

A MIXED METHOD ANALYSIS OF THE INDUSTRIAL SHRIMP FISHERY IN EL SALVADOR

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ABSTRACT

The industrial shrimp fishery is one of the most important in El Salvador. However, key management requirements are absent in the national fisheries system. By describing the status of the industrial shrimp fishery and its management system, and analyzing the value chain, this paper aims to identify improvements needed for more efficient resource management and to explore the industry's potential to access better markets.

A mixed-method research approach was used, collecting qualitative data from interviews with key participants in the authority and the industry, and performing a literature review on management standards and guidelines for comparison. Secondary quantitative data from different sources was used to integrate the information in the interpretation of the results to support the findings.

The results show that there is no specific management plan for the shrimp fishery and through the analysis of the value chain many issues arise: The lack of a scale system for the catches; an outdated data collection system; deficiencies in monitoring, control, and surveillance activities (especially for the landings and transshipments), and the lack of dedicated monitoring programs for the stock assessment are among the most important. In regards of the exports, it is concluded that the lack of a management plan, a traceability system, and a stock assessment program - requirements that are needed to fulfil the standards of the U.S and EU markets - are the main impediment to export the shrimp and access a better market.

From a wider perspective of the identified issues, this study emphasizes the need of the development of a fisheries management plan with co-management as a strategy; adjustments on current instruments and improvements in data collection methods and traceability that can open the possibility of the industry to access better markets in the future.

Key words: industrial shrimp fishery, fisheries management, market access, El Salvador

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ABBREVIATION LIST

CABs	Conformity Assessment Bodies
CDS	Catch Documentation Scheme
CENDEPESCA	General Directorate of Fisheries and Aquaculture
CFO	Common Fisheries Policy
EEZ	Exclusive Economic Zone
ERS	Electronic Report System
EU	European Union
FAO	Food and Agriculture Organization
FMP	Fisheries Management Plan
GS1	Global Standard organization
IAF	International Accreditation
ICES	International Council for the Exploration of the Sea
IQ	Individual Quota
ISO	International Organization for Standardization
IUU	Illegal Unreported and Unregulated
JICA	Japan International Cooperation Agency
LGOPPA	Ley General de Ordenación y Promoción de la Pesca y Acuicultura
LMI	Local Management Institution
MARN	Ministerio de Medio Ambiente y Recursos Naturales
MCS	Monitoring Control and Surveillance
MSC	Marine Stewardship Council
NOAA	National Oceanic and Atmospheric Organization
OES	Bureau of Oceans, International Environmental & Scientific Affairs.
PAO	Annual Plan of Operation
RFBs	Regional Fisheries Bodies
RFMOs	Regional Fisheries Management Organizations
RNPA	Registro Nacional de Pesca y Acuicultura
SIMP	Seafood Import Monitoring Program
STECF	Scientific, Technical and Economic Committee
TAC	Total Allowable Catch
TED	Turtle Excluding Device
US	United States of America
VMS	Vessel Monitoring System

1 INTRODUCTION

1.1 Background

According to the latest statistical annual report of the General Directorate of Fisheries and Aquaculture (CENDEPESCA) in 2019, the artisanal continental fisheries sector produced approximately 1% of the total fisheries and aquaculture production, the marine artisanal fisheries sector produced approximately 11%, the industrial fisheries sector produced approximately 75% of the total production, and the remaining 13% was produced by aquaculture (CENDEPESCA, 2022a).

Looking at the industrial fisheries records separately, the total production for tuna species was approximately 96%, with a total catch of approximately 48,000 tons, and shrimp species registered around 4% of the total production with approximately 1,800 tons (CENDEPESCA, 2022a).

Tuna is the most important fishery sector in El Salvador and is carried by foreign investment and managed under the established regulations of the Regional Fisheries Management Organization (RMFO) El Salvador is member. However, shrimp fishery is an important activity in both the industrial and artisanal sectors, where it provides direct and indirect jobs for local communities.

Shrimp, especially white-leg shrimp, is a valuable species traded in the international market, with a growing demand in the last decade. While most of the production comes from aquaculture and there is important competition in the market, there are some important markets, such as the United States, that certify shrimp fisheries to allow the export of wild catch of shrimp (OES, 2022; FAO, 2022).

El Salvador wild shrimp harvesting has been certified by the National Oceanic and Atmospheric Administration (NOAA) and is eligible to enter the U.S market by implementing the use of the Turtle Excluding Device (TED) in trawl net vessel license renewal, which is inspected by the NOAA every two years (OES, 2022). However, for industrial shrimp vessels, the management being used by the authorities is outdated, and key requirements for export of products, such as traceability and certifications, are missing.

The industrial fisheries sector sells the product only in the local market at the minimum price range. It is commercialized onshore directly from transshipment conducted with small boats and transported with vehicles to the local market. Poor enforcement at landing sites and the absence of a data collection system have made it difficult to obtain or even estimate the exact quantities of catches. Owners may be reluctant to provide production numbers because low production in shrimp fisheries is used as an allegation to reduce the restricted areas for trawl net vessels. However, in El Salvador, there is interest in the industry to access new markets and export products.

1.2 Rationale

Participants in the industrial shrimp fishery sector are interested in improving the operation regarding data collection, traceability, and accommodation of facilities to process shrimp with

the objective of selling the product to better markets and increasing the revenue of the activity. In the past, shrimp was exported to the United States market with relative success, coming to an end around 2002 due to changes in market prices, increased fuel prices, and reduced fishing areas due to changes in legislation.

Although the CENDEPESCA¹ is the competent authority to apply the General Law to Manage and Promote Fisheries and Aquaculture (LGOPPA) which covers the fishing activity of trawl net vessels, there are other actors that intervene when it comes to exporting the product. Improvements in Monitoring Control and Surveillance activities have been made in recent years, such as the implementation of the Vessel Monitoring System (VMS) in 2018, but little information has been documented about the current state of the industry and the system currently being used for management is not organized, thus possibly hindering the industry options to increase the revenue of the activity.

Industrial shrimp fisheries have also been very difficult to assess in recent years, mainly because of incomplete historical data, and the absence of sampling and data collection programs. The current management measures were established using a precautionary approach with poor scientific advice recommendations. The latest surveys recommend the necessity of implementing data collection programs to improve the quality of data for stock assessment and management to improve the management system, data collection, and traceability of the product, which might give the industry an opportunity to access better markets and allow CENDEPESCA to have a better understanding and control of the activity.

1.3 Goal and objectives

1.3.1 Goal

The main goal of this research project is to describe the status of industrial shrimp fisheries in El Salvador and compare the management system with good management standards to provide CENDEPESCA and industry with a recommendation for the improvements needed to achieve a better management system that could allow the industry to access better markets.

1.3.2 Research Questions

1. What improvements do CENDEPESCA need to manage the resource more efficiently?
2. Is it possible for the industrial shrimp fishery sector to export its products?

1.3.3 Objective:

Collect data through interviews with CENDEPESCA officers and the industrial shrimp fishery sector and use data available from the Fisheries and Aquaculture Statistics Department and FAO, analysing it using a mixed method approach - which combines both quantitative and qualitative research - to describe the main aspects of the value chain, the fisheries management system, and the data collection system.

¹ Dirección del Centro de Desarrollo de la Pesca y la Acuicultura

2 METHODOLOGY

This project was a desk study conducted from Akureyri, Iceland; from January to April 2023. The data for the study was both qualitative and quantitative; the qualitative data was collected through interviews with key participants in CENDEPESCA and participants in the shrimp industry. In addition, quantitative data was obtained from statistical reports from CENDEPESCA, FAO Global Capture Production 1950 – 2019 data, and FAO Trade Statistics.

2.1 Design

The design chosen was a concurrent mixed method procedure; as defined by Creswell (2009); as those in which the researcher converges or merges quantitative and qualitative data to provide a comprehensive analysis of the research problem. Allowing the collection of both forms of data and integrating the information in the interpretation of the results.

2.2 Qualitative data

The qualitative approach selected was evaluation research. According to Patton (2015), cited by (Ravitch & Carl, 2021), it is used to support and provide contextualized parameters for accountability in programs and initiatives, to analyse and learn from them in specific areas related to stated objectives and indicators, and to facilitate improvement, resource allocation, and advocacy.

Evaluation research can be quantitative and/or qualitative; the goal of qualitative data in evaluation research is to create greater understanding and to contextualize and humanize statistics and numbers. Qualitative research methods can contribute to multiple kinds of evaluations, including program evaluation, which focuses on the process and outcomes of a program, and quality assurance, which is focused on how processes and outcomes affect individuals.

One of the most important aspects of this approach is that despite the different kind of evaluation research, researchers do not need to follow strict methodological guidelines and the context greatly influences the type of research that will be conducted.

The primary data collection methods in qualitative research include individual interviews, focus groups, observational fieldnotes, qualitative questionnaires, and a review of pre-existing documents.

2.2.1 Site

The criteria for the choice of site and key participant selection were made following the considerations proposed by (Ravitch & Carl, 2021) for the site; taking into consideration the research questions and goals, the concrete situations of the issues and the relevance of the participants and organizations involved. The sites selected were CENDEPESCA and the industrial shrimp fishery sector.

2.2.2 Participant selection

For the participant selection, the purposeful sampling approach was selected as it is the primary sampling approach used in qualitative research (Coyne, 1997; Patton, 2015 cited by Ravitch & Karl, 2021). Purposeful sampling means that individuals are purposefully chosen to participate

in the research for specific reasons. The purposeful sampling approach allows to deliberately select individuals and research settings that can help to get the information needed to answer the research questions. Therefore, the participants were selected and grouped in subgroups inside both CENDEPESCA and the participants in the shrimp industry.

For the sampling size, guidelines by Ravitch & Carl (2021) were considered, a number of people subdivided by group were obtained from the CENDEPESCA organization chart and included administrators and fishery officers directly involved in the industrial shrimp fishery activity. As for the industry, there are two legally constituted associations, that include 20 of the 22 vessel owners, 52 of the 55 licensed vessels, and 133 accredited captains operating on the vessels (appendix 1), the selection of key participants was made from these associations due to time constraints related to online communication with the participants.

Considering the number of people in CENDEPESCA and considering proposals by Ravitch & Karl (2021), when it comes to the participant selection and purposeful sampling, the chosen number of participants in CENDEPESCA was one person from each department and one fisheries officer per regional office. For the number of participants on the industry side, different criteria for the selection of sampling were needed due to the different structure and relationship with owners and captains. When it comes to the owners, there are 27 owners who own 55 vessels in the register, and they are distributed over a total of 4 jurisdictions according to the National Register of Fisheries and Aquaculture of CENDEPESCA, thus; the selection aimed to have representation from each jurisdiction. For the captains, the same criteria as for the owners was taken into consideration (see Appendix 1).

Table 1: Number of people involved in industrial shrimp fishery activity in CENDEPESCA. Source: Portal of transparency, Ministry of Agriculture of El Salvador (2022)

DEPARTMENT	Number of people per Department
Monitoring Control and Surveillance Department	3
Administrative Department	11
Management Department	0
Fisheries and Aquaculture Statistics Department	3
Fisheries Research Department	3
Fisheries officers	11

2.2.3 Interviews

The design of the questions for the interviews was made taking into consideration the guidelines proposed by Malterud (2001) (Appendix 2) and was developed to collect information following the value chain, the management system, and the data collection system and reports. The interviews were semi-structured, and two sets of questions were developed to gather more precise data from CENDEPESCA and the industry, separating questions in sections to facilitate the transcript coding process, both sets of questionnaires can be found in Appendix 3.

Prior to the interviews a *project description* document was provided to the participant containing a summary of the project and his goals (See Appendix 4). The interviews were conducted in Spanish and recorded using Zoom, although there were instances where the interviews needed to be conducted via phone call, they were also recorded in Zoom to be consistent with the digital record (See Appendix 5).

2.2.4 Confidentiality aspects in the interview

In accordance with the proposals by Brinkman & Kvale (2015) precaution needed to be taken to protect participants' privacy, thus, one key consideration while conducting the interviews was to protect the anonymity of the participants and a section with confidentiality considerations was included in the *project description* document (see Appendix 4).

2.3 Quantitative data

The Quantitative data was collected from three main sources:

- From the Fisheries and Aquaculture Statistics Department of CENDEPESCA, unpublished historical data of industrial shrimp vessel catches and annuaries were collected.
- FAO Data, from the Fisheries and Aquaculture Statistics. Global Capture Production 1950 – 2019, and Global Trade Statistics.
- From the National Registry of Fisheries and Aquaculture of CENDEPESCA, to collect data on the number of vessels, size, and horsepower of the engine.

2.4 Fisheries Management Standards

This information was collected by conducting a literature review on relevant papers and books about fisheries management systems, data collection, traceability, certification, and instruments from the Icelandic Directorate of Fisheries, and it was used for comparison in the discussion and recommendation on the possible improvements that could be applicable and adopted by CENDEPESCA.

2.5 Data analysis

2.5.1 Interview transcripts

All transcripts were made by the researcher and due to time constraints, some considerations were needed; the interviews were transcribed onto an excel sheet containing the questions separated by sections (which was used as pre-coding) and were edited to extract the most relevant information, mainly due to the necessity of translating the data from Spanish to English language for the final outcome. The transcript also took into consideration the proposals by Ravitch & Carl (2021) and were made in the most objective and faithful way, respecting the participant's opinion. The transcripts were circulated to the participants via email for confirmation of the information collected through the interview.

2.5.2 Coding

Open coding was used to select the sections of text from the transcript. The first round of coding used the sections of the questionnaires as pre-coding, although some of the sections were broad, they facilitated the classification of the information in major sections for the analysis. The second round of coding was focused specifically on aspects of the main objective and research questions. After this step, *Axial coding* – which is a process to relate data to conceive categories – was conducted to put the codes together into sections to situate and construct the arguments and develop the findings.

2.5.3 *Data display*

The participant answers were combined and put together on a table to display the results of the interviews, that were used to conduct the Axial coding. The data was divided into two sections, one for CENDEPESCA and one for the industry. The major findings were highlighted and categorized in accordance with relevance in relation to the research questions; this display was used as a guideline in the generating of the results.

2.5.4 *Generating*

The findings were put together in major sections with the aim to describe the status of the management system, the value chain, the data collection system, and the export standard.

2.5.5 *Validity*

Triangulation was the process used to achieve validity; which specifically entails seeking “convergence among multiple and different sources of information to form themes or categories in a study” (Creswell & Miller, 2000; Schwandt, 2015). For this study, secondary quantitative data was analysed and used as additional point of triangulation for validity as suggested by (Ravitch & Carl, 2021) in the mixed method approach; the quantitative data was used to better understand the issues related to the research questions.

2.5.6 *Statistical reports*

FAO data set from the Fisheries and Aquaculture Statistics and Global Capture Production 1950 – 2019, for El Salvador was compared with the historical catches and statistical production reports from CENDEPESCA, by using charts to analyze the tendencies, compare capture between artisanal and industrial sector, global catches, and also to identify discrepancies on the data submission and use these findings as part of the triangulation for the validity and answer the research questions.

2.5.7 *Vessel information*

The vessel information collected through the National Register of Fisheries and Aquaculture (RNPA) of CENDEPESCA was used to describe the characteristics of the fleet, length size, horse power of the engine, material, carrying capacity, and holding capacity, and used as part of the triangulation to get a better description of the vessels.

