deeper in order to prevent an illegal activity from being masked in the context of an informal activity. It should also be considered that part of what is estimated to be an informal fishing activity may be included in the definition of illegal, unreported and unregulated (IUU) fishing and that the global trend is to fight against IUU fishing because of its negative impacts on the sustainability of fisheries resources. Therefore, if part of the informal fishery is considered as IUU fishing, it should be taken into account that this could have economic implications for our artisanal fisheries due to the potential closure of international markets that include criteria to fight IUU fishing.

In Peru, artisanal fisheries have lacked, in part or in full, of basic information for their management. There is no good record on commercial fisheries landings for Direct Human Consumption (DHC). Nor is there a complete record of the fleet or the number of fishermen. Basically, there is no proper monitoring of seafood along the different links of the supply chains. These information gaps, which translate into lack of data for decision-making, have been reported for more than a century by Coker (1908) and more than 20 years ago by Wosnitza-Mendo (1992). However, to date, no comprehensive action has been taken by the State to address the country's artisanal fisheries.

The mahi mahi fishery has not been the exception to the rule. The research team working on this study believes that this fishery is a good example to understand the importance of traceability and how its results can be extrapolated to other artisanal fisheries. Its large landing volumes, its contribution to food security and the country's fish exports make this fishery one of the most important in Peru. For this reason, it was decided to characterize its supply chain, in order to understand the gaps that exist along its links and to demonstrate the need to make reforms for the transparency of the national fishing sector, the improvement of a particular link or the resolution of cross-cutting issues to the whole activity.

II. METHODOLOGY



This study characterizes the supply chain of the mahi mahi fishery in Peru. Therefore, we have identified each of its links and different interrelations.

Between February and April 2015, primary information was collected through direct interviews with key stakeholders and through the extension agents¹ of the Ministry of Production (**Annex 1**). The ports of Paita, Pucusana and Ilo were visited and 37 agents involved in the mahi mahi fishery were interviewed (Paita = 15, Pucusana = 10 and Ilo = 12). Information was gathered on the characteristics of the fleet and its fishing gear, work and fishing operations, catch volumes, fleet cost and revenue structures, as well as a description of the main problems and expectations of the agents interviewed. The information collected was complemented and compared with data from I-CENPAR (PRODUCE, 2015a). Semi-structured interviews were also carried out with middlemen and/or refrigerated truck drivers (n = 9), obtaining information on suppliers, buying and selling prices, unloading costs, transportation costs, marketing channels at source, target markets, work system with suppliers and customers.

Also, this primary information was supplemented with the information collected in the eleven workshops conducted by the Marine Program team of WWF-Peru, under the Fisheries Improvement Project (FIP) of the mahi mahi fishery, during July 2014 and June 2015 (Paita = 2, La Isilla = 2, IMARPE Paita = 1, Lima = 1, Pucusana = 1, Ilo = 2, Tacna = 2). On the other hand, interviews were carried out with academics from the Peruvian fishing sector (n = 4), as well as managers of mahi mahi import companies in the United States (n = 2).

1 The extension agent is a professional of the Ministry of Production who acts as an interlocutor between artisanal fishermen and regional and national authorities. They perform their tasks in the marine, lake and fluvial environment. Its main tasks include: (i) formalization; (ii) good fishing practices; (iii) organizational strengthening; (iv) integration into the marketing system; (v) creation of an organizational credit culture; and (vi) social security.

In order to understand the role of government agencies in this fishery, stakeholders from IMARPE (n = 4), the Production Field Office (OZOPRO-Paita, n = 1), the Artisanal Fisheries Extension Service (SEPA-PRODUCE, n = 2), the National Fish Health Agency (SANIPES, n = 1), the Pucusana Artisanal Fish Landing Site (DPA-Pucusana, n = 1) and General Directorate of Captaincy and Coastguards (DICAPI, n = 2). Additionally, the fisheries regulations, as well as the processes that the stakeholders must follow to achieve the formality and ensure the traceability and safety of the fishery products along the supply chain were analyzed.

Likewise, the production records of two mahi mahi frozen plants located in Paita - Piura were analyzed, from which the final product types, yields, production costs and income structure were taken. In addition, field visits were made to wholesale markets (n = 2) and food markets (n = 29) in Lima. Information on the origin of the mahi mahi, its marketing formats, prices and costs, number of jobs and problems in the development of the activity was recorded.

Secondary sources were also reviewed, such as official statistics from the Ministry of Production (PRODUCE) and the National Superintendency of Customs and Tax Administration (SUNAT), FAO databases, Peruvian Institute of the Sea (IMARPE), Peru Exports and Tourism Promotion Board (PROMPERU) and the National Oceanic and Atmospheric Administration (NOAA), as well as national fisheries legislation and relevant scientific literature. Also, primary information was generated through direct interviews with key stakeholders.

Likewise, the information collected was discussed, and information gaps were identified in each link as well as cross-cutting issues to the entire activity and those that were particular to each link. Finally, the corresponding recommendations were made for this fishery to be more transparent.

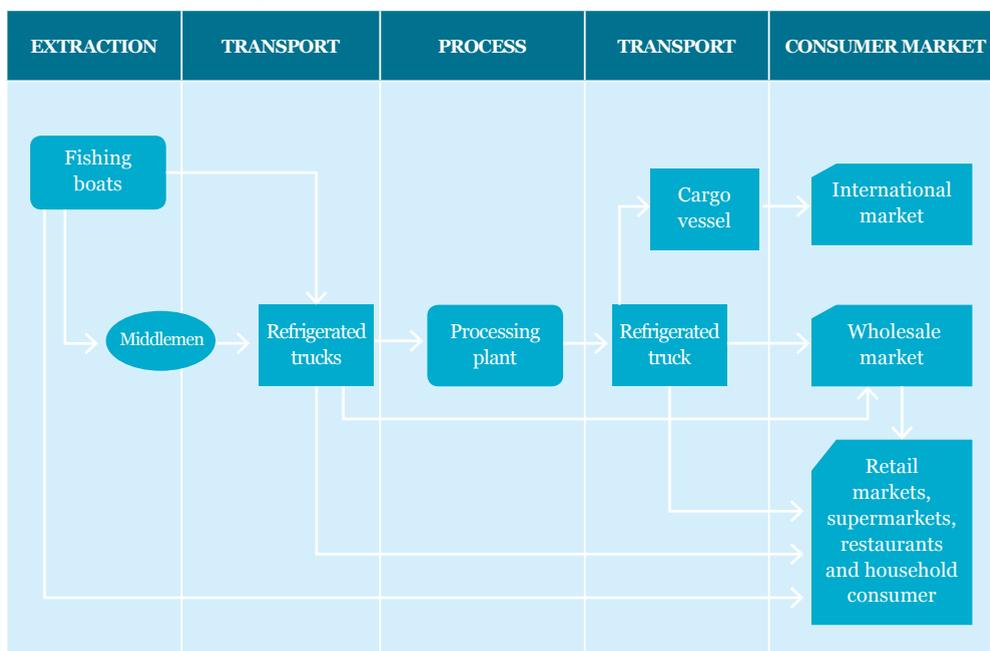
III. RESULTS AND DISCUSSION



3.1. MAHI MAHI SUPPLY CHAIN IN PERU

Based on the information collected at primary and secondary levels, we propose that the supply chain of the mahi mahi fishery at national level is made up of the following four main stages: (a) Extraction, (b) Intermediate commercialization and transportation, (c) Processing plants and (d) Local and international trade (Figure 2). These stages have particularities (Annex 2) and differences between locations. However, it brings together the universe of stakeholders involved in this fishery.