3 LITERATURE REVIEW

This chapter contains general information about fisheries in El Salvador, specific information about shrimp fisheries, global and local markets of shrimp, management in El Salvador and management standards; and certification and traceability. The literature review is divided into four sections and the information compiled comes from books and guidelines about fisheries management systems, data collection, traceability, certification, and instruments from the Icelandic Directorate of Fisheries.

3.1 Fisheries in El Salvador

3.1.1 Geography of El Salvador

El Salvador has a population of approximately 6,454,000 people and an area of 21,041 km². It is bordered in the south by the Pacific Ocean, in the northeast with Honduras and in the southeast with Guatemala. It is the only country in Central America that is not bordered by the Caribbean Sea. Climate in the coastal zone up to 600 meters above sea level has an average temperature between 23°C and 28°C. There are two main seasons: rainy season (May to October) and dry season (November to April) (JICA, 2002; FAO, 2019). The country has 321 km of coastline from the Paz River on the Guatemalan boundaries (West) to the Gulf of Fonseca, which is shared with Honduras and Nicaragua, and its continental shelf increases from west to east and it has an exclusive fishing zone of 87,510 km² (JICA, 2002; MARN, 2007; FAO, 2019).

3.1.2 Economic Exclusive Zone and fishing zones

The Economic Exclusive Zone of El Salvador is defined by the constitution as: “The adjacent sea zone that extends itself beyond the territorial sea at two hundred nautical miles from the baseline and is called the economic exclusive zone, in which El Salvador exercises sovereign rights to explore, exploit, conserve and manage natural resources, living and non-living, of the water supra laying the seabed and subsoil and to develop any other activities with a view to the exploration and economic exploitation of that area”.

The Environmental Law of El Salvador defines the coastal marine zone as the area comprising the first 20 kilometres inland from the coastline and the marine zone in the open sea, from a depth of 0 to 100 meters, where benthonic species are distributed. This zone covers an area of approximately 21,000 km², of which one third belongs to the coastal zone, approximately 7,000 km², and two thirds to the marine zone, about 14,000 km². (MARN, 2007).

The artisanal fishing zone goes up to 50 m. in depth and varies from 5 to 10 nautical miles from the coast. The primary fishing zone for white leg shrimp and similar shrimp species is located up to 50 m. of depth. The pelagic artisanal fishery is carried out at 60 nautical miles with depths reaching up to 200 m. (JICA, 2002).

3.1.3 Fisheries sector in El Salvador

Fisheries sector in El Salvador is divided into three categories according to the General Law for Management and Promotion of Fisheries and Aquaculture: industrial fisheries, artisanal fisheries, and continental waters fisheries (Galdámez, 2020).

The fishery in El Salvador generates around 27,000 direct jobs in the catch phase. The RNPA has 21,193 fishermen registered with the authority and there are 2,345 vessels; of which the industrial sector has 55 trawl net vessels with licenses issued to catch shrimp and 7 large purse seiner vessels catching tuna in international waters (CENDEPESCA, 2022b).

Industrial fisheries have been an important economic sector for the country in terms of production of high value products destined for export, mainly to the European market, and this can be divided into two main categories, the tuna fishery, and the shrimp fisheries.

The tuna fishery is being conducted in international waters and Economic Exclusive Zones of third-party countries in both Pacific and Atlantic Ocean in accordance with international treaties

ratified by El Salvador and under the management and recommendation of the RMFOs, and is the main fishery of the country, representing around 90% of the catch production export (Machuca, 2019; Galdámez, 2020).

The Shrimp fisheries in El Salvador is carried out by Florida type vessels, with a length between 16 and 24 m, built in iron, fiber glass and wood, with an engine of 170 to 455 Hp. The fishing trips generally last up to 15 days, and sets last up to 4 hours, working 19 hours per day (Galdámez, 2020).

According to Gross, cited by Barahona (2021), the fishing fleet concentrates on white shrimp from October to April. The catch-per-day for white leg shrimp is highest in October to March, and the best months are November through February. However, the largest white leg shrimps are taken from April to July when catches are scarcer.

Barahona (2021) states that; the registry of fisheries production in El Salvador started in 1950, mainly with artisanal fisheries. The shrimp trawl net fishery started at the end of the 50s and the fishing effort recommended by FAO during that time was 43 vessels in 1955. The effort was increased to 60 vessels in 1959 and over time the fishing effort increased, reaching the highest number during the 1990s with 105 vessels (JICA, 2002; Galdámez Olmedo, & López Rivera, 2015; CENDEPESCA, 2020; Barahona, 2021). In 1960 the total catch of white shrimps in trawl net fisheries was 2,026,417 kg, but since 2009 there was a collapse, however, with closure periods for shrimp fisheries and increased enforcement, the production has started to show a slow and relative recovery in recent years (Figure 2) (Barahona & Galdámez, 2020; Barahona, 2021).

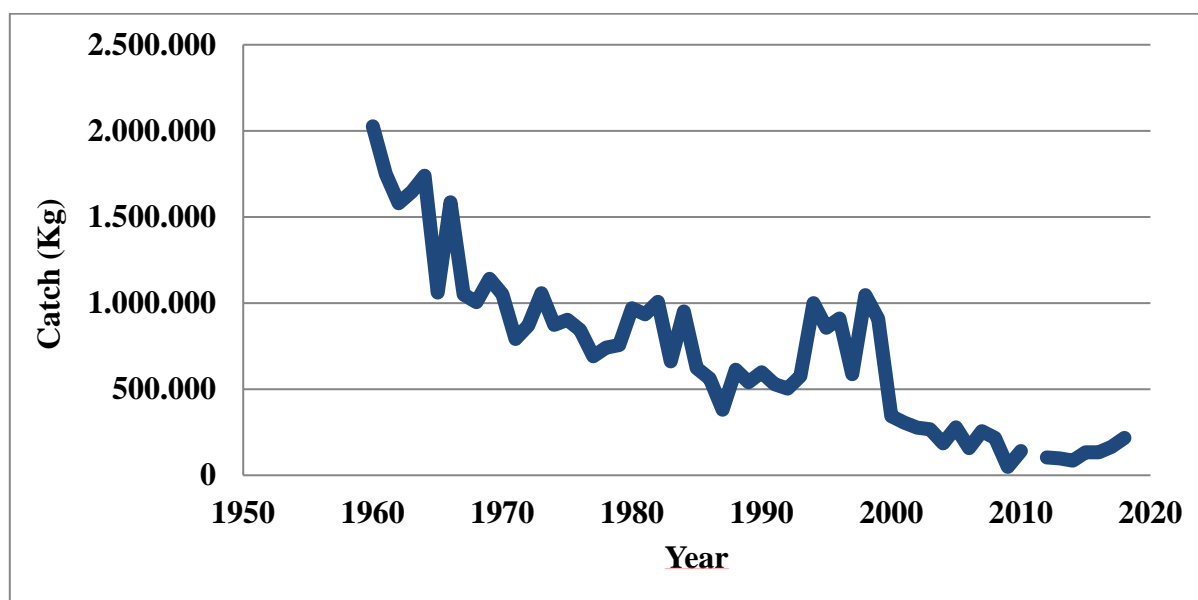


Figure 1: Catch trend of white shrimps in trawl net fisheries in El Salvador, 1960 – 2019. Source; (Barahona, 2021).

3.1.4 Shrimp species and biology

Marine shrimp species are primarily found in shallow or moderately deep waters. Commercial shrimps are caught in continental platforms less than 100 m deep and can live in various types of sea bottoms (Fischer, et al., 1995).

Penaeus species spawn in the open ocean, 10 to 80 m deep. The eggs hatch, releasing nauplius and protozoa stages, transported by currents to the coast. Some species arrive as post-larvae approximately 3 weeks after spawning and invade estuaries or coastal lagoons. There they go through a stage of accelerated growth and quickly reach juvenile stage before migrating back to the sea. (Fischer, et al., 1995, cited by Barahona, 2021).

El Salvador's main commercial shrimp species are red, brown, and white shrimps. The red shrimps are *Penaeus brevirostris*, brown shrimps are *P. californiensis*, and the white shrimps are *P. vannamei*, *P. stylirostris*, and *P. occidentalis*, with the white shrimps being the most important in the global market. All benthonic species of the Penaeid family live on the continental platform of fishing area 77, with some relying on estuaries for their development (Fischer, et al., 1995, Barahona, 2021). The white leg shrimp, or *Penaeus vannamei* Boone, 1931, can reach up to 23 cm in length and live in muddy or sandy-muddy grounds between 5 and 72 m deep. The Western white shrimp, or *P. occidentalis* Streets, 1871, can reach up to 24 cm in length and are found in shallow waters associated with muddy areas. The blue shrimp, or *P. stylirostris* Stimpson, 1874, lives in waters less than 30 m deep and can reach up to 26.3 cm in length for females and 21.4 cm for males (Fischer, et al., 1995).

3.2 Market and trade

3.2.1 Shrimp global production and market

According to FAO (2022), supplies of farmed shrimp increased in Latin America and Asia compared to 2020. Imports in China and Japan, the two largest markets in Asia, increased marginally.

In 2021 the global aquaculture and fisheries sector produced 4.5 million tonnes of shrimp which is 12.5% higher than 2020. Ecuador is the top shrimp producer, harvesting 1 million tonnes of shrimp in 2021. Production increased in China, India, Viet Nam, and Indonesia. And the estimated international trade for shrimp in 2021 is thought to have reached a historical high of 3.35 million tonnes (FAO, 2022c).

As for imports, the top seven importers in 2021 were the United States of America, the European Union, China, Japan, the Russian Federation, the Republic of Korea, and the United Kingdom, where the combined imports of these markets were 2.82 million tonnes in 2021, thus representing 85% share of the international shrimp trade.

According to the latest FAO (2022) data, the average reported export price for shrimp in 2019 was 10.3 USD/kg, remaining relatively stable compared to 2018's average price of 10.1 USD/kg. Meanwhile, import prices averaged 10.5 USD/kg. The United States emerged as one of the most significant markets for shrimp, importing approximately 900,000 tonnes valued at USD 8 billion in 2021. While the proportion of shrimp sourced from wild catch versus aquaculture is not specified, the U.S. shrimp market is highly competitive, driven by both increasing demand and robust international supply.

3.2.2 Landing and market in El Salvador

When it comes to fisheries, El Salvador had a catch production of around 50,000 metric tonnes in 2019, of which approximately 40,000 MT came from the pelagic species catch, mainly tropical tuna species, while the white leg shrimp had a production of 420 MT (FAO, 2022a).

According to the statistical annual report from CENDEPESCA, the value of industrial fisheries catches for 2019 was approximately USD 85.5 million, with tuna representing 97% of the total volume, shrimp 3.5% and other pelagic species made up just 0.01%. (CENDEPESCA, 2022a).

Individually the industrial shrimp fishery reported a total annual landing of approximately 2,000 MT. and its composition was estimated to be 590 MT of shrimp species, 760 MT of small shrimp (*Xiphopenaeus spp* and *Trachypenaeus spp*), with non-target species reaching 610 MT. Production comes from an estimated effort of 574 fishing trips and around 60,000 sets from 55 vessels (estimation made with extrapolations of the monthly catch report provided by vessel owners). As for the artisanal effort, it was reported to be approximately 140 MT of shrimp, representing 1.7% of the artisanal total landings (CENDEPESCA, 2022a).

The shrimp is commercialized at local markets reaching prices that range from 4.7 USD to 8 USD, with the potential to reach up to 14.7 USD (JICA, 2002).

3.3 Fisheries management

3.3.1 Fisheries management strategy

Fisheries are managed because the consequences of uncontrolled fishing are seen as undesirable. These consequences can include fishery collapse, economic inefficiency, loss of employment, habitat loss or decreases in the abundance of important species. Fisheries management aims to maximize specific biological, social, or economic benefits from the fishery while minimizing costs. This is achieved through the design of a management strategy with specific objectives that can be evaluated and measured. The strategy should be supported by the best scientific advice and management actions (Jennings, Kaiser, & Reynolds, 2001).

There are some instances where the fisheries scientist can face uncertainty due to a variety of factors, and a precautionary approach is often adopted by the managers. The precautionary approach as used today is based on the application of prudent foresight, but from the perspective of the manager and not the fisherman. In overexploited fisheries objectives such as rebuilding of stocks, immediate limit on the access, and reduction of the fishing capacity, can be marked as strategy, but this clearly requires high investment (FAO, 1995; Jennings, Kaiser, & Reynolds, 2001).

For such objectives time closures can protect annual stocks until their production and quality is high but can also lead to market gluts at the start of the fishing season. This can cause prices to fall, and force processors to invest in capacity that is idle for much of the year. Area closures may stimulate effort redistribution and increase fishing cost without reducing fishing mortality. Time and area closures have been most effective when used in conjunction with other measures such as catch and effort controls (Jennings, Kaiser, & Reynolds, 2001).

When it comes to the enforcement, this becomes easier and cheaper if fishers can see that management actions benefit them. In a few well-managed fisheries, fisheries scientists and managers are now treated as though they are working for the fishers and not against them. If fishers actively oppose regulations, the enforcement is less likely to be effective (Jennings, Kaiser, & Reynolds, 2001).

3.3.2 Co-management in fisheries

Collaboration between managers and fishers is often more successful in managing and enforcing fisheries. Co-management refers to a partnership in which the government, the

fishers, and external agents and other stakeholders, are accountable for fisheries management, occupying a middle ground between the state imposing regulations and fishers having complete autonomy. At other levels, the state and fishers may engage in discussions, provide recommendations, and collaborate extensively. Co-management minimizes disagreements that obstruct management and enables fishers to point out when policies, such as quotas that promote discarding or catching prohibited fish, are not suitable, even if they are practical in theory (FAO, 2009; Jennings, Kaiser, & Reynolds, 2001).

According to Pinkerton (1994) cited by Jennings, Kaiser, & Reynolds (2001), co-management has worked best when the fishery is under the control of fishers, either through ITQs or tenure arrangement. Co-management has also helped to improve understanding between fishers, managers and scientists that were formerly at odds with each other.

Co-management is a useful concept that if developed correctly may help government and managers to improve fisheries. Common issues in fisheries that can be addressed in co-management are: poor data and data analysis; low credibility of data and data analysis; inappropriate harvest regulations; low legitimacy of regulations; inadequate enforcement of regulations; and overfishing (FAO, 2009).

3.3.3 Management in El Salvador

In El Salvador, there is no established program for collecting biological data for stock assessment, neither for the artisanal sector, nor the industrial sector. Data scarcity, particularly relating to shrimp fisheries, compounds wider issues to assess the fisheries resources (Barahona, 2021), making it difficult to provide recommendations to CENDEPESCA.

Fisheries management in El Salvador is a responsibility that the General Law of Fisheries and Aquaculture confers to CENDEPESCA, which is the competent authority to apply the law (Asamblea Legislativa, 2001).

Management in El Salvador is primarily based on laws that establish the rules and responsibilities for obtaining licenses and authorizations for fishing, as well as guidelines for the types of fishing gear that are allowed and areas that must be closed off, both the artisanal and industrial sectors. Information about the number of fishermen, active vessels, licenses issued, and authorizations granted, are all recorded in the National Register of Fisheries and Aquaculture (RNPA).

Although the fishery in El Salvador is open access, there are specific restrictions that apply to the industrial fishing sector, which is categorized by vessel size. According to the law, industrial vessels are defined as mechanized vessels longer than 10 meters. Additionally, the number of active trawl net vessels is limited by resolution to a maximum of 55. For large purse seiner vessels, limitations are imposed based on the allocated carrying capacity, fishing quota, and fishing rights of El Salvador within the RMFOs, of which El Salvador is a member (Asamblea Legislativa, 2001).

Management measures and efforts to recover the resource begun in 2011, when a restriction for industrial vessel activities in the first three nautical miles was approved by law (Figure 1) (Galdámez & Barahona, 2020). The amended law in 2015 established new regulations in the form of Vessel Monitoring System (VMS) technology for industrial fisheries; that led to the creation of the Monitoring, Control and Surveillance Department, which began full operation

in 2017 with the implementation of the Satellite Monitoring and Control Centre. This centre has monitored the whole industrial fleet on a 24/7 basis since 2019.

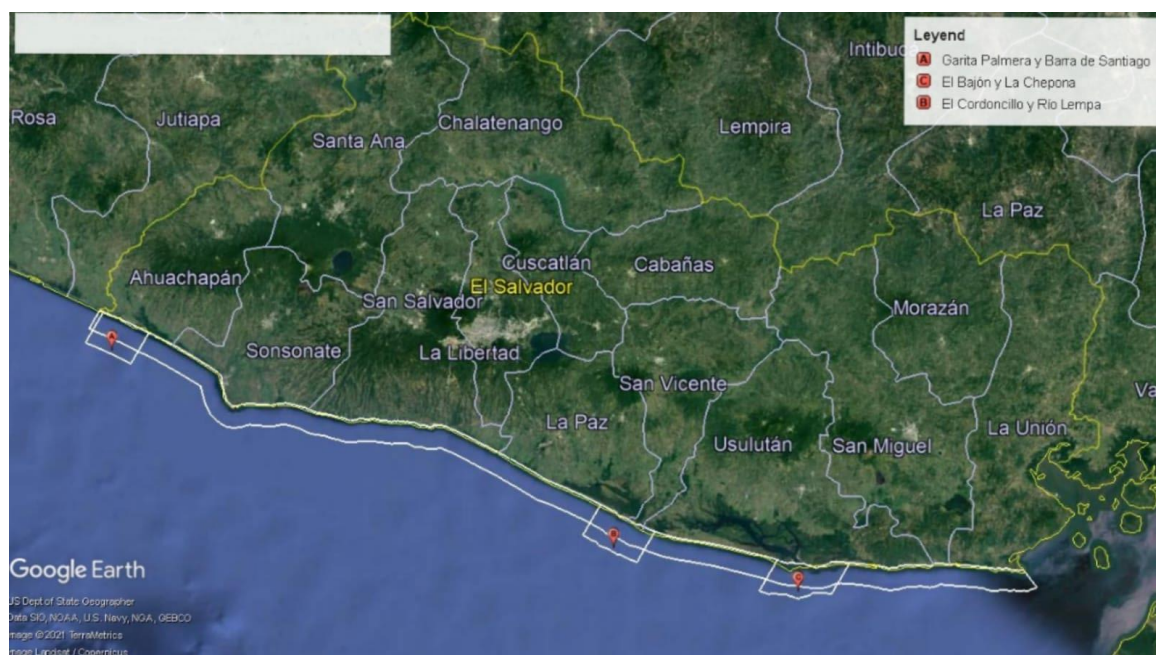


Figure 2: Trawl net vessel closed areas according to LGOPPA. Source: Author work from Google Earth (2022).

3.3.4 Data collection

Making decisions in fisheries policy and management requires the use of trustworthy data. Such decisions can be categorized into food security, socio-economic, and environmental concerns, and each category requires specific types of information to be effective. When there is insufficient data available, a precautionary approach can be used. However, it is generally best to base management decisions on the "best scientific information available," which has implications for the kind, amount, and quality of data that should be gathered (FAO, 1998).

The design of data collection programs for fisheries varies depending on the type of fishery, which can range from industrial to recreational. Each fishery has unique characteristics, importance, and potential for data supply. External sources such as international market data may also be needed. Strategies for data collection require a combination of complete enumeration and sampling, which may shift over time as knowledge and resources change. Sampling strategies are occasionally supplemented with complete enumeration to reassess baseline data (FAO, 1998).

The FAO has put together a series of papers that covers the guidelines and procedures to develop the strategies and methods needed to design an efficient data collection program. Other agencies, such as NOAA also provide guidelines for data collection and surveys.

- FAO (1975) - Guidelines for collecting and compilation of fisheries statistics.
- FAO (1999) - Guidelines for the routine collection of capture fishery data.
- FAO (2002) - Sample-based fishery surveys – a technical handbook.
- FAO (2005) - Guidelines for designing data collection and sharing systems for co-managed fisheries. Part II: Technical guidelines.

- NOAA, 2020 - Recreational Fishing Survey and Data Standards

The FAO (1999), Guidelines for the routine collection of capture fishery data identifies six categories of data collection sources:

- Harvest: This level is where the fish is caught and includes landing sites, boats, and the fishermen or fishing households. This will include the LMI² and local resource users.
- Post harvest: This includes sources through which fish pass before reaching the market and includes fish traders, auctions, cold storage, processors, and transport networks.
- Market: All sources through which fish are commercially transferred and includes primary (landing site) and secondary (wholesale, processing, and consumer) markets.
- Consumers: Includes individuals, households, hotels, restaurants, etc.
- Government: related agencies. Any agencies or institutions forming part of the government including customs, trade ministries, research departments of relevant or related ministries, bureaus of statistics, results of national censuses, etc.
- Support industry: These relate to industries which provide raw materials and services such as gear manufactures, bait suppliers, boat builders, etc.

In addition, five categories identified for data collection methods:

- Registration: Data is collected and stored in a depository for the purpose of licensing and access agreements.
- Questionnaires: A structured format of questions answered by respondents. Advantages include low-cost data collection.
- Interviews: Data is obtained through inquiries and recorded by enumerators. Interviews can be open-ended, involving focus groups or panels, or structured based on pre-defined forms.
- Direct Observations: Data is collected through direct measurements by fisheries department or relevant government administration members, fishers, or intermediary organizations. Participant-observation is recommended for learning about local institutional and decision-making arrangements.
- Reporting: Data is collected through reporting by fishers, fish traders, processors, and other stakeholders using pre-defined formats such as logbooks or ledgers. This category also includes market sales and trade records from customs or government administration.

3.3.5 Data collection standard (Iceland and FAO)

For Iceland, the data collection system is based on the EU data collection framework that involves the following standards (Chee, 2022):

- Icelandic Fisheries Management Standards
- Scientific advisory bodies:
 - Scientific, Technical and Economic Committee (STECF)
 - International Council for the Exploration of the Sea (ICES)
 - Regional Fisheries Management Organizations (RFMOs) and regional fisheries bodies (RFBs)

² Local Management Institution

According to Chee (2022), data collection in Iceland includes all fisheries and species that are reported as caught at the time of catch. All vessels are obliged to land all fish being caught. The fish products that are exported from Iceland to the U.S markets include iced fish, fresh fish, fish meal or fish oil.

According to Article 3 of the Regulation N° No. 307/2023 on digital registration and submission of catch information; captains must record as accurately as possible the following information:

1. Ship name and ship registration number.
2. Fishing gear, type, and size.
3. Location determination (width, length, and depth).
4. Catch by quantity and species.
5. Hunting day.
6. Port of landing and date of landing.
7. Seabirds by number and species.
8. Marine mammals by number and species.
9. Information about catches caught but released in accordance with the instructions of the law or other government orders.
10. Information about the time fishing gear is in the sea when it is laid down and when it is taken up.

3.3.6 Monitoring Control and Surveillance in Iceland

According to Chee (2022), the Icelandic Directorate of Fisheries receives verified electronic reports from various authorized persons including vessel operators and exporters. The Icelandic monitoring control and surveillance (MCS) team conducts onsite verification of the activities based on risk assessment.

Licensed fishing vessels in Iceland are required to report all their fishing activities and to deliver their catches at approved landing ports. Prior to landing, vessel operators must submit an electronic logsheet (eLogsheet) to the directorate via the Electronic Register System (ERS). This report contains all necessary catch information from the fishing trip. To ensure the accuracy of the records made by the fishing operator, the Icelandic Coast Guard conducts inspections on board the vessel by checking the vessel holds. In addition, the Directorate of Fisheries inspector monitors the landing and compares it to the logsheet (Chee, 2022).

Only approved ports with certified scales are allowed for the landing of catches from fishing vessels in Iceland. At these landing sites, accredited harbour officials are trained by the directorate to conduct landing monitoring, which includes reading the weighing scales. They collect all necessary information from the fishing vessel operator and complete the landing forms, which are then submitted to the directorate through the ERS. If the catch is sold through an auction, the auction market compiles and submits a landing report to the directorate's ERS. Although harbour officials must weigh and report the landing, they have no authority over inspections and monitoring, which are conducted by officials from the directorate. These officials are present to monitor and audit voluntarily (Chee, 2022).

3.4 Certification and traceability

3.4.1 Certification and ecolabelling

Product certification and ecolabelling are two important tools that can be used to support fisheries management. While both aim to ensure the sustainability and legality of fish products, they have important differences. Product certification is mandated by governments and regional fisheries management organizations to ensure that only legally harvested and reported fish are traded and sold in domestic and international markets. Ecolabelling programs, on the other hand, aim to create market-based incentives for better management of fisheries by creating consumer demand for seafood products from well-managed stocks (FAO, 2001). Ecolabels are seals of approval given to products that have fewer impacts on the environment than functionally or competitively similar products. The goal of ecolabelling initiatives is to promote sustainably managed fisheries and highlight their products to consumers. Product certification and ecolabelling can influence consumer choices and tap into the growing demand for environmentally preferable products (FAO, 2001). Fisheries managers are increasingly using product certification as an extension of their normal monitoring and enforcement activities. It is being used to support management and conservation efforts and to ensure the sustainability of fish stocks (FAO, 2001).

3.4.2 MSC Certification

The Marine Stewardship Council is an international non-profit organisation that aims to promote the health of the world's oceans through various means such as acknowledging and incentivizing sustainable fishing practices, encouraging people to make sustainable choices when purchasing seafood, and collaborate with partners to shift the seafood market towards sustainability. Their assessments are conducted by accredited independent certifiers - Conformity Assessment Bodies (CABs).

The fisheries are scored against three principles of the MSC:

- **Sustainability of the stock:** fisheries must operate in a way that allows fishing to continue indefinitely, without overexploiting the resource.
- **Ecosystem impacts:** Fishing operations need to be managed to maintain the structure, productivity, function, and diversity of the ecosystem upon which the fishery depends, including other species and habitats.
- **Management:** All fisheries need to meet all local, national, and international laws and have an effective management system in place.

3.4.3 Traceability

The concept of traceability has gained increasing attention and importance in industrial logistics since the mid-1990s, regardless of the production regime and type of product (Melania & Olsen, 2022). The same authors emphasize the significance of implementing traceability systems in the food supply chain for improving food quality and safety, optimizing production, and documenting sustainability.

The increasing demand for detailed information on the nature and origin of food products has made traceability a legal and commercial necessity (ISO, 2015). The ISO definition of traceability focuses on the ability to trace the history, application, and location of the product under consideration, including the origin of food materials, processing history, and distribution

and location of the product. Traceability encompasses not only the physical tracing of products but also the provision of information on their composition, safety, quality, and labelling (ISO, 2015).

The Global Standard organization (GS1) highlights that traceability has become a strategic priority for organizations worldwide. The implementation of traceability systems not only enables increased supply chain quality, efficiency, and transparency but also supports the development of solutions that enhance supply chain security and safety. The importance of data accessibility and analysis in traceability is emphasized because data accessibility is key to drive speed of response and precision of analysis. It involves gathering, storing, and reporting detailed information about every important event throughout supply and production. Thus, enabling organizations to control and proactively monitor their supply chains, make informed decisions, and improve operations (GS1, 2017).

3.4.4 Traceability standards (Iceland, EU, and U.S)

According to (Chee, 2022), the Icelandic fisheries authority operates and utilizes a complete ERS, where information about the catch, landing, processing, and export are collected and stored. The ERS contains all data reports from catch to processing with necessary data elements that are required to produce, verify, and validate catch certificates of export of fish products that are destined for any market including the US and EU.

For traceability Iceland uses the Responsible Fisheries Management (IRFM) Chain of Custody (IRFF, 2019) certification, that is also based in the FAO guidelines highlighted in section 3.3.4.

The primary goal of the IRFM Chain of Custody Certification in Iceland is to offer suppliers the means to prove that their products originate from an IRFM certified fishery and reduce the chances of consumers mistaking uncertified fish products for certified ones. This is accomplished by implementing a comprehensive product traceability system that allows for the tracking of products from their suppliers to their purchasers.

This standard has the following requirements:

1. General Principles of Traceability
2. Traceability Between the Supply Chain
3. Traceability and Labelling
4. Training

For export to the EU, Iceland implements the European Union Regulation 1005/2008 – Catch Documentation Scheme (CDS) which aims to prevent, deter, and eliminate all trade of fishery products into the EU deriving from IUU fishing.

For export to the U.S Iceland follows the NOAA (2018) - Seafood Import Monitoring Program (SIMP). This is a risk-based seafood traceability program. It requires the importer to provide and report key chain of custody data from the point of harvest to the point of entry into U.S. commerce. It identifies imported fish and fish products particularly vulnerable to IUU fishing and/or seafood fraud; more than 1,100 unique species, categorized in 13 species groups, are included in SIMP.

Species groups included are Abalone, Atlantic cod, Blue crab (Atlantic), Dolphinfish (Mahi Mahi), Grouper, King crab (red), Pacific cod, Red snapper, Sea cucumber, Sharks, Shrimp, Swordfish, and Tuna (Albacore, Bigeye, Skipjack, Yellowfin, Bluefin).

Data collected through SIMP allow these priority species of seafood to be traced from the point of entry into U.S. commerce back to the point of harvest or production to verify whether it was lawfully harvested or produced.

The NOAA provides a SIMP form model catch certificate to export products to the U.S, Table 3 summarizes the requirements that might apply to the industrial shrimp fishery:

Table 2: NOAA-SIMP form model requirements for catch certificates. Source: NOAA Model Catch Certificate (2018)

Data Element	Mandatory/Optional	Format/Code for NMFS
Applicable to both Wild-capture and Aquaculture Operations		
Catch Document Identifier	Optional	Free text format
Wild Harvest	Mandatory	A code of "HCF" (wild capture)
Applicable to Wild-Capture Operations		
Flag state of Vessel	Mandatory	Standardized data format of the two-alpha International Organization for Standardization (ISO) country codes
Name of Harvesting vessel	Mandatory	Free form text
Unique Vessel Identifier (registration, or License number)	Optional	Free form text
Geographic Location or Ocean Harvest Area	Mandatory	FAO fishing area with an additional note regarding withing or beyond the EEZ of a coastal state
Fishing Gear	Mandatory	Free text and FAO Gear Codes
Applicable to both Wild-capture and Aquaculture Operations		
Company name of landing recipient, processor, or buying entity and contact information	Mandatory	Free from text
Facility or vessel landed/Delivered to	Mandatory	Free form text and in the case of transshipment vessels, the vessel name and Identifier should be provided
Harvest date	Mandatory	Date of landing/offloading at the end of at the end of a fishing trip or the date of transshipment at-sea or in-port
Landing Port or Delivery location	Mandatory	Free form text
Species name and ASFIS code	Mandatory	ASFIS 2 alpha coding
Total weight of product at landing	Mandatory	Numeric value and the reporting unit
Processing description (Product form at landing)	Mandatory	Standard set of codes that needs to be developed (e.g., NDR – Dressed; NFL – Fillet; NGG – Gilled and gutted; NOT – Other; NRD – Round (whole))

4 RESULTS

This chapter contains the results of the analyzed data sets. The results were divided into 3 sections; the first section is a summary of the interview results in the sub-sections; the second section contains the summarized results of the transcript divided in two tables, one for CENDEPESCA and the other for industry. Finally, the third section contains the quantitative data results obtained from the data of CENDEPESCA and FAO.