Figure 2. Simplified supply chain of mahi mahi fishery in Peru



Source: Prepared by the authors

a. Extraction

This stage includes the activities concerning the **fishing trip** and its interrelation with the different governmental organizations that have competences in the marine and fishing environment. It also includes the **middlemen**, who is the connecting element between this link and the next. The middlemen performs multiple tasks (formal and informal), from buying the mahi mahi being landed in the port to financing the fisherman carrying out the fishing and/or maintenance activities and to make improvements in the boats. On the other hand, if the fisherman does not have documents in order, the middlemen can fulfill the role of biller, i.e., provide documents (legal or illegal) that allow fishing to enter the formal cycle.

b. Transport

It can start with the middlemen or the fisherman, who directly sells his catch to the vehicle (refrigerated truck), which transports the fish to processing plants or consumer markets. Transport intervenes as a connector between the fisherman and the processing plants, as well as between processing plants and the consumer market.

c. Processing plants

Here the fish is transformed into different products according to the destination markets. These plants can also serve for storage for transporters, who will then sell the products in the domestic markets.

d. Consumption markets

It includes markets at national level as well as international markets.

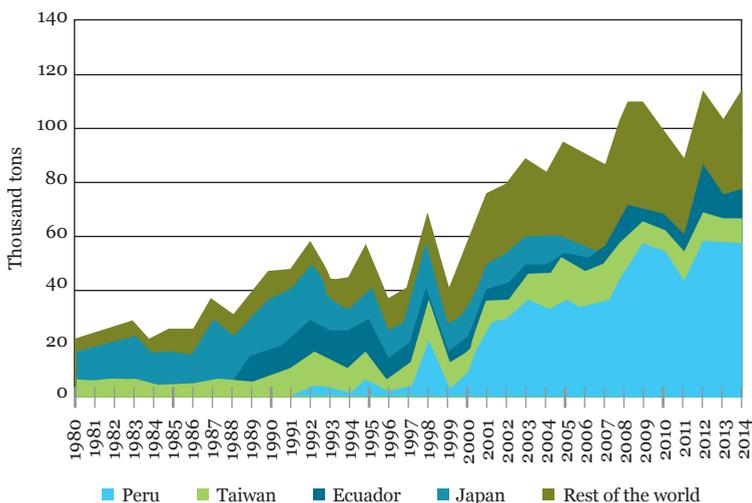
3.2. MAIN LINKS IN THE SUPPLY CHAIN

3.2.1. Extraction

Peru is a key country for the landing of this resource worldwide (**Figure 3**). In 2014 it captured 48% of the world total; while the following countries, Taiwan and Ecuador, accounted for 10% each. (FAO, 2017). In our country landings are reported since 1971 (IMARPE, 2015); However, these do not significantly increase until after the El Niño event of 1997-98 (Estrella & Swartzman, 2010).

The main ports, due to their contribution to landings between 2000 and 2013, are Paita (23,6%), Chimbote (10,4%), Ilo (9,7%), Pucusana (7,5%) and Matarani (7,4%).

Figure 3. Historical landings of mahi mahi worldwide



Source: Prepared by the authors with data from FAO (2017)

The mahi mahi is considered an opportunity resource since this fishery occurs only in the spring and summer months, due to the seasonal incursion of surface subtropical waters (SSA) (Solano et al, 2015). This allowed the fishing to take place in the spring and summer months (southern hemisphere). However, with the increase in their demand, the fishing seasons began increasingly early (winter months) and the landings showed a percentage of juveniles greater than the established tolerance. Therefore, the mahi mahi fishing season was established between October 1st of each year and April 30th of the following year, by RM N° 245-2014-PRODUCE.

According to I-CENPAR, carried out in 2012, the fleet that claimed to have caught mahi mahi in the last six months was nearly 2 129 boats (PRODUCE, 2015a). 73% of this fleet was equipped with longlines (n = 1 547), and 61% (n = 945) was built between 2006 and 2012. Likewise, boats have tended to increase length and number of hooks over the years. In general, there has been an uncontrolled increase in the fishing capacity of this resource, which is reflected in the increase in the number of longline vessels from 219 in 1996 to 947 in 2005 (Estrella et al, 2010), and finally to more than 2 000 in 2012 (PRODUCE, 2015a).

By analyzing the information in I-CENPAR regarding the formality of the vessels, it was identified that a large percentage of the vessels surveyed (88%, n = 1 363) had a valid registration certificate at the time of the census. However, only 65% (n = 1 009) had a valid fishing license and 29% (n = 444) complies with the health authorization. It is worth mentioning that only 67% of the vessels (n = 1 036) wanted to share information about their hold capacity.

Finally, there are a lot of procedures that must be done to formally participate in this fishery. This incurs economic and time investments because these procedures are required by different institutions, such as DICAPI, PRODUCE, SUNAT, SUNARP, the Regional Governments, among others, with little or no intra and inter-institutional coordination. For example, the cost to formalize an artisanal fishing vessel exceeds S/. 4 000.00 (approximately US\$ 1 250) and may require more than three months.

It was found that the Paita fleet, compared to the fleet of Pucusana and Ilo, has a larger hold capacity, uses a larger number of crew, a larger longline, captures more tons per trip, but its costs per trip are a lot higher (**Table 1**). Also, **Table 2** presents a comparative table between the characteristics of the fishing operations of the mahi mahi fleet.

Table 1. Comparative chart between the fishing fleet of Paita, Pucusana and Ilo

Fleet characteristics	Paita	Pucusana	Ilo	
Hold capacity (t)	10-32,6	8-12	3-6	8-15
Crew (#)	7-10	4-6	3	4-6
Longline length (nm)	12-19	10-12	5-6	10
Hooks (#)	1 300-2 400	1 200-2 000	500-600	1 000-1 200
Catch per trip (t)	7-21	5,6-8,4	3,5	8,4
Cost per trip (thousand S/.)	15,4-32,1	7,6-13,3	3,01	7,1

Source: De la Puente *et al*, 2015

Table 2. Characteristics of fishing operations of the mahi mahi fleet

Characteristics of fishing operations	Alfaro-Shigueto <i>et al.</i> (2010) [Sampling: 2000-2007]	Ayala & Sanchez-Scaglioni (2014) [Sampling: 2009-2010]	This study [Sampling: 2015]			
			Paita (n=21)	Pucusana (n=10)	Ilo (n=12)	
					4-6 t fleet	8-12 t fleet
Total fishing time (days)	2-17	10-25	20-25	15-20	5-8	10-12
Navigation time from the port to fishing area (days)	-	-	3,5-5	2-3	1	2-3
Fishing time (days)	-	7-17	15-18	12-15	4-6	7-8
Fishing sets per trip	2-16	4-13	10	6	10	10-12
Effective fishing time per set (h)	2	3	3-4	5	4	4
Hauling time (h)	0,5-5,3	1,7-7,3	4	4	2	3
Average catch (Kg)	-	-	8 500	5 000	3 000	7 000
Catch considered a "good catch" (Kg)	-	-	15 000	4 000	4 000	9 000
Bait used ²	Jumbo squid, jack mackerel, flying fish	Jumbo squid, chub mackerel, longnose puffer, skipjack tuna, flying fish	Jumbo squid and longnose puffer	Jumbo squid, <i>potilla</i> ³ and longnose puffer	Jumbo squid and flying fish	Jumbo squid and flying fish

Source: De la Puente *et al.*, 2015

2 Jumbo squid (*Dosidicus gigas*), jack mackerel (*Trachurus murphyi*), flying fish (*Exocetus sp.*), chub mackerel (*Scomber japonicus*), skipjack tuna (*Katsuwonus pelamis*) and longnose puffer (*Sphoeroides lobatus*).

3 *Potilla* is a small specimen of squid.

About the number of fishermen involved in the fishing activity, 4 269 (9,69%) reported that the mahi mahi was their main species caught in the last six months, according to I-CENPAR. However, 2 968 (6,7%) reported having mahi mahi as the main species in the last six months and also used longlines as their main fishing gear. Mahi mahi fishermen were mainly distributed in the areas of Arequipa (35,8%), Piura (26%) and Moquegua (17,2%). This is not consistent with the origin of the fleet or with the main landing sites. Although the fishermen specialized in this resource and the fleet has high mobility, it is questionable the level of representativeness of I-CENPAR and its usefulness in the analysis of the traceability of the resource.

Usually, the work of the artisanal fisherman is informal, with few or no social benefits. Also, the fishery may require long fishing operations (20-25 continuous days offshore per trip) in precarious conditions (poor safety on board, poor condition of vessels, etc.). However this is an opportunity fishery for them, for the high incomes they can get.

There is no biological fishery monitoring plan for the mahi mahi resource. For its part, IMARPE also has no plan or budget for the periodic evaluation of this resource, so no fishing survey has been programmed. In addition, there is no programmatic work for the collection of biological and fishery information from onboard observers on artisanal vessels.. On the other hand, records taken during landings do not have full coverage.

Another problem is the lack of investment in technology by the boat-owners, who are afraid of stop been considered artisanal because of the use of new technology⁴. Also, they did not internalize how the technology would reduce the operating costs of the trips. In addition, a lack of recognition of the quality of fish in the sale price on the beach has been identified. That is, the boat-owner is not properly rewarded for having invested in bringing fish of optimum quality.

4 According to article 30° of the Regulations of the General Law on Fishing, artisanal (embarked) fishing is defined as that carried out using vessels of up to 32,6 cubic meters of hold capacity and up to 15 meters in length, predominantly manual labor .

3.2.2. Intermediate commercialization

This is one of the most complex links in the supply chain, because of the diversity of cases presented. It begins with the negotiation of the fish at the landing port until the refrigerated truck is directed to its next destination (processing plants or local markets). Considering only the generalities of the fishery, this link can be divided into two main streams: 1) the one derived from an extractive activity according to the law and 2) the one from an informal extractive activity (for this study we will consider as informal the extractive activity carried out without fishing license).

In both cases, there may or may not be an “enabling merchant”, who finances the cost per trip (**Table 1**) when the ship-owner does not have the liquidity to carry out the job. It can also fund the regular maintenance of the boat. With this investment ensures that the product of the fishing is negotiated only with him.

The “biller” figure is necessary when fishing comes from an informal extractive activity (e.g. when the owner does not have a fishing license in force) or when it comes from an illegal activity (adulterated documents are used). This figure not only allows selling this fishery, but also is responsible for issuing the necessary receipts so that the product can enter a processing plant. This is a critical control point for this fishery, as it is here where illegal or informal fishing can become “legal” (whitened) or formal, as the case may be, and pass smoothly to the next links in the supply chain. Given the level of informality of extractive activity (described in the previous link), one could speak of this case as a major problem, which overlaps with the poor capacity to exercise control and vigilance, and corruption at different levels of the sector.

However, there are other marketing modalities. For example, when the ship-owner has the capacity to finance their fishing and negotiates directly with the processing plants or takes their fishing to the wholesale or stock market. Likewise, in Paita there are processing plants that have their own fleet.

There are also particular flows for the lower quality mahi mahi, commonly known as “tail mahi mahi”. It should be mentioned that quality perception is subjective according to the crew.

It is not customary to perform an organoleptic evaluation. This production, of lower value, is not received in the processing plants, but is destined to the local consumption in its totality.

3.2.3. Processing plants

In the Peruvian coast there are 123 plants of frozen seafood with operation license in force; the accumulated installed capacity is 8 094 t/day (PRODUCE, 2017). However, in this study it was impossible to establish the number and installed capacity of the plants that process frozen mahi mahi, due to the seasonality of the production and the lack of transparency of the sector. Likewise, it has not been possible to establish with certainty the origin of the raw material that reaches the plants located in different regions of the coast. The existence of traceability records at the plants does not ensure the full information of the origin of the parakeet, since the main objective of these is to code the production lot for storage and dispatch. It has been identified that in many cases the information recorded at the plant on the transportation chamber and the vessel is not reliable. About the suppliers, plants prefer to work with middlemen traders because they are seriousness when fulfilling orders, in addition to having the required documentation. Ship-owners and merchants stated that not all plants require an invoice; however, the fishing license is the main requirement in most cases.

According to PRODUCE, between 2000 and 2015, 34% of mahi mahi landings (226 300 t) were destined for the industrial processing of frozen mahi mahi. Between 2000 and 2016, Peru's main frozen product was mahi mahi steak (~ 44 000 t), followed by mahi mahi portions (~ 35 000 t), whole mahi mahi (~ 31 000 t) and mahi mahi slices (~ 17 000 t) (SUNAT, 2017). Using the production records of two mahi mahi freezing plants, located in Paita-Piura, we obtained the yield in finished product, which varies between 32% and 85% depending on the type of product (**Table 3**). However, it is important to indicate that mahi mahi enters the processing plants already gutted on the high seas. This may mean a weight reduction of up to 30% (Christensen et al, 2014).

Plant purchase prices, during the period 2010-2014, fluctuated between S/. 4,3-7,8 per kilogram for the small mahi mahi and S/. 5,6-9,8 per kilogram for the big mahi mahi. The average cost of production to process one ton of frozen mahi mahi is S/. 6,739 soles.

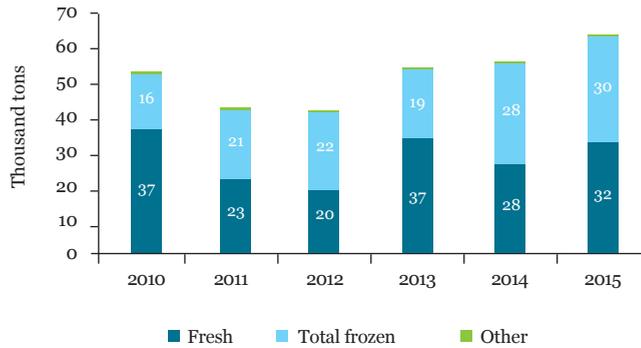
Table 3. Yield in finished frozen product of mahi mahi

Type of product	Yield
Mahi mahi tails and nape	32%
Mahi mahi darnes or slices	70-85%
Fillet with skin 1-3, 3-5, 2-5, 5-7, 7-up oz	51%
Fillet without skin 1-3, 3-5, 5-7,7-up oz	46%
Flèches 1-3, 3-5, 5-up oz	36-38%
Loin 5-32 oz	38%
Pieces 4, 6, 8 oz	34-36%
Portions w/skin w/bloodline w/o spine	52-53%
Pieces w/o skin w/fat w/o bloodline w/o spine	37-38%

3.2.4. National and international trade

The mahi mahi has two main consumption modalities: fresh, mainly intended for domestic consumption, and frozen, reserved for export. However, the whole mahi mahi is in contact with ice in flakes during all its permanence in the haul of the boat in the high sea before its landed. Between 2010 and 2015, mahi mahi landings have been mainly used for frozen and fresh products in similar proportions. Mahi mahi exports have been characterized for being mainly frozen, so it can be assumed that fresh mahi mahi is consumed locally (**Figure 4**).

Figure 4. Landings of mahi mahi according to use between 2010 and 2015

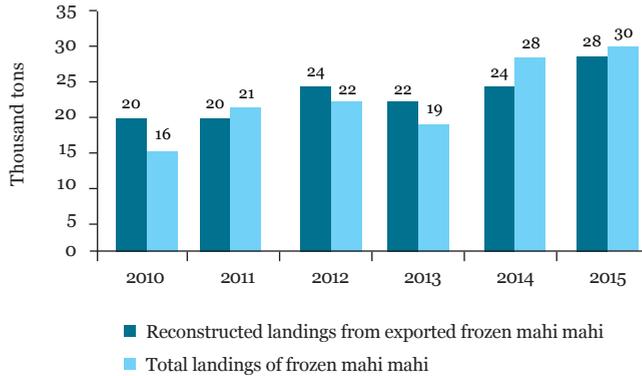


Source: Prepared by the authors with data from PRODUCE (2017)

In that sense, the domestic consumption of mahi mahi can be calculated based on the statistics of “fresh landing” of PRODUCE. However, there is no information on the domestic consumption of frozen mahi mahi, for which the export of frozen mahi mahi exported according to Paredes & De la Puente (2014) was reconstructed. **Figure 5** shows the reconstructed landings of exported frozen mahi mahi and the total landing of mahi mahi intended for freezing. A difference can be seen between both data, which would indicate that a very small amount remains in the local market for domestic consumption.