4.1 Summary of interview responses

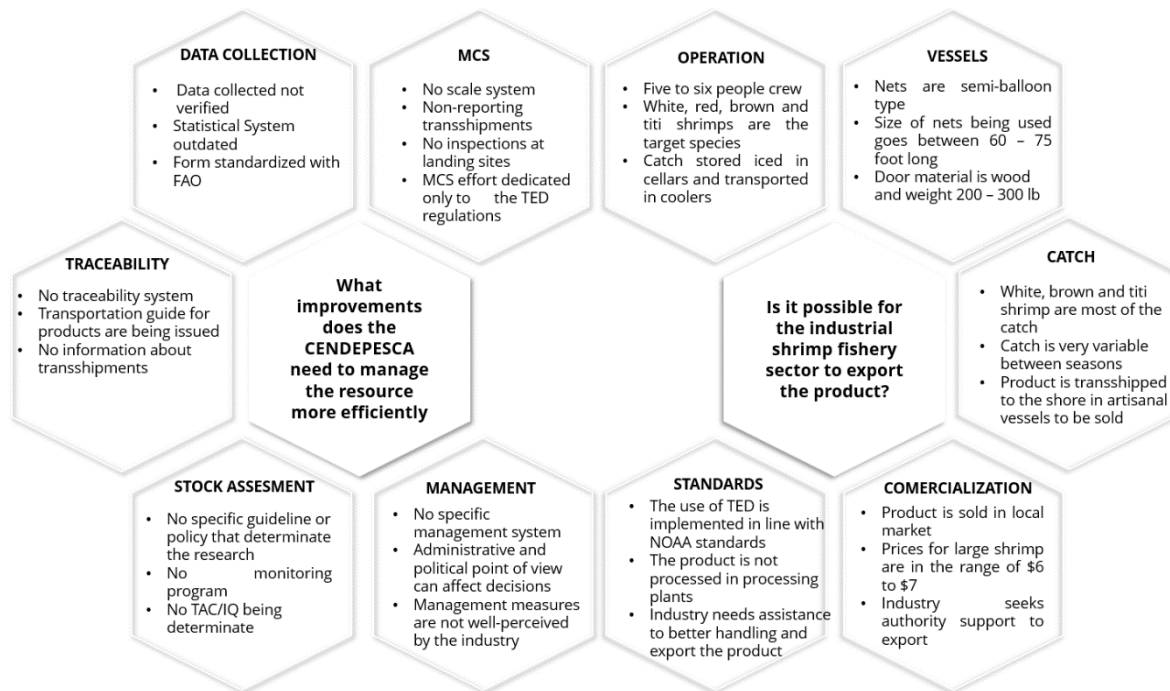


Figure 3: Data display showing major findings from the interviews related to research question. Source: Author based on interviews.

Figure 3 displays the major findings in the interviews related to issues concerning the research questions. The findings are displayed in bullet points and are divided into major sections that were used as guidelines to compile the summary of results.

4.1.1 Vessels and fishing gears

Participants from CENDEPESCA responded that information about the vessel characteristics such as length, width and capacity are checked and measured on a yearly basis, when the technical - functional inspection - is conducted to issue the fishing license renewal. According to the participant responses from CENDEPESCA, no information on the fishing gears is collected, and the only characteristic of the net that is verified in the inspections is the Turtle Excluding Device (TED) and the mesh size. Participants also mentioned that the inspections being conducted at sea are more focused on the TED regulations and revision of documentation of crew members and vessel.

According to the responses from the industry, the most common type of net being utilized is the semi-balloon type, this material can be of polyethylene and treated twine. The size of the net varied between the participants responses, but it can be mentioned that sizes vary from 60

to 75 ft long. The vessel carries two trawl nets and uses four doors made of pine wood that weighs in the range of 200 to 300 lbs. When it comes to mesh size, most of the participants responded that they are using a mesh size of 2" but a few mentioned that they are using trawl nets with 1 ¾" mesh size.

4.1.2 Operation and catches

In accordance with the participant responses, the main target species are shrimps: white shrimp brown shrimp, red shrimp, and titi shrimp. For the species that are captured as part of the by-catch, the participants mentioned a variety of fish species like queen, drums, croaker, snapper, flatfish and morralla³. Additionally, other crustaceans like lobster, crab, and mollusks, such as snails and squid, were mentioned.

All the participants mentioned that catches are very variable through the year and seasons, mentioning that the shrimp species tend to be more productive in the dry season, and the titi shrimp tends to be more productive in the rainy season. As for the fish, they mentioned that the catches are higher during the rainy season.

Regarding catch quantities, participants reported that during the dry season, shrimp catches can reach up to 500 lb, while in the rainy season they range from 2,000 to 4,000 lb. For titi shrimp, catches can be as high as 2,000 lb in the dry season and up to 10,000 lb during the rainy season per fishing trip. Fish catches vary between 400 and 2,500 lb per 30-day fishing trip on average, with higher yields during the rainy season. This includes the total catch of "morralla" and "white fish."

For the landing sites, all participants mentioned that all the catch is landed by transshipments using artisanal vessels to move the product from the trawl net vessel to the landing sites. These transshipments are performed every 48 to 72 hours, and depending on the catches they can occur up to every 5 days. Among the landing sites mentioned were the beach of La Puntilla, El Espino and El Cuco, which are areas where many of the landings for artisanal vessels occur.

4.1.3 Commercialization

According to the participant responses, the product is caught and classified on deck by species and is stored on ice in the hold, and then is transshipped every 40 to 72 hours in an artisanal vessel, transported in coolers containing ice. The product is landed on shore, is weighed, and is commercialized at the landing point. Currently, the product is being sold in local markets and there is no export of any species caught by the trawl net vessels. Regarding the prices, participants mentioned that the shrimp is being categorized as one specie - that includes the three main species - and is classified by size, using the units per pound measure. On average the responses of the participants in this regard were as in Table 4 below:

Table 3: Shrimp categorization for commercialization. Source: Author based on interviews

Size	Units/Pound	Price
Large	8 -10 units	\$6 - \$7
Medium	11 to 16 units	\$4 - \$5
Small	16 - 25 units	\$3 - \$4

³ Morralla: common way to refer to a variety of small size fish species that has low commercial value.

For the by-catch species the participants mentioned that the titi shrimp can be sold in the dry season at a price of \$3 per pound, and in the rainy season for \$1 per pound. The fish that is classified as “white fish” can be sold for \$1 to \$1.50 per pound and the “morralla” can be sold for \$0.30 to \$0.40 per pound.

Based on participant opinion, support from the authorities to help them export the product could provide more opportunities and revenue. It was also mentioned that the authorities need to conduct more enforcement in the artisanal sector with smuggling which lowers the prices of shrimp in local markets.

4.1.4 Data collection system

The participants from CENDEPESCA mentioned that there are no designated data collectors in CENDEPESCA, and data collection is a complementary activity that fisheries officers and administrators must fulfil. As for how the data is collected, participants responded that the information is being provided by the industry using the statistical form, and no data is collected directly on site. It was also mentioned that this data provision is not verified by CENDEPESCA.

According to the participants the statistical system being used to compile and store the data was developed following a scientific advice recommendation provided by international cooperation, but it has not been updated since its implementation. It was also mentioned that the data must be digitized and is processed and stored digitally in excel files, which are consolidated to be published in the annual statistical reports.

Participants from the industry responded that when it comes to the data they collect, data of each set is collected and the location of the set is registered, along with the common name of the target and non-target species and its weight in pounds. This information is physically registered in the captain’s logbook; a record that is often requested by the owner of the vessel at the time of the operation and is used to keep control of the landing’s when the transshipment happens. Some of the captains and owners keep an extended record of their logbooks for accountability, but it is limited to providing the information that the statistical forms request, which does not require information on the sets and location.

4.1.5 Stock assessment

The participants from CENDEPESCA mentioned that the focus of the research division is in accordance with the Annual Operational Plan (PAO) and responds to the National Fisheries and Aquaculture Policy. However, they mentioned that there are no specific guidelines or policy that determinates the research to be conducted on a yearly basis and depends on the institutional interest. It can also be determined by the General Director that can prioritize the research to be conducted due to sector pressure or requests in regard to specific topics.

It was also mentioned that there is no monitoring program implemented for the shrimp because of the lack of human and financial resources in maintaining a monitoring and scientific data collection program. For the same reasons, while other scientific recommendations have been given, closures are being implemented due to the difficulties of enforcement and limitation of the MCS activities that are needed for the success of other measures.

Lastly, the participants mentioned that neither a TAC or IQ is being issued for the shrimp, and the only limitation on the effort is the number of vessels that is set at 55 vessels by CENDEPESCA resolution.

4.1.6 *Management*

Each Regional Office of CENDEPESCA has approximately 3 to 4 persons involved in the industrial shrimp fishery activity, most of them are fisheries officers that are also in charge of the artisanal sector MCS activities. In some offices, shifts must be taken between administrators and fisheries officers to cover complementary activities such as data collection. The current management measures implemented to secure the sustainability of the shrimp research identified by the participants were:

- The marine shrimp closures on reproduction and recruitment periods
- The fishing area restriction for trawl net vessels of 3 nautical miles and 5 nautical miles around the mouths of the rivers
- The use of TED on the nets
- The requirement of 2” mesh size in the nets

When asked if the current management measures implemented are supported by scientific advice or precautionary approach, participants responded that they have both components. Still, many of the participants from CENDEPESCA were not sure if the research division provided scientific recommendations to the General Director.

In addition, some of the participants mentioned that regarding closure periods, the need of industry is often put above the recommendations, hindering their effectiveness, and administrative and political decisions can affect the implementation and time frame of the closure periods.

Participants from industry responded that they are not in agreement with the implementation of the closure periods, arguing that the resource is already in permanent closure, since they can't access the first 3 nautical miles to fish the shrimp. They also mentioned that they disagree about the 3 nautical miles restriction, and they would prefer to have a restriction of only 2 nautical miles, arguing that the resource tends to move closer to the shore when the water cools down due to natural phenomena.

4.1.7 *MCS*

According to the participants from CENDEPESCA, for the inspections conducted on the trawl net vessels, only the TED inspection is conducted at sea, technical-functional inspection and VMS equipment inspections are conducted at port.

For the landings, it was mentioned that due to the limited number of officers and workload, the landing inspections are scarce, and there is no updated control mechanism to keep the records. Only one participant responded that his regional office receives and inspects the vessels at the end of the fishing trip. The participants from industry responded in a similar fashion, they mentioned that they don't receive landing inspections at the end of the fishing trip and that they are only occasionally received at port by CENDEPESCA officers.

Participants responded that there is no scale system implemented to weigh the catch at the landing points and the only information being registered is the one provided in the statistical

form that the owners sent to the Fisheries and Aquaculture Statistic Department, information which is not verified by CENDEPESCA.

For the transshipments, according to the participants; these are not being monitored or controlled by CENDEPESCA fisheries officers, for the same reasons mentioned regarding inspections at the landing points. Industry participants mentioned that they are being carried out every 48 to 72 hours and that the ruleset about transshipments lacks clarity and standardization, therefore they conduct the transshipments without the clarity in regards of the legal procedure, mostly just notifying the regional office or the Monitoring, Control and Surveillance Department.

Some participants from CENDEPESCA mentioned that their regional office can receive transshipment notification and can authorize transshipments. Most participants from CENDEPESCA referred to the statistical form when asked about the forms used during transshipments and landings.

4.1.8 Traceability

According to the responses from CENDEPESCA, a system to register the traceability has not been implemented and the only instrument being used to collect information about the product is the Transportation Guide of the Product, which is used to certify that the product has been moved from point A to point B.

The participants from industry responded that they don't have an established system to record traceability, but they keep a physical record of each sale. The way this is recorded varies from owner to owner, but in general they all keep some kind of physical register of the sold product, and the people who buy the product must carry the transportation guide to move the product to the local markets.

4.2 Transcription summary results

4.2.1 CENDEPESCA

Site: CENDEPESCA	
Section: Administration and Management	
Question	Answer
How many people (inspectors, data collectors, administrators) are involved in the activity of industrial shrimp vessels?	Participant 1 responded that approximately 35 to 40 people participate in total.
	Participant 2 said that he did not have this information.
	Participant 3 responded that the inspectors involved are those belonging to the regional offices of Puerto El Triunfo and La Unión. Regarding the collectors, CENDEPESCA does not have assigned data collectors.
	Participant 4 responded that there are 14 inspectors for the 5 regional offices and data collection is covered by the same 14 people as a complementary activity.
	Participant 5 responded that his regional office has 3 inspectors and 1 data collector.

	Participant 6 responded that 4 people participate in his regional office and these 4 people take turns to collect data.
	Participant 7 responded that 3 people participate in his regional office and that one of them oversees data collection.
	Participant 8 responded that 3 people participate in his regional office. Regarding data collection, it's worth noting that no industrial fleet data is collected in this regional office.
Which are the current management measures implemented to secure the sustainability of the resource?	Participants 1, 2, 4 and 8 responded that there are 2 marine shrimp closures per year, which respond to the reproduction and recruitment periods of the shrimp species.
	Participant 1 responded that there is a fishing restriction for industrial vessels within three nautical miles and five nautical miles around the mouths of the rivers, which were defined by legislative. And mentioned that the closure periods can be affected by administrative and political points of view.
	Participant 3 stated that he does not have this information.
	Participant 5 mentioned that there is a resolution that requires the use of a TED device.
	Participant 6 commented that there are no management measures being implemented.
	Participants 4 and 7 confirmed that there is a resolution requiring the use of mesh number 7 (2")
Are the current management measures supported by scientific advice or precautionary approach?	Participant 1, 2, 3 and 7 responded that they are supported by scientific recommendation.
	Participant 4 responded that it has both components, precautionary approach, and scientific recommendation.
	Participant 6 commented that he does not know the answer.
	Participant 8 responded that they are supported by the precautionary approach.
Are there any inspections being conducted to the vessels or landing sites? If so, explain the requirements that need to be fulfilled	Participants 1,4,5,6,7 and 8 responded that there are mainly two types of inspections; the technical-functional inspection, established in the General Law for the Promotion and Management of Fisheries and Aquaculture. And TED inspection, which follows the regulations established by NOAA, for which there is an inspection form.

Is there a form for transshipment and landings?	Participants 1, 4, 5 and 6 responded that due to the shortage of personnel and workload of the inspectors, there are deficiencies in the inspections that should be carried out at the landing points and that these are carried out sporadically. Participant 4 commented that there is no updated mechanism for controls at the landing sites due to a shortage of personnel and resources.
	Participant 7 responded that his regional office receives and inspects vessels at the end of the fishing trip.
	Participants 1, 6 and 7 commented that there are VMS equipment inspections, which take place in port.
	Participants 2 and 3 said they were unaware of these procedures.
	Participants 1,3,5,6,7 and 8 responded that there is an application form in accordance with the LGOPPA and that it is submitted by the vessel owner and processed at the central office. Participants 6 and 8 commented that it can also be processed and authorized at their regional office.
	Participant 4 responded that there is no form, but the law allows transshipments if they are authorized by CENDEPESCA.
Are the inspections at sea and landing sites being conducted under a policy framework? If so, explain briefly.	Participants 1,3,4,5,6,7 and 8 commented that for landings there is a statistical report that is submitted to the Fisheries and Aquaculture Statistics Department.
	Participants 1,4,5,6,7 and 8 responded that they are not monitored by inspectors.
Are in-water and landing site inspections conducted under any policy or structure?	Participants 2 and 3 said they did not know if they are monitored.
	Participants 1,4,5, and 8 responded that TED inspections are conducted under the guidelines provided by NOAA and a form is available to conduct them.
	Participants 1, 4, 6 and 7 commented that the technical-functional inspections are carried out under the guidelines established in the LGOPPA.
	Participants 2 and 3 said they did not know the answer.

Is there a scale system being used to weigh the landings? If not, how is the landing data being collected?	Participants 1,2,3,4,5,6 and 7 responded that there is no weighing system implemented by CENDEPESCA to weigh the landings, and that in cases where the landings are weighed at the reception point, an estimate of the catch is made.
	Participant 8 responded that no shrimp vessels are received at their regional office, as there are no authorized landing points.
Are there any mechanisms implemented for catch traceability? If so, how is it being registered and what species are covered?	Participants 1, 2, 4, 5, 6 and 7 responded that there is no mechanism in place for traceability, only the fish product transfer guides that are used to allow the transport of the product from point A to point B, and their issuance is regulated by the LGOPPA.
	Participants 3 and 8 commented that they did not know how this register is kept.
In your opinion, what aspect, situation or phenomena do you think hinders and limits the shrimp fishery industry the most?	Participant 1 said that what harms and limits the industry is the lack of knowledge of the biomass of the resource, in addition to the unstable prices of the product.
	Participant 2 expressed his opinion that what harms and limits the industry is the lack of controls in relation to transshipments and catch reports, since vessels report what they want and tranship and unload without reporting or notifying CENDEPESCA.
	Participant 3 believes that what affects the industry the most is the lack of diversification in catches.
	Participant 4 expressed the opinion that what is most detrimental and limiting to the industry is the high number of vessels operating.
	Participant 5 believed what hurts and limits the industry the most is the size of the catches of the FAC due to the high fishing effort.
	<i>The answer was illegible in the interview recording due to connection problems.</i>
	Participant 7 believes that what is most damaging and limiting to the industry is the lack of exports and the low prices at which the product must be sold in the local market.
	Participant 8 said that what harms and limits the industry the most is the traditional management practiced in shrimp fishing, referring to the lack of added value and good product management.
Section: Vessel and fishing gear	

<p>What information is being collected about the vessels?</p>	<p>Participants 1, 2, 4, 7 and 8 responded that the characteristics of the vessels are found in the RNPA and are reviewed and updated every year at the time of the technical-functional inspection.</p>
	<p>Participant 6 responded that no information is being collected from the vessels.</p>
<p>Is there any information being collected on fishing gear? If not, briefly explain why.</p>	<p>Participants 1, 2, 4 and 6 responded that no information on fishing gear is being collected.</p>
	<p>Participants 3, 6 and 7 commented that in the technical-functional inspections, information is collected only on the size of the net and the number of the mesh.</p>
	<p>Participants 5 and 8 commented that they do not know what information is being collected about fishing gear, since the regional office does not carry out this activity.</p>
<p>Section: Data collection</p>	
<p>What data regarding the catch is being collected? and what is the procedure to collect it and store it?</p>	<p>Participants 1, 2, 3, 4, 6, 7 and 8 responded that production data are collected through the statistical data collection form, which is a physical form that shipowners must submit to the Fisheries and Aquaculture Statistics Department; however, this information is not verified or contrasted in any way.</p>
	<p>Participant 3 pointed out that these data are processed through Excel and systematized to obtain a total capture figure at the national level. In addition, these data are stored digitally in Excel files.</p>
	<p>Participant 5 commented that his regional office does not collect any data on industrial fishing.</p>
<p>Is the data collected following a guideline or scientific recommendations?</p>	<p>Participants 1, 2, 3, 4 and 6 responded that, yes, a scientific recommendation for data collection is followed and that the statistical data collection system was generated through scientific advice but has not been updated in "many" years.</p>
	<p>Participants 5, 7 and 8 did not know if any scientific guidelines or recommendations are followed.</p>

How is the data collected being processed and published?	Participants 1, 2, 3, 4, 6 and 7 responded that the data is processed through a platform and stored digitally, the information is digitized by the fishery statistics technicians and the information is published in a consolidated form in the fishery statistics yearbooks.
	Participants 5 and 8 said they were unaware of this information.
Is the data collected being used to compare with the stock assessment?	Participants 2, 3 and 4 responded that statistical data are used for comparison with data collected through surveys.
	Participants 1, 5, 6, 7 and 8 responded that they were not sure if these data are used to compare them with the stock assessments.
Section: Stock evaluation	
What is the current focus of the research division and the current work plan and/or policy that guidelines the research?	Participants 1, 2 and 4 responded that scientific research is in accordance with CENDEPESCA's Annual Operational Plan and responds to the National Fisheries and Aquaculture Policy.
	Participants 2 and 4 added that there is no specific guideline or policy that determines the research to be conducted each year and depends on the institutional interest, it can also be determinate by the General Director that can prioritize the research to be conducted due to sector pressure on requests.
	Participants 3, 5, 6, 7 and 8 said they did not know the answer.
Is scientific advice being provided to the General Director for implementation of new management measures for the resource? If so, briefly explain.	Participant 2 responded that scientific recommendations are provided to the General Director, each scientific report has scientific recommendations from research.
	Participant 2 also mentioned that while other measures have been recommended, the closures are being implemented due to the difficulties of the enforcement and limitation of the MCS activities that is needed to the success of other measures. And mentioned that when it comes to closure periods, the need of the industry is put on top the recommendations, hindering their effectiveness.
	Participant 4 responded that there are no scientific recommendations to the Director, except for shrimp closures.

	Participants 1, 3, 5, 6, 7 and 8 commented that they were not sure if any scientific recommendation is provided to the director.
Is there a stock assessment program for the shrimp species targeted by the industrial sector? If not, briefly explain the reasoning or difficulties.	Participants 1, 2, 4, 6 and 8 responded that there is no monitoring program in place due to the lack of human and financial resources to maintain a monitoring and scientific data collection program.
	Participants 3, 5 and 7 did not know if there is a stock assessment program for shrimp species targeted to the industrial sector.
Is there a Total Allowable Catch (TAC) issued for the industrial shrimp fisheries? If so, is it based on the stock assessment?	Participants 1, 2, 4, 6 and 8 responded that there is no TAC being issued.
	Participants 3, 5, and 7 commented that they did not know if there is a TAC issued for the shrimp industry.
Is there an Individual Quota (IQ) being issued or effort system for industrial shrimp vessels?	All participants responded that there is no individual quota system or effort system for shrimp vessels. The only thing that exists is a limited number of vessels, set at 55 vessels by CENDEPESCA resolution.
Section: Export Standards	
Is the production being processed at an approved and registered fishing processing plant?	Participants 1, 2, 4, 5 and 6 responded that the product is not processed in processing plants since it is sold in the local market.
	Participants 3, 7 and 8 responded that yes, part of the catch is processed in processing plants approved and registered in CENDEPESCA. However, they did not specify what type of species are processed.
What standards the industry fulfill to export the product to other markets?	Participants 1,4,5,6,7 and 8 responded that the requirement for the use of TED is met and is in line with the NOAA requirement and the legal requirement established in the LGPPA.
	The participants 3 commented that they did not know what requirements the industry complies with to export the product.
In your opinion, which area of the industry needs support from the authority to be able to access better markets?	Participant 1 responded that there is a need to support the industry in exports, traceability and value added.
	Participant 2 responded that there is a need to support the industry by better managing the resource and standardizing marketing sizes.

	Participant 3 responded that the industry should be supported by diversifying its catches due to the critical state of the shrimp resource, in addition to focusing efforts on aquaculture.
	Participant 4 responded that the industry should be supported by reducing the number of intermediaries and seeking new market opportunities for them.
	Participant 5 responded that the industry should be supported by looking for ways to reduce bycatch and that this could give the industry the opportunity to access new markets.
	Participant 6 responded that the industry should be supported with the renovation of technologies, vessels, and fishing gear. In addition, catch quotas should be implemented to help maintain stable production over time.
	Participant 7 responded that the industry should be supported by giving equal opportunities to all users and companies.
	Participant 8 responded that the industry should be supported to implement sustainable and certified fishing to open the opportunity to access new markets and export the product.

4.2.2 Industry

Cluster: Industry	
Section: Value chain	
Question	Answer
Can the vessels be categorized into different groups? If so, which group are we covering now?	Participants 1,2,4,5,6 and 7 commented that the boats in the question can be classified in the same category.
	Participant 3 commented that except for one boat, all the boats he owns can be classified in the same category, however the only difference between the groups is the engine power and length.
How many people is being employed per fishing trip as part of the fishing crew?	All participants responded that 5 to 6 people are usually employed per fishing trip. During the summer due to the increase in shrimp catches, the number of people may increase to 3 to 5 more, to process the shrimp.

<p>What are the main target species and bycatch species with commercial value?</p>	<p>All participants responded that the target species are white shrimp, brown shrimp, red shrimp, titi shrimp, and their accompanying fauna, where it was mentioned; different species of fish such as: "ruco", "guabina", "curvina", "pargo", "caite" and morralla fish. In addition to other crustacean species such as "lobster" and "crab" and mollusk species such as "snail" and "squid".</p>
<p>What is the quantity of target species and bycatch species per trip?</p>	<p>All the participants responded that the catch is varied and depends on the season; in general, during the dry season the catch is lower, while during the rainy season the catch increases.</p>
	<p>Participant 1 responded that during the dry season, up to 2,000 lb of shrimp, 2,000 lb of titi shrimp and up to 700 lb of fish can be caught per 30-day average fishing trip. During the rainy season the catch can reach 500 lb of shrimp, 10,000 lb of titi shrimp and up to 2,000 lb of fish.</p>
	<p>Participant 2 responded that on average 2500 lb of shrimp are caught per fishing trip, up to 1,000 lb of titi shrimp in the dry season and up to 10,000 lb of titi shrimp in the rainy season, fish can reach 400 lb per trip.</p>
	<p>Participant 3 responded that normally on each fishing trip 150 lbs of shrimp and titi shrimp per day are caught. In terms of fish, it depends a lot on the fishing area, but it can reach 200 lb per day.</p>
	<p>Participant 4 responded that on average 4,000 lb of shrimp are caught per fishing trip, titi shrimp can be 400 lbs in summer and fish can be up to 2,000 lbs per fishing trip.</p>
	<p>Participant 5 responded that each 15-day trip can achieve catches of 2,000 lb of shrimp, 5,000 lb of titi shrimp and 3,000 to 5,000 lb of fish.</p>
	<p>Participant 6 responded that catches of up to 10,000 lb of shrimp, between 2,000 and 3,000 lb of titi shrimp, fish between 400 and 600 lb and "morralla" up to 1,000 lb can be achieved.</p>
	<p>Participant 7 responded that shrimp can be caught up to 1,000 lb, titi shrimp up to 2,000 lb and fish including morralla up to approximately 2,500 lb.</p>

What landing sites are being used to unload the product and how often are the landings being made?	All the participants responded that transshipments are being carried out for product unloading, which take place every 48 to 72 hours, depending on the catches, and can last up to every 5 days.
	Participants 1,2,3,5 and 7 mentioned the beaches of La Puntilla, El Espino and El Cuco, as beaches where transshipments take place.
	All participants mentioned that unloading is always done at the end of the fishing trip at the authorized ports, but this is the production of between 3 and 5 days.
Is there a scale system at landing sites implemented by CENDEPESCA?	All participants responded that there is no system implemented by CENDEPESCA.
Are the transshipments at sea being done following the General Law for Promotion and Management of Fisheries and Aquaculture? If not, explain briefly.	Participants 1 and 2 responded that this is done following the procedures established in the LGPOPA, for which they send a request for scheduled transshipment for a term of three months.
	Participants 3, 5 and 7 responded that no request is being processed but that they are currently informing the respective Regional Office each time they make the transshipment.
	Participants 4 and 6 responded that there is no clarity on the part of the authority regarding the standardization for requesting transshipment authorizations, and that they are currently being carried out without clarity in the legal procedure.
Are the transshipments being monitored by CENDEPESCA inspectors?	All participants responded that they are not monitored or inspected by CENDEPESCA inspectors.
How do you register traceability of the product?	Participants 1,2,3,4 and 6 answered that they keep traceability through physical records and the invoices they deliver to the client, which are subsequently declared to the tax authorities.
	Participant 5 responded that he only delivers a consignment note.
	Participant 7 responded that he keeps a physical record of the captures.
How is the product being processed and transported?	All participants responded that the product is caught, sorted on deck by species and stored in ice cellars and then transported in coolers by boat when transshipments are made.
	The product is transported in coolers, the boat takes the product on ice from the ship to the landing point, it is received on the beach and there it is weighed and marketed, kept in ice, and sold to the wholesaler.

Is the product sold in the local market or exported?	All participants responded that the product is sold in the local market and that there are no exports at this time.
What is the export price and the importing country?	<i>The question was omitted since there are no exports.</i>
What is the average price for shrimp at landing site species and the value of bycatch species?	Participants 1,2,3,4,5 and 7 responded that shrimp are classified into 3 sizes for sale, and approximately large shrimp sell for \$6 to \$7, medium shrimp for \$4 to \$5, small shrimp for \$3 to \$4.
	Participants 1,2,3,4,5 and 7 responded that large shrimp ranged from 8 to 10 units per pound, medium shrimp ranged from 11 to 16 units per pound and small shrimp ranged from 16 to 25 units per pound.
	Participant 6 responded that shrimp is classified into 2 sizes for sale, and approximately large shrimp sell for \$4 and small shrimp for \$1.50 to \$2.50 depending on the season.
	Participant 6 responded that according to their classification, large shrimp range from 10 to 12 units and small shrimp up to 25 units per pound.
	All participants responded that titi shrimp is sold in the dry season at a price of \$3 per pound and in the rainy season at a price of \$1 per pound.
	All participants responded that the fish is classified as "white fish" which is marketed between \$1 and \$1.50 per pound, and as "morralla" which is marketed between \$0.30 and \$0.40 per pound.
	All participants mentioned that squid is marketed between \$1.25 to \$2 per pound.
	All participants mentioned that crab is traded between \$0.5 to \$1.
Participants 1,3,5 and 7 mentioned that the snail is marketed between \$5 and \$7 per dozen.	
Section: Vessel and fishing gear	
What is the vessel length and horsepower?	All participants responded that the engine power in the boat range from 350 to 400 hp.
What type of trawl net is being used by the vessel?	All participants responded that they use semi-balloon trawls, polyethylene material and treated twine.
What is the length size of the net?	Participant 1, 2, 6 and 7 responded that 65-foot nets are used.
	Participant 3 responded that nets are used in the range of 60 to 70 feet.
	Participant 4 responded that they use 75-foot nets.
	Participant 5 responded that they use 70-to-75-foot nets.