Also, is necessary to point out some years (2010, 2012 and 2013) when the reconstruction was greater than the official value, which makes us question the methodology used to collect the landings data, also showing a lack of knowledge of local trade flow. On the other hand, we must consider that this study has not deepened on the rejections of mahi mahi due to health issues from the United States, which when re-exported could be duplicating the statistics.

Figure 5: Landings of frozen mahi mahi between 2010 and 2015

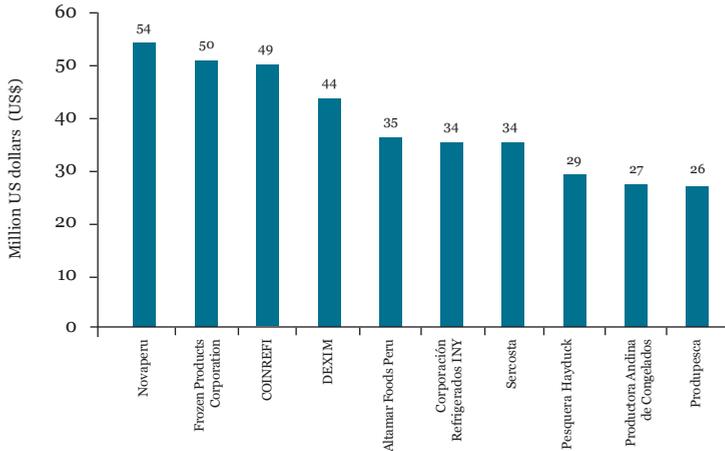


Source: Prepared by the authors with data from PRODUCE (2017)

In general terms, there is information available on mahi mahi exports, compared to the rest of the links in the supply chain. It is possible to check the SUNAT online database and the monthly or annual fishing export development bulletins published by PROMPERU. However, differences have been found in export statistics reported by national organizations, as well as among import statistics reported by the United States. (*Marine Fisheries Service*, 2015). Likewise, we must not lose sight of the lack of clarity in the various previous routes the resource has to go through before being exported.

Between 2000 and 2016, exports of 325 companies were recorded. However, this number has reduced in 2016, year in which only 49 companies registered mahi mahi exports. This is reinforced by the fact that only 10 companies have managed 52% of the volume and 49% of the value exported between 2000 and 2016. A detail of the most relevant companies in the exports of mahi mahi can be seen in **Figure 6**.

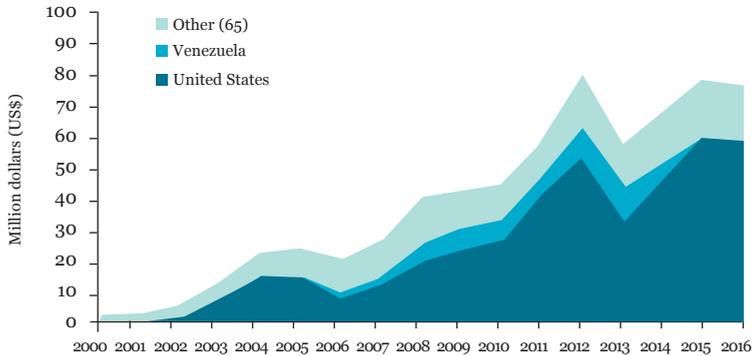
Figure 6. Main exporting companies between 2000 and 2016



Source: Adapted from De la Puente *et al*, 2015

In 2016, mahi mahi represented 12% of the total frozen seafood exports. Money equivalent to US \$ 82,9 million FOB was obtained, and the market was dominated by the United States with an 81% share (US \$ 67.1 million FOB). Ecuador followed by 7% (6 million dollars FOB), Guadeloupe with 3.7% and Martinique with 1.5% (**Figure 6**). About 11 thousand metric tons were registered in exports (SUNAT, 2017). There is also extensive information available on the types of products exported, such as fillets of mahi mahi, whole mahi mahi, portions of mahi mahi, mahi mahi slices or flèches (**Figure 7**).

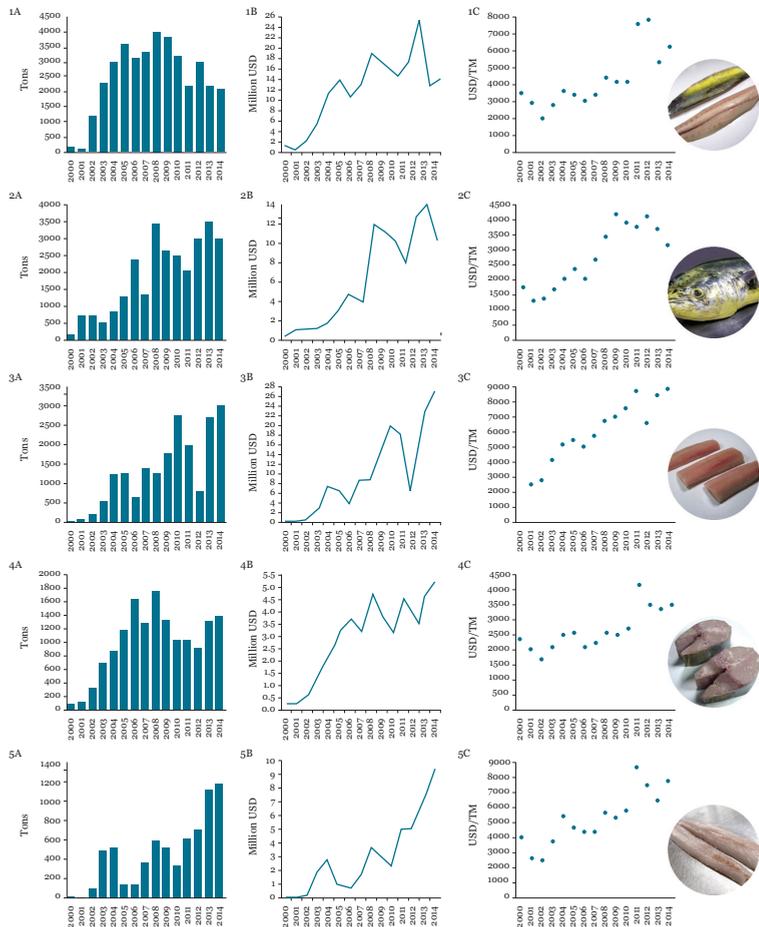
Figure 7. Exports of mahi mahi according to destination country



Source: Adapted from De la Puente *et al*, 2015

About the price of mahi mahi products exported to the American market, it was found that the prices of Ecuadorian products are above Peruvian products because they have better quality and traceability, do not require prepackages, and have better commercial relations. In that sense, an improvement in the traceability of the supply chain of Peruvian mahi mahi would not only have positive implications for the sustainability of the resource, but would also mean economic improvements for the traders who export them.