	<p>Participants 3 and 7 responded that the mesh size is 1"3/4.</p> <p>Participants 1,2,4,5 and 6 responded that the mesh size is 2".</p>
What is the mesh size?	All participants responded that in the bag the mesh is 2".
What is the material of the doors and what is their weight?	All participants responded that the material of the doors is wood, usually pine and almond, and the hardware is ordinary iron.
	All participants responded that the size of the gates is 6 to 7 inches.
	Participants 1, 2 and 7 responded that the weight ranges from 200 to 250 lb per hatch.
	Participants 4 and 5 responded that the weight is 300 lb per gate.
	Participants 3 and 6 said they were unaware of this information.
Is there any type of fishing excluding device being used?	All participants responded that the TED is only used in accordance with current regulations.
Section: Inspections and management	
Are there any inspections from CENDEPESCA being done in any of the phases of the operation?	All participants responded that they receive two types of inspections; the TED inspection and the technical-functional inspection.
	All participants responded that they do not receive inspections during unloading, they are only received on some occasions by CENDEPESCA inspectors at the end of the trip.
Are you getting inspections at sea? If so, can you explain about the procedure and about the framework of the inspection?	All participants responded that they receive the TED inspection, such procedure is explained by CENDEPESCA inspectors and follows the guidelines established by NOAA for this type of inspections.
Would you agree on CENDEPESCA implementing a TAC/IQ system?	Participants 1,2 4, 5 and 7 responded that they would not consider the establishment of a TAC or IQ as beneficial for the sector, stating that this would restrict their catches, and that artisanal fishing does not have any type of restriction for the extraction of the resource.
	Participant 3 responded that it would be very beneficial if CENDEPESCA could implement a system of this type that would allow them to have better production.
	Participant 6 commented that he could not answer this question because many factors would have to be considered.

In your opinion what aspect, situation or phenomena do you think hinders and limits the shrimp fishery industry the most?	Participants 1,2,3 and 4 responded that they did not agree with the implementation of the closed periods, arguing that the product is already closed due to the 3 nautical mile restriction.
	Participants 5 and 6 responded that they agree with the closed periods, adding that they are necessary to maintain healthy shrimp stocks.
	Participants 1,5,6 and 7 responded that they do not agree with the 3 nautical mile restricted zone and would prefer that it be reduced to 2 nautical miles.
Would you agree on CENDEPESCA implementing a TAC/IQ system?	Participants 1,4,5 and 7 responded that artisanal fishing, as an activity that is not very well controlled by CENDEPESCA, generates unfair competition, price reductions and
	Participants 1, 5 and 6 added that the lack of exports and the lack of marketing opportunities for the product forces them to sell the product in the local market at low prices.
	Participants 3 and 5 added that the cost of fuel is also a factor that affects them as an industry.
Section: Data collection	
What data regarding the landings and catch is being collected?	All participants responded that the weight in pounds of each species is collected, shrimp is categorized into the three main species, white, brown, and red, titi shrimp is categorized as a single species and fish is divided between "white fish" and "morralla fish", for this they use a physical logbook where they keep a record of each set, species caught and weight of the catch.
Is data from the bycatch being collected by species?	All participants responded that the same data is collected, sorted by species and weight in pounds and recorded.
Is any data or information about the discards being collected?	All participants responded that no record is kept of discards.
What is the procedure to collect it and store it?	Participants 1,2,3,4,5 and 6 responded that the catch is weighed each time a set is made, sorted by species and the quantities per pound are recorded in a logbook.
	Participant 7 responded that after each set an estimate of the catch is made which is then weighed at the time of marketing and the amount in pounds is recorded in a logbook.

Is the data collected provided to CENDEPESCA? If so, explain how the data is presented?	All participants responded that for CENDEPESCA a format provided by the Fisheries and Aquaculture Statistics Department is filled out and the catches are noted in pounds. They added that shrimp is divided by the 3 main species, titi shrimp is a general category, and FAC fish appears as a general category, along with lobster, squid, snail, and others. They also added that the data is submitted in physical format at the end of the fishing trip or docked month by month and is delivered to the regional office or directly to the statistic department.
Section: Export Standards	
Is the production being processed at an approved and registered fishing processing plant?	All the participants responded that all the catch obtained is sold in the local market; none of the product goes through a processing plant because there are currently no exports.
What standards does the industry already fulfill to export the product to other markets?	All participants responded that they are currently in compliance with the use of the TED, which is a requirement for exporting the product to the United States. Participant 3 responded that no other requirements are being met to be able to export.
In your opinion in which area do you think the industry needs support from the authority to be able to access better markets?	Participants 1,2,3,4, and 5 responded that support is needed from CENDEPESCA for marketing, export, and traceability. Participants 3 and 6 responded that support is needed to improve product handling and processing practices for better quality. Participants 4 and 5 commented that they need support from CENDEPESCA to better control artisanal fishing extraction and smuggling, which keeps the prices of catches from industrial boats low.

4.3 Quantitative data results

4.3.1 Trawler vessel characteristics

Table 2 shows the mean, maximum and minimum measures of the trawl net vessel characteristics, capacity, and engine horsepower, registered on the RNPA of CENDEPESCA.

Table 4: Trawl net vessel characteristics. Source: CENDEPESCA (2022b).

Measure	Mean	Max.	Min.
Length (m)	20.83	24.46	16.03
Width (m)	6.23	7.3	5.3
Height (m)	3.82	8.49	2.24
Draft (m)	2.45	3.7	1
Carrying capacity (MT)	99.15	196.18	40
Holding capacity (MT)	68.87	160	32
HP of the engine	372.34	470	240

Figure 5 shows the percentage distribution of the material used in the trawl net vessel hauls. Data from the RNPA (CENDEPESCA, 2022b). The materials found in the vessel were steel, fiberglass and iron.

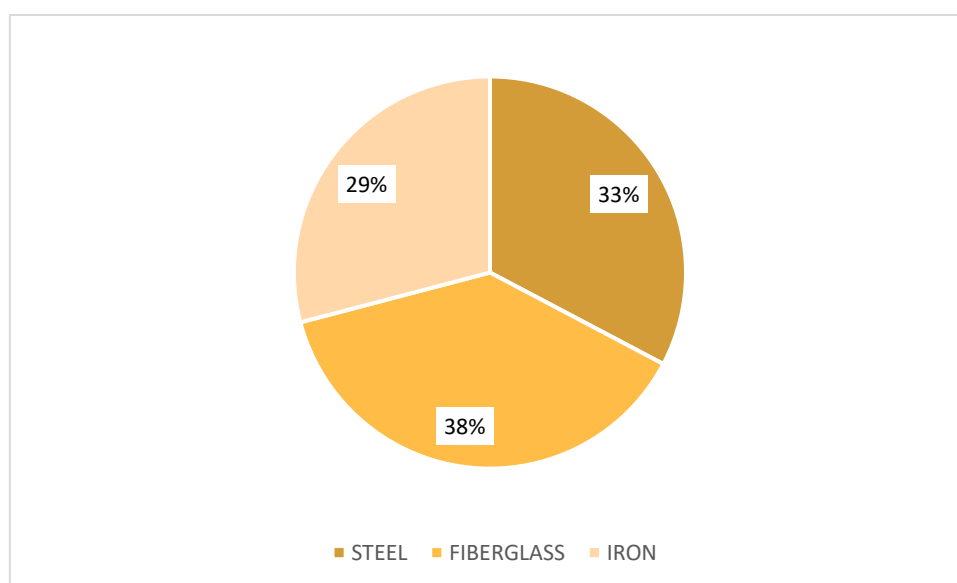


Figure 4: Material of the trawl net vessel haul. Source: CENDEPESCA (2022b).

4.3.2 Catches

Figure 6 shows the historical catches for the industrial shrimp fishery industry. This data includes the capture of the three main shrimp species (white shrimp, brown shrimp, and red shrimp) categorized in the Fisheries and Aquaculture Statistics Department data collection system.

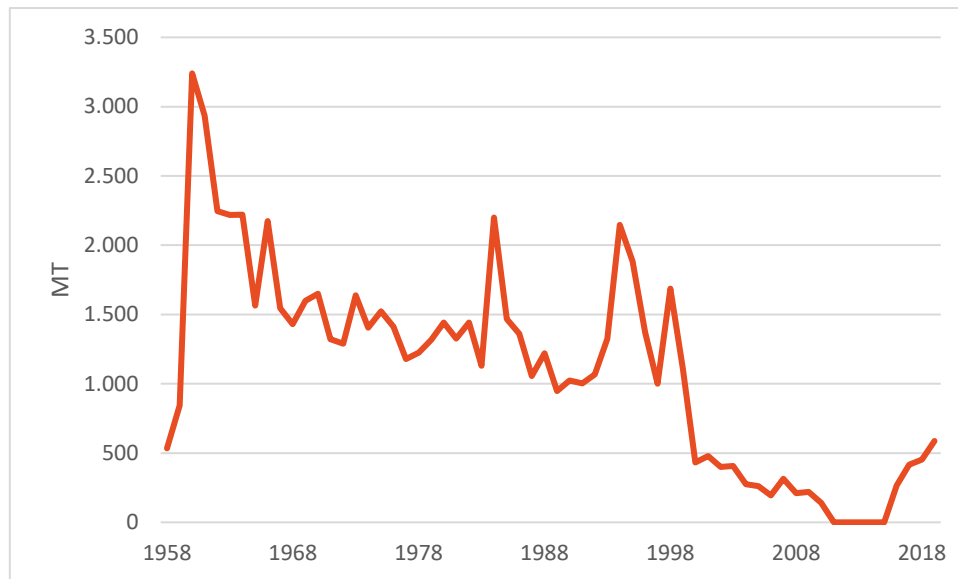


Figure 5: Total shrimp catches from trawl net vessels. Data from the Fisheries and Aquaculture Statistics Department CENDEPESCA (2023).

Figure 7 shows the historical catches of white leg shrimp (*P. vannamei*), crystal shrimp (*P. brevirostris*) and Panaeus shrimps for El Salvador since 1950 to 2019. Before 1994, the white leg shrimp was being reported as NEI⁴.

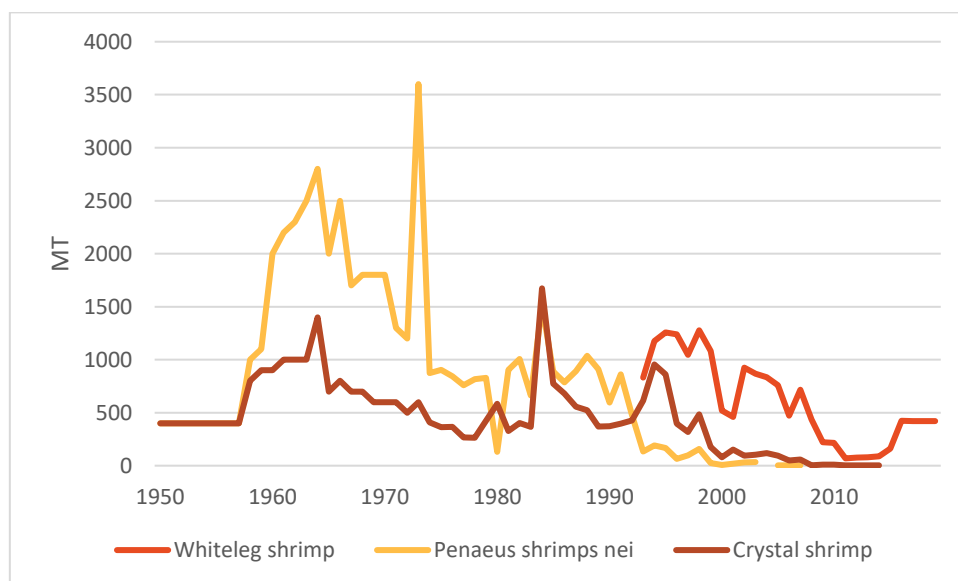


Figure 6: White leg Shrimp, Crystal shrimp and Panaeus NEI historical catches of El Salvador. Source: FAO (2022c).

The quantity of shrimp captured from the shrimp fishery industry as compared to the artisanal sector is addressed in Figure 8 below. Data aggregated is for white leg shrimp (*P. vannamei*) and crystal shrimp (*P. brevirostris*). This data comes from the Fisheries and Aquaculture Statistics Department of the CENDEPESCA.

⁴ NEI: Not Elsewhere Included

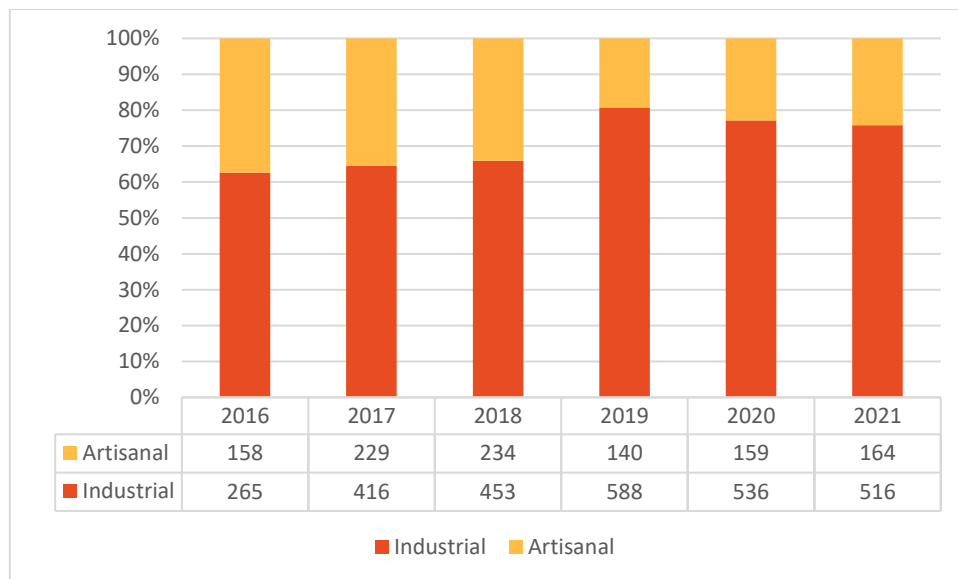


Figure 7: Industrial catches vs. artisanal catches, 2016 to 2021. Source: CENDEPESCA (2022a).

The distribution of the three main species of shrimp captured by the trawl net vessels from 2016 to 2020 is shown in Figure 9 below. Distribution in latest years shows similar quantities in the catch of white shrimp and red shrimp.

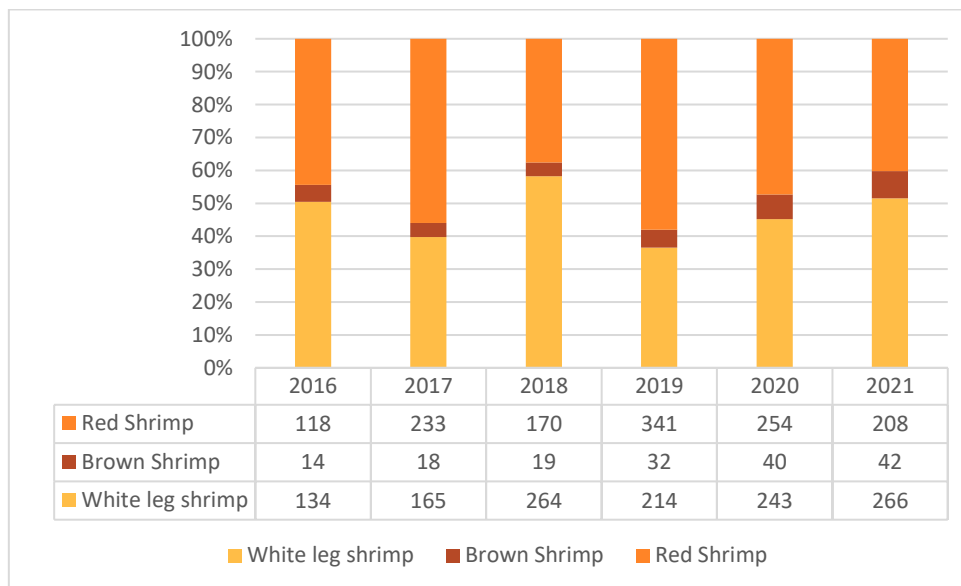


Figure 8: Industrial shrimp fishery objective species distribution. Source: CENDEPESCA (2022a).

Figure 10 below illustrates how El Salvador compares to other countries that have fished white leg shrimp since 2001 to 2019 according to the FAO Fisheries and Aquaculture Statistics. Global Capture Production 1950 – 2019 data.

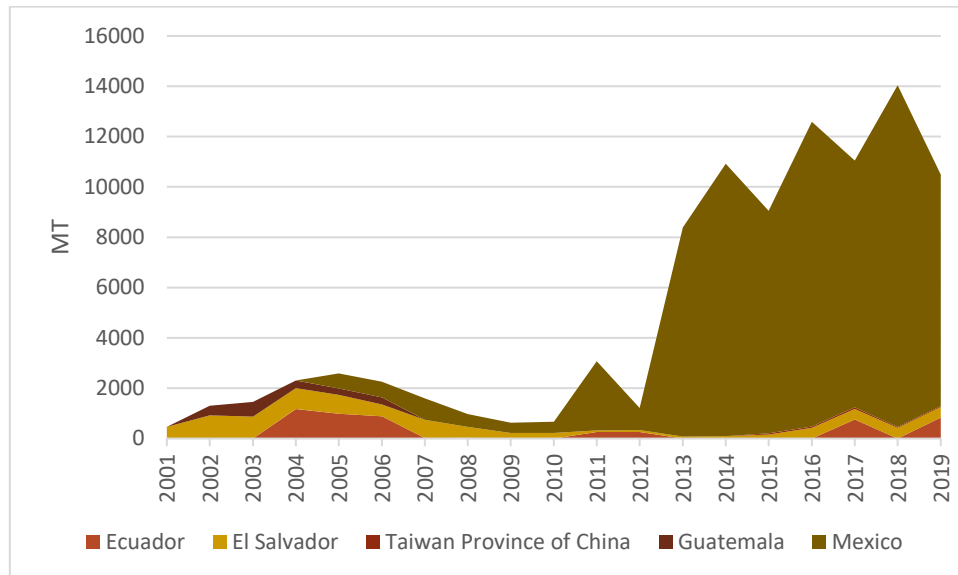


Figure 9: FAO data on white leg shrimp catches per country from 2001 to 2019. Source: FAO (2022a).

4.3.3 Data collection

Figure 11 shows the Fisheries and Aquaculture Statistics Department total shrimp catches for the industrial shrimp fishery industry per year as it appears in the annual statistical reports vs. the data that is being held by the FAO for white leg shrimp and crystal shrimp in the FAO Fisheries and Aquaculture Statistics. Global Capture Production 1950 – 2019.

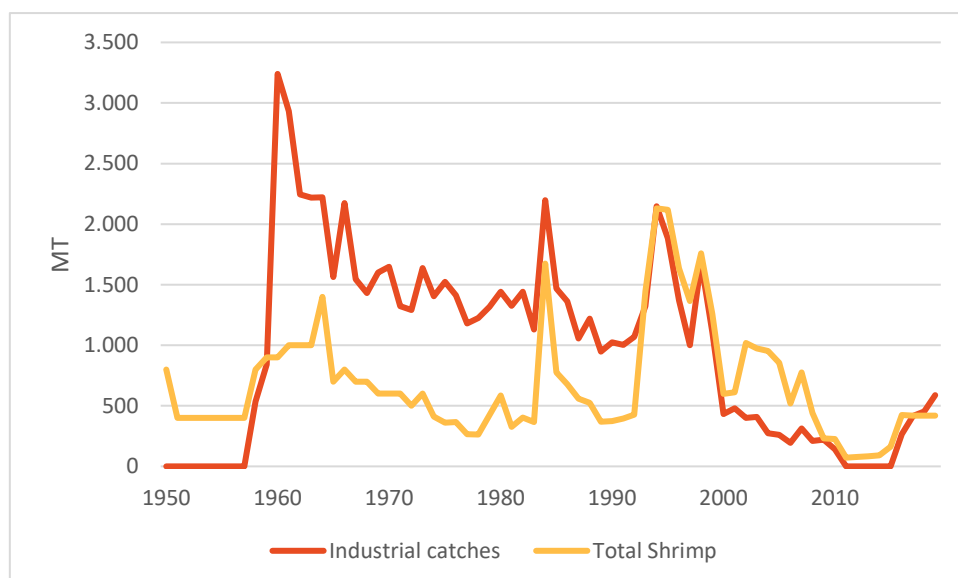


Figure 10: Annual CENDEPESCA vs FAO data. Source: (CENDEPESCA, 2022a) (FAO, 2022c).

4.3.4 Export and trade

Figure 12 below shows the historical shrimp EX from El Salvador according to the FAO Global Fish Trade. This number is for “shrimps and prawns” category and includes capture and aquaculture production.

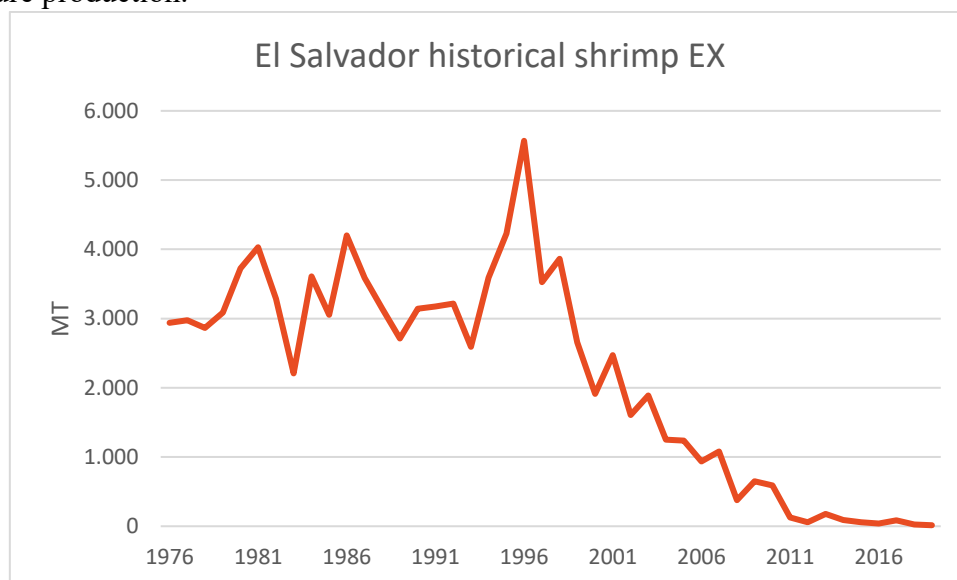


Figure 11: El Salvador historical shrimp EX. Source: FAO (2022b)

White leg shrimp exports in the Central America Region from 2001 to 2019 is shown in Figure 13 below, data is from both fisheries and aquaculture.

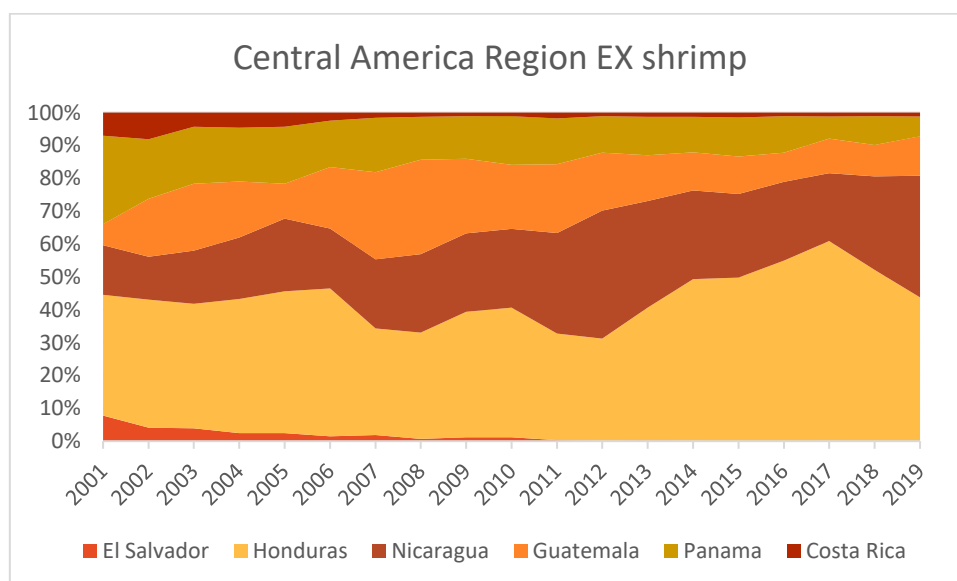


Figure 12: Central America Region shrimp exports from 2001 to 2019. Source: FAO (2022b).

5 DISCUSSION

The discussion is structured using a triangulation process, incorporating both quantitative and qualitative data to examine and explain issues related to the entire value chain and the management system.

5.1 Vessels and fishing gears

5.1.1 Available data

The quantitative data analysed from the RNPA (Table 2) shows that the number of vessels with active fishing license is 55 vessels, with a minimum length size of 16 m, a maximum length of approximately 24 m and an average length of approximately 20 m. The data analysed also reveals that the minimum carrying capacity is 40 MT, the maximum 196 MT and the average is approximately 99 MT.

Figure 5 indicates that the fiberglass was the most common material in the haul being present in 38% of the vessels, followed by steel with 33% and 29% for iron. About the engine, 240 HP was the minimum, 470 the maximum HP and the average HP of the engine was approximately 372 HP.

For the material used in the vessel haul, Figure 5 shows that there is very similar distribution of the haul material in the trawl net vessels, with iron having the lowest percentage of use.

5.1.2 Legislation

The General Law to Manage and Promote Fisheries and Aquaculture does not establish any regulation regarding the vessel and fishing gears. According to the law the only limitation for the vessels is the length size to categorize industrial and artisanal vessels, no limitation or categorization exist in regards of carrying capacity or other vessel characteristic. With regards to the mesh size of the trawl net, CENDEPESCA resolution: MDO-2023 *Resolution of fisheries and aquaculture management measures, closure period of marine shrimp and titi shrimp of the penaeid family*, in this paragraph 13 establishes a mesh size of 2” to be used in the trawl net vessels after the closure period.

5.1.3 Vessel characteristics

Although none of the interviewed participants were able to provide the exact size of the vessel and engine horsepower, their responses were in the range of the information that the RNPA holds for the vessels owned by the participants. There are some significant differences on some of the vessel's characteristics, like length size and carrying capacity, which is expected since the General Fishing Law only limits the length size of the vessel. This could be an important consideration in the planning of a management strategy for this fishery.

The results of the data analysed from the RNPA can be compared with the findings of Galdámez (2020) who mentioned that the max length of the vessels at the time was also 24 m. The same author also found big differences on the the horse power of the engine, but mentioned that the lowest horsepower at the time was 170 instead of the 240 registered in 2023.

5.1.4 Fishing gears

The information available about fishing gears in the trawl net vessels is very limited and CENDEPESCA does not collect and record any information about the fishing gears. The RNPA does not have any information related to the net or any of its components, and since there is no restriction aside from the mesh size, each owner seems to use a different net size based on experience. It is important to note that some of the participants mentioned that they are using trawl nets with 1 ¾” mesh size in contravention with the CENDEPESCA resolution MDO-2023 which establishes a mesh size of 2”.

There is very little information available about the fishing gears. Management efforts have been developed based on vessel efforts not considering characteristics of the fishing gears. Effort controls like vessel/gear restrictions can increase the race to fish and increase the enforcement costs. This is one of the key issues argued by the CENDEPESCA when it comes to the deficiencies on MCS activities. Therefore, collecting more information about the fishing gear and vessel characteristics could help the authority to standardize effort and help the industry to optimize the operation.

5.2 Operation and commercialization.

5.2.1 Objective species

Participants mentioned that when it comes to catches, this are very variable through the year and seasons, mentioning that shrimp species tend to be more productive in the dry season, and the titi shrimp tends to be more productive in the rainy season, as well as the fish. This information goes in line with the findings of Fuentes & Hernandez (2003) who mention that stationary changes are an important factor that influences the composition and abundance of the companion fauna. The same authors mention that the months of June to August were months that shows a higher diversity and abundance in the catch composition. The information gathered from the interviews is also in line with the findings of Gross et al (n.d) who stated that the fishing fleet concentrates on the white shrimp from October to April. The catch-per-day for white leg shrimp is highest in October to March, and the best months are November through February.

It is worth mentioning that the information provided about the species was in common names and in recent years no efforts have been made to assess the by-catch in the industrial shrimp fishery. However, the fish species mentioned by the participants are included in the findings of Fuentes & Hernandez (2003) who identified: *Cyclopsetta querna*, *Pomadasys panamensis*, *Ophioscion strabo*, *Pomadasys macracanthus*, *Polydactylus approximans*, *Diapterus peruvianus*, and *Lutjanus guttatus* y *Cynoponticus coniceps* as the most important commercial species found in the industrial shrimp fishery by catch.

5.2.2 Capture in recent years

It must be clearly stated that El Salvador has no scale system to weigh and collect data from the landings on the artisanal and industrial vessels that operate in jurisdictional waters, relying only on the statistical form provided to CENDEPESCA by the owners to gather data from the trawl net vessels capture.

Data from Figure 6 show the decline on catches in the industrial shrimp fishery sector, that reaches his maximum capture in 1960 and shows a steady decline since 1998. It is important to mention that in terms of FAO species, the summary of the white shrimp and brown shrimp is used for CENDEPESCA to report the white leg shrimp (*P.vannamei*) catches, and the red shrimp is reported as crystal shrimp (*P.brevirrostris*). Table 7 shows that before 1994 the white leg shrimp was being reported as NEI⁵ to FAO.

Figure 8 shows the quantities captured by the industrial sector and the artisanal sector. This figure shows that since 2016 the shrimp catches come mainly from the industrial sector reaching between 60% to 80% of the total catches. Is important to mention that there is no data collected from industry landings from 2011 to 2015, and data prior to those years is inconsistent.

Figure 9 compares the main shrimp species catch composition for the trawl net fisheries since 2016. White leg shrimp (*P. vanammei*) and Crystal shrimp (*P. brevirrostris*) have a similar representation in the total catches through the years; in the range of 46% for each specie in the last six years. For the *P. californiensis*, it represents an average of 6% of the total shrimp catches.

Globally, most of the total shrimp production comes mainly from aquaculture, reaching a production of 5,5 million MT in 2019, and registered catch reached around 10,500 MT; where Mexico registered most of the catch with approximately 9,200 MT, a similar trend in captures has been registered since 2013 (FAO, 2022b).

Figure 10 shows that Mexico reports the biggest white leg shrimp catches among countries that harvest wild shrimp species, and also shows countries like Ecuador that had moved away from the wild catches (opting for aquaculture); while El Salvador started a decline tendency on the catch reports in 2007.

It is important to clarify that although there is no guideline, according to the interview responses, the data from the annual statistical reports is used to compare with the data gathered from the surveys to provide recommendations for the closure measures. However, the reports available show no clarity in this regard and the shrimp has been evaluated as a single specie through the years, therefore no comparison could be made from the results of the analysis with the previous figures. But is important to highlight these results when it comes to catch composition, due to the market value of the white leg shrimp that represents approximately 46% of the catch in the trawl net vessels.