Figure 8. Main frozen mahi mahi products exported by Peru. (1) Mahi mahi fillets, (2) whole mahi mahi, (3) portions of mahi mahi, (4) slices of mahi mahi and (5) mahi mahi flèches. (A) Volume exported, (B) value of exports, and (C) price per ton

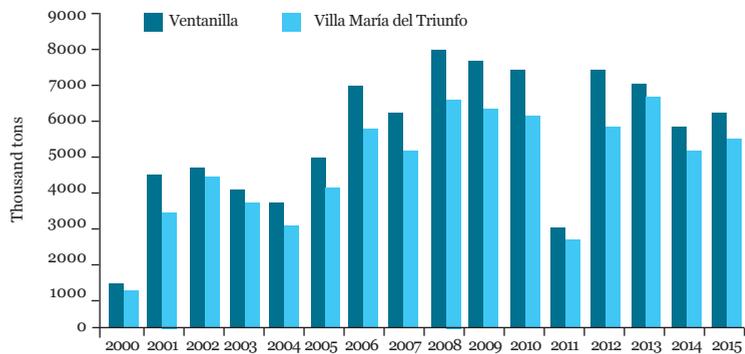


Source: De la Puente *et al*, 2015. Images: courtesy of COINREFRI.

In contrast, domestic markets lacks an efficient traceability system. This link includes the final destination of the bulk of the landed mahi mahi and is subdivided into four areas: a) wholesale markets, b) retail markets, c) supermarkets and d) restaurants.

The bulk of the mahi mahi ends at one of the fishing terminals. According to data from PRODUCE, in 2015, 12 thousand tons were marketed between the Fishing Terminal of Villa María del Triunfo and Ventanilla, both located in Lima (**Figure 8**). This value represented about 20% of the mahi mahi landed in that year.

Figure 9. Volume of mahi mahi marketed in the wholesale markets of Ventanilla and Villa María del Triunfo (Lima - Peru) between 2000 and 2015



Source: Adapted from De la Puente *et al*, 2015

Usually, retail markets, supermarkets and restaurants, are supplied from wholesale markets (Sueiro and Lopez de la Lama, 2014). However, it was not possible to obtain clear information about the origin of the products offered in each of these markets. Twenty-nine retail markets were visited, which reported buying seafood at the nearest fishing terminal and that their choice was based primarily on price and availability (**Annex 3**).

Table 4 details the characteristics related to quality and prices in the different food markets in Lima. In supermarkets, mahi mahi is offered, but there are no records that guarantee traceability. In restaurants, this species does not usually appear on the menu, or appears as mahi mahi or dorado. In the worst case, it is passed as corvina drum.

Usually, consumers in restaurants are not aware of the type of fish they eat, so this information is overlooked and is not recorded. Likewise, in Lima alone there are 12 thousand *cevicherías* (seafood restaurants) (Christensen et al, 2014).

Table 4. Sale price, type of product and quality of the mahi mahi offered in different food markets of Lima

Zone	District	Food market	Mahi mahi sale price by presentation (soles/kg)			Sanitary quality of mahi mahi ⁵
			Whole	Fillet	Spine	
Callao	Callao	Mercado Modelo Colon	10	22	-	Low
Center	La Victoria	Balconcillo	-	20	-	Medium/ Low
	Lima	Mercado Central de Lima	12	20	2	Low
	Breña	N° 3 de Breña	-	23	-	Low
East	San Juan de Lurigancho	La Huayrona	12	20	3	Low
	El Agustino	Mercado Cooperativo 24 de Junio	-	20	-	Low
	Santa Anita	Lampa de Oro	9	15	-	Low
	Ate	Santa Rosa	-	20	-	Low
North	Puente Piedra	Huamatanga	10	-	-	Low
	Comas	Chacra Cerro	10	19	-	Low
	Los Olivos	Modelo Covida	9	15	-	Low
	San Martin de Porres	San Antonio	10	20	-	Low

5 The quality of the fish evaluated has been determined by the subjective perception of the team carrying out the work. No methodology for organoleptic evaluation or biochemical testing was followed.

South	San Juan de Miraflores	Ciudad de Dios	10	18	2	Low
	Villa María del Triunfo	Mujer Peruana	10	20	2	Low
	Villa El Salvador	Jesús El Salvador de Llanavilla	-	18	3	Medium/ Low
	Chorrillos	Santa Rosa	-	21	-	Medium/ Low
Southeast	Surco	Anexo N° 2 – A	-	22	-	Medium/ good
	Barranco	N° 2 de Barranco	-	20	-	Medium/ Low
	Miraflores	Santa Cruz	12	22	-	Medium
	San Isidro	Municipal San Isidro	-	60	-	High
	Surquillo	San Felipe	12	20	-	Low
	Lince	N° 1 Lobatón	12	22	-	Medium/ Low
	Jesús María	San José	12	23	-	Medium
	Pueblo Libre	Bolívar	13	23	-	Medium
	Magdalena del Mar	Modelo de Magdalena del Mar	12	20	-	Medium
	La Molina	Edén	-	22	-	Medium/ Low

Source: De la Puente *et al*, 2015

Regarding the final commercialization at national level, to which about 50% of the mahi mahi landed is intended, it is impossible to identify any traceability record. Although a large amount of the production was centralized in the fishing terminals of Lima, this only represents a percentage of the mahi mahi landed. Another large percentage was sent to other wholesale markets, which could not be analyzed in this study.

3.2.5. Government agencies and regulations

IMARPE complies with the biological monitoring of the mahi mahi, unfortunately, not enough information about the coverage has been achieved to help improve its fisheries management. The DICAPI gives authorization to sail, however,

there is a high degree of cloning in the documentation of fishing vessels (certificate of registration and fishing license) as well as impersonation of crew members (seaman's book and fishing ID). SEPA plays a leading role in the formalization of artisanal fishermen, among other functions, but it does not exercise any kind of control. For example, DIREPRO Piura requires obtaining the Certificate of Origin for the transportation and reception in the plant of the mahi mahi landed in the Piura region, which is processed at the OZOPROs. The document specifies the quantity, vessel, date and catch coordinates. SANIPES has an inspection and certification system to ensure that the lots to be exported comply with national and international sanitary standards. However, to date, a comprehensive traceability system from bait to plate has not been implemented.

IV. CONCLUSIONS



The mahi mahi (*Coryphaena hippurus*) is a highly commercial and very important resource for fisheries at national and international level. In that sense, Peru is positioned as its main producer, with landings representing more than 50% of global catches. However, its fishery is poorly regulated. It also presents a high level of informality along its supply chain, which makes it difficult to control the growth of fishing effort, traceability and economic development of the agents involved in this fishery, especially those related to the extraction of the resource.

The supply chain of Peruvian mahi mahi is comprised of four basic stages: a) extraction, b) intermediate commercialization and transportation, c) processing plants, and d) commercialization at national and international level. Although these stages are interrelated, they also have particularities that change between localities.

Traceability in this type of fishery is weak. There is no adequate control or monitoring of the extractive activity. There are links that allow the entry of fishing from informal sources to formal channels, as well as the “laundering” of illegal fishing to make it legal. There are not enough incentives for the formalization of the extractive activity, as the formalization process is complex and expensive.

In the mahi mahi supply chain, different agencies of the State, with different competences, participate. However, intra and interinstitutional coordination between them is minimal or nonexistent.

V. RECOMMENDATIONS



We recommend for the artisanal fisheries sector to be given higher priority in sectoral policies. This has been a sector often ignored, although it generates significant economic income: more than 82 million dollars FOB in exports during 2016, and an estimated contribution to the national GDP of 204,9 million dollars, of which 67.4 million are generated in the extraction at sea and 137,5 million in the land trade (Christensen et al, 2014). It also generates thousands of direct and indirect jobs, among other aspects.

There are different characteristics in each of the identified stages of Peruvian mahi mahi supply chain: a) extraction, b) intermediate commercialization and transportation, c) processing plants and d) commercialization at local and international level. In that sense, reforms to improve traceability should be done within each of these, considering their interrelationships. It should be noted that the first two are key to the success of these reforms. Also, it is important to take into account that, in different parts of Peru, the middlemen replaces some of the state functions. For this reason, the reforms must be accompanied by a strengthening of the competent governmental institutions.

Considering that the high informality found in the mahi mahi fishery can promote illegality, it is extremely important that the different stakeholders in the supply chain of this fishery internalize the benefits of ensuring traceability and operating under conditions of formality. Improving the traceability of this fishery will also improve its sustainability and fight illegal, unreported and unregulated (IUU) fishing.

It is necessary to improve fisheries management, to cease the fishing effort growth, and improve monitoring, control and surveillance processes, in order to ensure the sustainability, traceability and quality of the resource, as well as the development of the people involved along the supply chain.

The establishment of an intra and inter-institutional working table is recommended for the development of a coordinated regulation for a better management of artisanal fisheries. This working table will promote the formalization of the sector.

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VII. ANNEX



ANNEX 1. VIRTUAL SURVEY FORMAT FOR SEPA PROFESSIONALS AT PRODUCE

Within the framework of the work carried out by the Ministry of Production, the productive sectors and civil and academic society to promote the development of a competitive and sustainable fishery in Peru, research is being carried out in order to solve gaps in information on traceability and supply chain issues in this fishery. Therefore, we kindly ask you to complete the requested information regarding each landing point within your jurisdiction. The information provided should be based on your work experience and your knowledge of the local reality. In you don't know the answer to any question, just leave it blank.

Port: _____

I. About the fishermen, boats, associations:

1. Approximate number of fishermen in the town: _____
2. Approximate number of fishermen engaged in mahi mahi fishing in the port: _____
3. Approximate number of vessels in the port: _____
4. Approximate number of vessels engaged in mahi mahi fishing in the port: _____
5. Number of fishermen associations in the area: _____
6. Number of fishermen associations grouping fishermen and/or ship-owners related to the mahi mahi fishery: _____
7. What percentage of fishermen engaged in mahi mahi fishery are organized (in OSPA) in the port? _____%
8. How many vessels in the area have insulated haul _____
9. What are the characteristics of mahi mahi fishing vessels?
 - a. Ownership: Own ____% / Leased ____%
 - b. Haul Capacity: _____
 - c. Length: _____
 - d. Age of vessels: _____
10. Price of a mahi mahi fishing vessel? _____

II. About formality

11. What percentage of the vessels landing mahi mahi in your port has:
Registration _____%
Health authorization _____%
Fishing permits _____%

Sailing _____%

Certificates _____%

Sale/purchase certificates _____%

12. What other requirements (procedures, papers, certificates, authorizations, etc.) are needed to be able to carry out the fishing activity and to trade the mahi mahi being landed? How many vessels meet these other requirements? (Explain)

13. What percentage of fishermen landing mahi mahi in their port has:

Fishermen ID _____%

Seaman's book _____%

14. What percentage of fishermen engaged in mahi mahi fishery have fishing permits in the port? _____%

III. About the fishing operation

15. What is the duration of a fishing trip (in days)? _____

16. Please detail days or hours of navigation invested in: search of the fishing zone, bait search, return, among others:

17. How far from the coastline do you usually fish (in nm)? _____

18. How many crew members usually go out to fish mahi mahi, per fishing vessel? _____

19. What is the average catch per fishing trip (in kg)? _____

How does this change in high season or low season? _____

20. What percentage of fishing operations fails to catch mahi mahi? _____%

How does this change in high season or low season? _____

21. Indicate the low season months: _____

Indicate the high season months: _____

22. What percentage of the total catch is discarded? (Indicate if it is low season or high season) _____%

	High season	Low season
a. Animal gutting		
b. Discarded for size		
c. Discarded for quality issues		
d. Discarded for bycatch		
e. Other wastes		

23. Which bait is used? _____

24. What is the percentage of bait caught and purchased? _____%

25. How much a fishing trip costs?:

High season _____ / Low season _____

	High season	Low season
a. Fuel <i>Liters/Gallons Soles</i>		
b. Lubricants <i>Liters/Gallons Soles</i>		
c. Food supplies <i>Soles</i>		
d. Ice <i>Kilograms Soles</i>		

e. Bait <i>Kilograms Soles</i>		
f. Payment to crew members <i>Soles</i>		
g. Different repairs <i>Soles</i>		
h. Crew transportation <i>Soles</i>		

26. Who pays for the following activities and how much do they cost? (Soles):

	High season	Low season
a. Owner of the vessel at port		
b. Payment to dock workers		
c. Primary processors at the port		

27. To whom the vessels sell the mahi mahi?

IV. About the processing

28. What documents are usually requested to buy mahi mahi?

29. What is the approximate price of mahi mahi (Soles per Kilogram)?

	High season	Low season
a. At the port or beach		
b. At the Plant		

30. What has been the trend in the price of mahi mahi in the last three years? Is this trend similar to the trend in operating costs?

31. In your port: How many people are employed to process mahi mahi in a processing plant? _____

32. In your port: How many tons of mahi mahi are processed annually in these establishments? _____

33. In your port: What percentage (by weight) corresponds to the processed mahi mahi of the total products processed by a plant: _____%

34. What percentage of the total processed mahi mahi is traded internally? _____%

35. What percentage of mahi mahi entering the plants is not processed and is directly sent to wholesale and retail markets? _____%

V. About the ice supply

36. Are there any ice plant in the area? _____

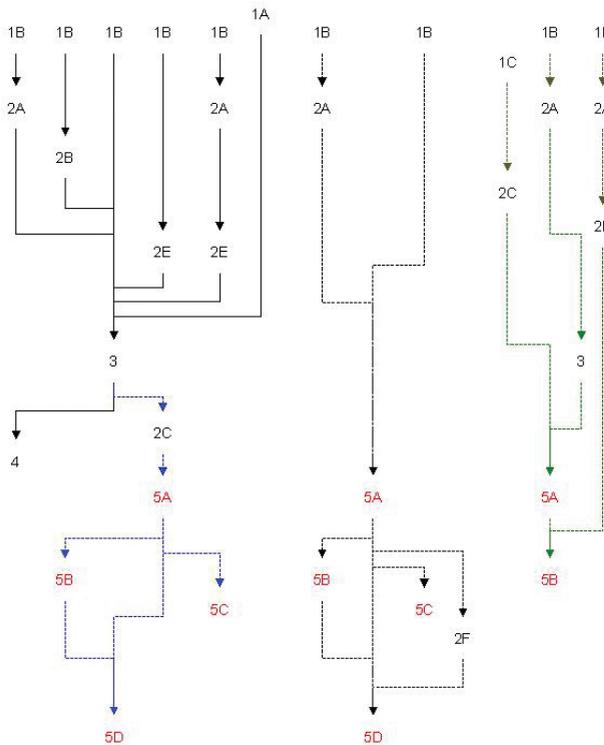
37. What is the production capacity (t/day)? _____

38. If the answer to question 36 was no, where does the ice used by the vessels come from? _____

39. What percentage of the vessels does not use ice?

High season _____% / Low season _____%

ANNEX 2. PERUVIAN MAHI MAHI DETAILED SUPPLY CHAIN



Description	
	Frozen mahi mahi supply chain
	Fresh mahi mahi supply chain
	Fresh mahi mahi supply chain discarded by freezing plants
	Supply chain of tailend mahi mahi
5A, 5B, 5C, 5D	Access points to final consumer of fresh mahi mahi
1A	Shipowner of a vessels belonging to a processing plant
1B	Independent shipowner
1C	Crew of an independent vessel
2A	Enabling trader
2B	Freezer trader
2C	Wholesale trader
2D	Retail trader
2E	Biller
2F	Supplier
3	Processing plant (frozen mahi mahi)
4	External market
5A	Wholesale market
5B	Food market (retail local sale)
5C	Supermarkets
5D	Restaurants

Source: De la Puente *et al*, 2015

ANNEX 3. CHARACTERISTICS OF THE MAIN FOOD MARKETS VISITED IN LIMA

Zone	District	Food market	Drinking water	Cooling	Use ice	N° of stands	N° of fish stands
Callao	Callao	Modelo Colon	Yes	No	Yes	800	15
Center	La Victoria	Balconcillo	Yes	No	No	131	4
	Lima	Mercado Central de Lima	Yes	Yes	Yes	-	12
East	San Juan de Lurigancho	La Huayrona	Yes	No	Yes	-	4
	El Agustino	Cooperativo 24 de Junio	Yes	Yes	Yes	60	3
	Santa Anita	Lampa de Oro	Yes	Yes	Yes	80	5
	Ate	Santa Rosa	Yes	Yes	Yes	-	2
North	Puente Piedra	Huamatanga	No	No	No	4 000	17
	Comas	Chacra Cerro	No	No	No	100	8
	Independencia	Los Incas	Yes	Yes	Yes	-	4
	Los Olivos	Modelo Covida	Yes	Yes	Yes	146	4
	San Martin de Porres	San Antonio	Yes	Yes	Yes	289	3
South	San Juan de Miraflores	Ciudad de Dios	Yes	Yes	No	876	12
	Villa María del Triunfo	Mujer Peruana	No	No	No	350	8
	Villa El Salvador	Jesús El Salvador de Llanavilla	Yes	Yes	No	360	16
	Chorrillos	Santa Rosa	Yes	Yes	No	400	6

Southeast	Surco	Anexo N° 2 – A	Yes	Yes	Yes	372	8
	Barranco	N° 2 de Barranco	No	No	No	392	4
	Miraflores	Santa Cruz	Yes	Yes	No	115	3
	San Isidro	Municipal San Isidro	Yes	Yes	Yes	93	9
	Surquillo	San Felipe	No	No	No	600	10
	San Borja	La Paz de San Borja	Yes	Yes	Yes	112	1
	Lince	N° 1 Lobatón	Yes	Yes	Yes	392	11
	Jesús María	San José	Yes	Yes	Yes	427	4
	Pueblo Libre	Bolívar	Yes	Yes	Yes	230	5
	Magdalena del Mar	Magdalena del Mar	Yes	No	No	814	2
Magdalena del Mar	Moderno de Magdalena	Yes	No	No	280	3	
La Molina	Edén	Yes	Yes	Yes	-	2	

Source: De la Puente *et al*, 2015

ANNEX 4. LEGAL REQUIREMENTS IN THE DIFFERENT LINKS OF THE MAHI MAHI SUPPLY CHAIN

Vessel



1. Registration certificate
 - a. Construction License certificate
 - b. Certificate of construction progress to 100%
 - c. Certificate of Maximum Load Line Assignment
 - d. Tilt test certificate
 - e. Annual countersigns
2. Sail
 - a. Radio beacon certificate
 - b. Daily/quarterly travel sailing certificate
3. Fishing license

1. Certificate of ownership of vessel

1. Artisanal boat fishing license
 - a. Fishing/diving license
 - b. Document certifying membership in the OSPA
2. Insurance (Integrated health insurance, +Salud, +Vida)
 - a. Certificate of artisanal fishermen/processor
 - b. Document certifying membership in the OSPA
3. Artisanal ship-owner certificate
 - a. Certificate of Ownership and / or Certificate of registration
 - b. To indicate characteristics of the vessel according to Format N° 12
 - c. OSPA certificate as ship-owner
 - d. Affidavit of not owning an industrial vessel

Plant



1. Certificate of registration for companies related to aquatic activities.
 - a. Public deed of the company's incorporation
 - b. Current municipal license
 - c. Title deed or lease agreement
 - d. RUC (taxpayer registration) of the company
 - e. Document of appointment of the Legal Representative of the company
 - f. Certificate of visual inspection of facilities
 - g. Description of services related to the activity to be carried out
 - h. Description of the protection and safety measures

1. Statement of solid waste management and solid waste management plan
2. License for the operation of fish processing plant
3. Certificate of origin of seafood products
4. Certificate of environmental impact study
5. Assessment of environmental impact statement
6. Assessment of environmental adaptation and management program
7. Evaluation of environmental report

1. Payment receipt or purchase settlement

Transportation



1. Payment receipt
2. Waybill
 - a. Shipper summary
 - b. Carrier summary

Trade



1. Authorization to the owner or consignee to operate as CUSTOMS dispatcher
 - a. Letter of bank guarantee or escrow policy
 - b. Municipal operating license
 - c. To have on the premises a data communication system that allows interconnection with SUNAT

DICAPI requirements

SURNAP requirements

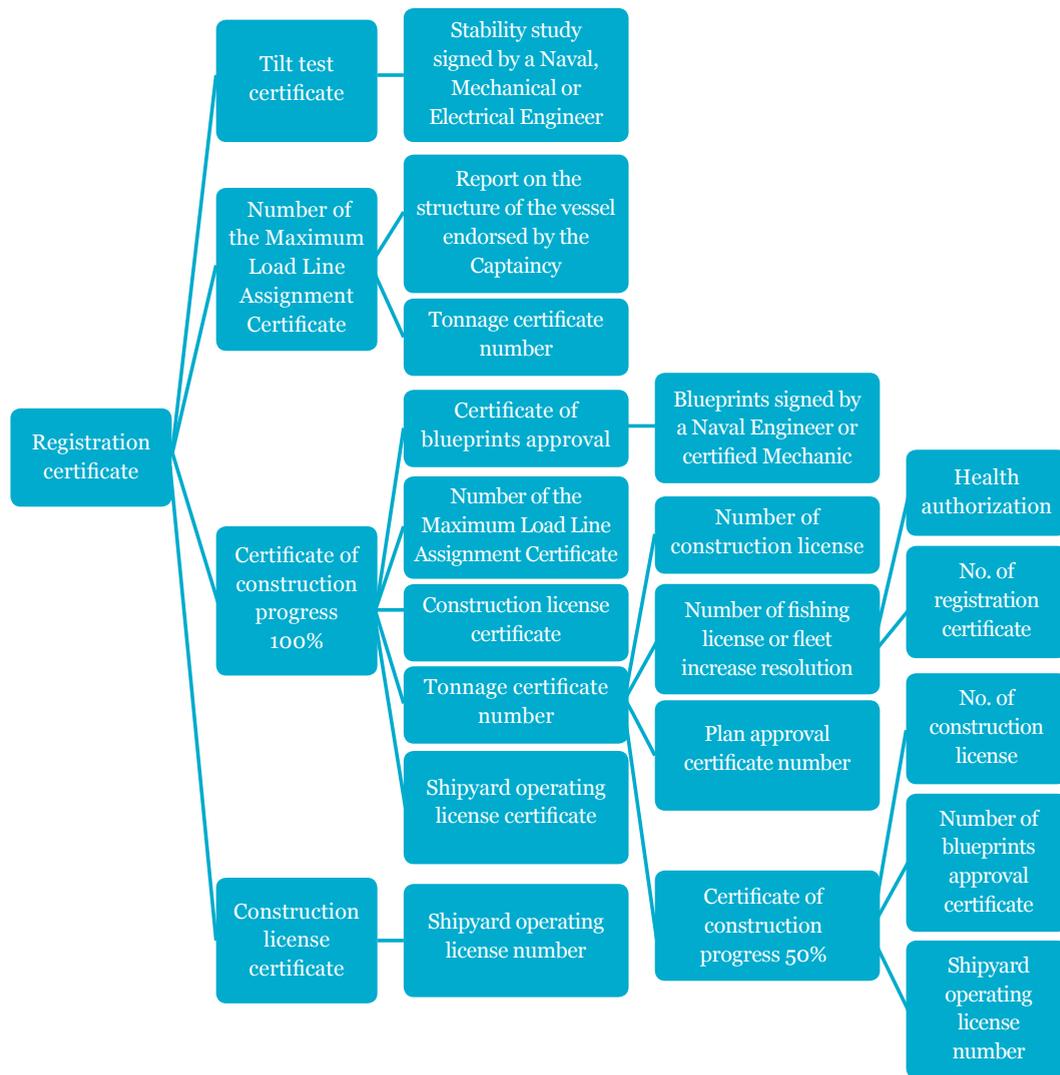
PRODUCE requirements

SUNAT requirements

Source: De la Puente *et al*, 2015

ANNEX 5. PREREQUISITES FOR THE MAIN PROCEDURES

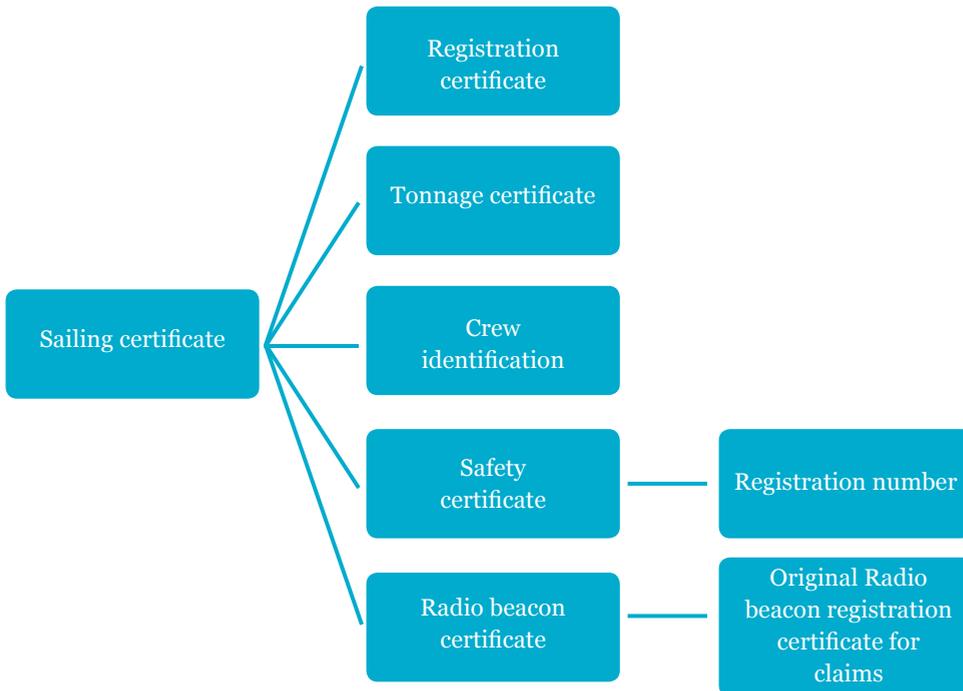
A. Requirements to obtain the registration certificate



Source: De la Puente *et al*, 2015

The Supreme Decree approving the Regulation of Legislative Decree No. 1147, regulating the strengthening of the Armed Forces in the competencies of the National Maritime Authority - General Directorate of Captaincy and Coastguards- Supreme Decree No. 015-2014-DE, in the Title VI: Ships and Naval Artifacts, Chapter I: Classification and Administrative Regime, Subchapter IV: Registration, indicates that “The registration is the procedure followed before the National Maritime Authority by the owner, ship-owner or legal representative of a ship or naval artifact, to hoist the Peruvian flag and take advantage of the rights and extensions that the Peruvian state grants him to be able to sail and operate freely inside and outside the aquatic environment. At the end of the procedure the registration certificate issued.”

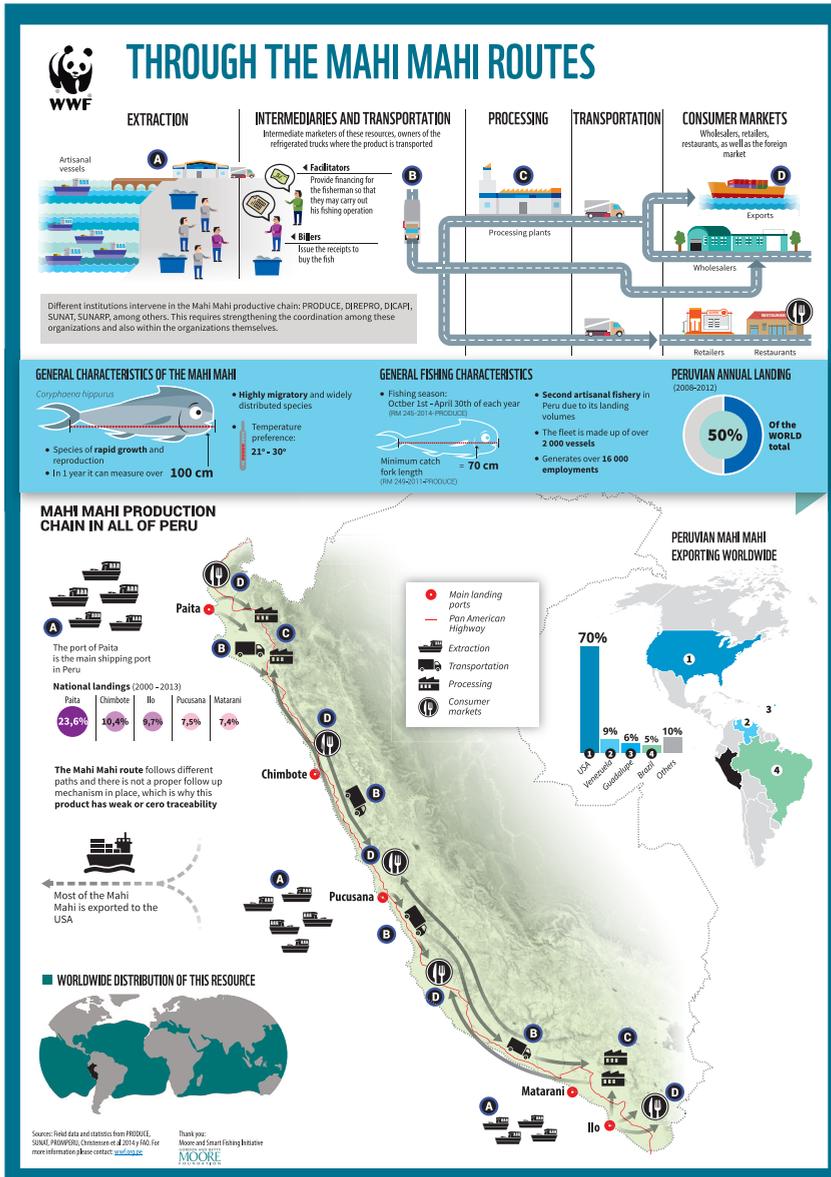
B. Requirements to obtain a sailing certificate



Source: De la Puente *et al*, 2015

The Supreme Decree approving the Regulation of Legislative Decree No. 1147, regulating the strengthening of the Armed Forces in the competencies of the National Maritime Authority - General Directorate of Captaincy and Coastguards- Supreme Decree No. 015-2014-DE, in the Title II: Navigation, Chapter I: Arrival and Departure of Ships, Subchapter IV: Arrival and Sailing of National Fishing Vessels, indicates that “Every fishing vessel that has a fishing license is included in the lists of fishing vessels authorized to carry out extractive activities by the Ministry of Production and complies with the provisions of said sector, must request sailing to the Maritime Authority National, in the established formats, before proceeding to the fishing operations.” Likewise, “During the closed season declared by the competent authority, the National Maritime Authority shall prevent the departure of fishing vessels that are included within the scope of the corresponding legal provisions.”

ANNEX 6. GRAPHIC OF THE MAHI MAHI TRACEABILITY





Why we are

To stop the deterioration of the planet's wildlife and to build a future in which humans live in harmony with nature.

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