5.2.3 Capture and landings.

It must be acknowledged that while the scope of the study was not to assess fishing effort or calculate production in detail, and a qualitative method approach such as interviews is not the best suited to get this type of data; it was important to gather this information to get an impression of the quantities being captured nowadays.

As it was mentioned by the participants the catches can vary between the seasons, but variation on the estimated production of the owners can also be related to different fishing gears and capacity.

⁵ NEI: Not Elsewhere Included

5.2.4 Commercialization

These results are in the range of findings from Machuca (2019), who found that the price of commercialization of the “large” shrimp captured by artisanal vessels - that conduct the handling of the product in the same way as the industrial vessels - is in the range of \$5.50 to \$8 with a maximum price of \$10 per pound. Table 5 shows the same author found the following retailer market prices for shrimp:

Table 5: Prices for shrimp size Source: Machuca (2019)

Size	Units/Pound	Price
Large	10 - 12 units	\$7 - \$10
Medium	15 - 25 units	\$4 - \$6.50
Small	26 - 40 units	\$3.30 - \$4

Although, the study by Machuca (2019) does not specify if the retailer market gets the product directly from industrial or artisanal fisheries, or both; the retail prices in Table 5 suggest a small profit for the vessel owners. It is important to highlight that the industrial shrimp industry competes directly with the artisanal sector in the local market. This competition and the lack of enforcement and controls over the artisanal sector is an important consideration when developing a strategy to manage the resource. Some of the industry participants mentioned that one of the key issues to get support from the authority is to improve enforcement in the artisanal vessels and the smuggling of shrimp product that affects prices. Also, some participants in CENDEPESCA recognize that equal opportunities and management must be delivered to both the artisanal and industrial sectors, and mechanisms to gain better control over the shrimp catches need to be implemented.

Related to these issues; the co-management has successful examples of FMP that cover both industrial and artisanal fisheries. Although complex, if these measures are developed in the right way, they can achieve success (FAO, 2009). However, while the industrial shrimp fishery competes with the artisanal sector when it comes commercialization, there is no competition on fishing areas, since the former have the advantage of access to the areas where the resource is distributed. The artisanal sector only has a restriction of 1 nautical mile. It also must be considered that the artisanal sector is a multi-specific fishery that do not use trawl nets to fish. Therefore, extra careful consideration needs to be applied to develop a fishing plan for the shrimp resource.

5.3 Data collection system

5.3.1 Available data

Figure 6 shows that there are discrepancies in the data being submitted to FAO and the data stored in the statistical system, especially in the last decade, where there is a data gap for the industry from 2011 to 2015, but not in the FAO data where it was submitted as an estimation. Also, the FAO data from 2016 to 2019 seems unreliable, since it has the exact same quantity reported.

5.3.2 Legislation

According to the Article 35 of the General Fishing Law Ruleset, CENDEPESCA will establish a statistical data system that will be responsible for collecting, compiling, processing and publishing the data related with any fisheries and aquaculture phase. Article 36 also mentions that anyone authorized for any of the fishing phases shall provide information for statistical purposes requested by CENDEPESCA, using a form provided by the authority. The General Fishing Law Ruleset also mentions in Article 38, that CENDEPESCA will develop the Statistical System Development Plan, in the year after the publication of the ruleset, but such a plan is still missing. However, the statistical data form is the instrument that CENDEPESCA currently uses to collect data from the industrial and artisanal sector (see Appendix 6).

The National Fisheries and Aquaculture Policy of El Salvador (2015-2030) highlights several issues with the current data collection system. It points to the lack of updated and reliable statistics on production and commercialization, as well as a deficiency in socioeconomic indicators that are crucial for informed decision-making and for gaining a better understanding of the sector's evolution.

Most of the issues related to this topic have never been properly documented in CENDEPESCA reports, nonetheless; as has already been highlighted in this study, there is no scale weighing system implemented for the trawl net vessels, and it is important to note that the information being provided by the industry in the statistical form is not verified by CENDEPESCA. The statistical form used by the CENDEPESCA to collect data is outdated, it does not require the capture per specie, information on discards, fishing gear characteristics, coordinates and depth of set, and time/duration of the set.

Other issues identified are that the information is provided by the owner in a physical format and the configuration of the compilation can vary from owner to owner, some owners present the information divided by month not dependent on the fishing trips, and others present the information per fishing trip.

Another important observation about the way the industry registers their catches is that for the non-target species, the fish is divided into two categories for commercialization: “white fish” and “morralla”. Some of the participants stated that they also classify “white fish” per specie, for commercialization. However, the form utilized by CENDEPESCA only requests information on fish species as a general category. The same thing occurs regarding titi shrimp, which is only a general category.

5.3.3 FAO and CENDEPESCA data

In accordance with the guidelines of procedure of FAO for the FISHSTAT_FI-NS1 form, the data must include all industrial, artisanal, subsistence and recreational fisheries. It is also important to highlight that CENDEPESCA takes into account the documented catches of “white shrimp” and “brown shrimp” collected in the statistical form for white leg shrimp (*Panaeus vannamei*) data submission. For the crystal shrimp (*Panaeus brevirostris*) and the documented catch of “red shrimp” in the form is submitted to the FISHSTAT-FI-NS1 for El Salvador.

When it comes to the data collected and stored by CENDEPESCA, the catch is aggregated by category and uses the common species name. For the size it uses units of product per weight, but no information about this registration category is found in the annual statistical reports, and

it is uncertain if the vessel owners are providing an accurate measure. For the by-catch categories they are also registered by common name and the only information requested is if the fish is whole or beheaded.

This information is only accessible through the Annularies of Fisheries and Aquaculture Production. There is no guideline developed for CENDEPESCA on how the information needs to be collected, managed or stored. It is also important to note that the annual reports were not published from 2011 to 2015 and there is no record of the statistical data of those years. In addition, the data from previous years is partial and not suitable to make comparisons that can help in this study.

Figure 11, shows notable differences in catches when it comes to data managed by the Fisheries and Aquaculture Statistics Department and data submitted to FAO. It has to be considered that the artisanal catches are missing due to a lack of data in the registry of CENDEPESCA. However, there are major discrepancies in both data sets and important data gaps, especially in recent years. Also the data obtained from FAO shows an almost exact trend of 420 MT from 2016 to 2019; this could possibly be due to an outdated system being used to collect and store statistical data.

5.3.4 Standards

The FAO guidelines outline categories and methods for data collection. This study focused on data gathered during the harvesting phase of the industrial shrimp fishery. While recognizing the importance of data collection in other phases for traceability and strategy evaluation, the harvesting stage presents several key issues that can be addressed and improved in the short term.

As previously noted, the current statistical data collection system used by CENDEPESCA is outdated and seems to be missing some recommendations from FAO or NOAA referenced in section 3.3.6. As mentioned by the participants, it was implemented by international cooperation and has not been updated since its implementation. However, the information requested by Regulation N° No. 307/2023 in the Icelandic system, is basic information that seems to cover the information needed for the activity of the trawl net vessels and is also information that some captains already collect for their own records. This type of data could be implemented in the short term by CENDEPESCA using a physical logbook.

5.4 Stock assessment

5.4.1 Legislation

In accordance with chapter II of the General Fishing Law, CENDEPESCA will develop strategies to monitor and assess the state of the resources whether they are non-exploited, partially exploited, exploited, or overexploited. The same chapter mentions that based on the assessment conducted, management measures regarding the methods, minimum sizes, fishing gears and vessels will be established to strengthen the sustainable use of the resources. The functions described here are the responsibility of the Research Division of CENDEPESCA, a branch of CENDEPESCA that oversees conducting assessment in fisheries and aquaculture.

The National Fisheries and Aquaculture Policy of El Salvador 2015-2030 outlines in its objectives that it; generates the required scientific evidence to support necessary management,

development, and diversification measures of fishing and aquaculture activities through a national program of interdisciplinary research, executed through inter-institutional and inter-sectoral networks of work. The National Fisheries and Aquaculture Policy also mentions in its strategic axis number 2 (section 7.2), the development of a National Program of Scientific and Technological Research with an ecosystem approach that will be formulated and promoted, considering the biological, environmental, social, and economic variables.

5.4.2 *Stock assessment and management measures*

The lack of a stock assessment program and an effective data collection system for the shrimp fisheries appears to be misaligned with the National Fisheries and Aquaculture Policy, creating significant challenges for CENDEPESCA in managing the resource. In addition, there are no clear guidelines for conducting research, and the work of the research division is driven by the operational objectives in the PAO (Annual Operational Plan) of the ministry and its agencies. These objectives, however, do not align with the considerations set forth in the National Fisheries and Aquaculture Policy. Despite the lack of a clear policy and monitoring programs, research has been conducted to evaluate shrimp in recent years and scientific recommendations have been provided to the General Director. Some recommendations provided in the latest surveys are:

- Design a program to collect data periodically to create a basis to understand the behaviour of the Penaeids species (Barahona, 2021).
- Involve the fishermen in collecting samples used to measure length and record sex and maturity (Barahona, 2021).
- Given the condition of various species in trawl fisheries, it is recommended not to increase the fishing effort due to the critical state of the main species targeted by trawl fishing (Galdámez & Barahona, 2020).
- To provide more accurate fisheries management measures; continuous fishing surveys are necessary to establish comparison points for assessing the recovery of the resource based on compliance with established measures (Galdámez & Barahona, 2020).
- To continue with resource management measures, such as shrimp fishing closures, that protect the three-month reproduction and recruitment seasons (Galdamez & Barahona, 2019).

The framework of the research division seems to be affected by administrative decisions when it comes to priorities and considerations for conducting research. It also appears that due to issues not explored in this study - like administrative and political decisions - the scientific recommendations are not being followed by CENDEPESCA.

It must be mentioned that some participants from the industry disagree on the current management measures, specifically the closure period and the fishing restriction of 3 nautical miles which was established based on scientific recommendation, according to the respondents from CENDEPESCA. While the reasons for the participants' disagreement seem to be based on perceptions, it is important to highlight the impact of the administrative and political decisions when it comes to changes or shortening of the closure periods. These decisions that seem to aim to benefit the industry, could hinder the effectiveness of the measures based on the scientific recommendations.

5.5 Management and MCS

5.5.1 Legislation

The management system in El Salvador is primarily based on laws, and the main instrument is the General Fishing Law that establishes the rules and responsibilities for obtaining licenses and authorizations for fishing, as well as some regulations for the different fishing phases and fishing areas that must be closed off for both the artisanal and industrial sectors. In addition, this law allows the General Director to issue management measures through resolutions that are published in the Official Gazette.

The National Fisheries and Aquaculture Policy of El Salvador (2015-2030) highlights the need to address weaknesses in the implementation of monitoring, control, and surveillance measures, as well as the low commitment of fishers to practicing responsible fishing. These issues have hindered efforts to prevent the use of illegal gear and methods, fishing in prohibited areas, and illegal, unreported, and unregulated (IUU) fishing, along with other violations of existing regulations.

Regarding inspections, Article 10 of the General Fishing Law grants CENDEPESCA the authority to conduct inspections to verify compliance with the law and its regulations, though it lacks further specifics. However, CENDEPESCA's management measures may include more detailed compliance requirements and procedural guidelines. The two primary resolutions for shrimp management measures are as follows:

- CENDEPESCA Resolution for the establishment of the use Turtle Excluding Devices.
- CENDEPESCA Resolution MDO-2023. Resolution on fisheries and aquaculture management measures, closure period of marine shrimp and titi shrimp of the penaeid family.

5.5.2 Monitoring Control and Surveillance

From the responses of the interviewees, it appears that the TED inspections have the priority over the landing and transshipment inspections, this could be because the TED inspections follow the recommendation established by NOAA and were implemented when El Salvador was exporting shrimp to the U.S and were included by resolution as a requirement for fishing license renewal by CENDEPESCA.

Notably, the lack of inspections of the transshipments and landings due to the limited number of persons and the lack of a scale system poses the biggest challenges to CENDEPESCA and gives the vessel owners the freedom to conduct activities the way they want. The only instrument the authority is using to monitor and control these vessels is the VMS, which is only being use in the industrial vessels, and cannot track the artisanal vessels that are being used for the transshipments.

5.5.3 Transshipments

For the transshipments, the Ruleset of the General Fishing Law Chapter VII establishes the procedure on how to request transshipment which can be programmed or non-programmed. According to the procedure the programmed transshipment must be requested to the General Director of CENDEPESCA, and name the vessels involved, registration number, dates of transshipment, coordinates and quantities of species must be specified, but there is no model or official form being used. For the non-programmed transshipment, the procedure states that it

can be performed by force majeure and notified to CENDEPESCA with a justification in the follow-up 48 hours.

Participants from the industry mentioned that the ruleset about transshipment lacks clarity and standardization, therefore they conduct the transshipments without clarity regarding the legal procedure, mostly just notifying the regional office or the Monitoring, Control and Surveillance Department. This is also reflected in the responses of CENDEPESCA, where some participants mentioned that their regional office can receive transshipment notification and can authorize transshipments.

5.5.4 Strategy

Co-management is a strategy that has been used with great success to manage fisheries and seems to accommodate the needs of CENDEPESCA in regard to the improvements needed to the management system, that is, for the development of a fisheries management strategy for the shrimp. It must be considered that the costs associated with co-management strategies are a significant factor in evaluating their performance, especially when compared to the benefits such as improved income, equity, and food security. It is a misconception that co-managing a fishery is always cheaper than conventional management, as costs can be higher, particularly if the state remains heavily involved in monitoring and enforcement. However, the initial costs may be covered by donor projects or programs, and long-term costs could be supported by access or licensing fees.

5.6 Certification and traceability

5.6.1 Legislation

The General Fishing Law only establishes the use of the Fisheries Product Transportation Guide and its respective canon. On the other hand, the National Fisheries and Aquaculture Policy of El Salvador in Axis 4 emphasizes that the development of a cross-sectoral and inter-institutional program will be promoted to strengthen extension, technical assistance, technology transfer, and the application of good fishing and farming practices, including traceability and safe handling of fishery products, especially for fishermen and traders.

5.6.2 Certification

When it comes to certification, as stated before, there are three main components that a fishery needs to fulfil to get certification according to the MCS; Sustainability of the stock; Ecosystem impacts, and Management. Currently the industrial shrimp fishery does not comply with this main component, specifically, there is no fisheries management strategy dedicated to the shrimp fisheries. While the journey towards getting a fishery certified can be long for the shrimp industry, the MSC has certified bottom trawls fisheries before. In addition, fisheries managers are increasingly using product certification as an extension of their normal monitoring and enforcement activities. It is being used to support management and conservation efforts and to ensure the sustainability of fish stocks, which can help CENDEPESCA in monitoring the resource.

5.6.3 Traceability system

CENDEPESCA does not have a system to keep the traceability of the product, and the way that the industry conducts the activity and registers product information at every stage does not align with the standards of the Icelandic fisheries authority. Iceland operates and utilizes a full ERS

where information about the catch, landing, processing, and export are collected and stored. Neither does CENDEPESCA align with GS1 standards that provide a comprehensive set of general traceability standards to identify, capture and share information about objects throughout their lifecycle.

5.7 Exports

5.7.1 *Exports through the years and potential*

Historical exports for El Salvador had been in decline, as it can be seen in Figure 6, the highest quantity in shrimp and prawn export according to FAO was reached in 1960. Figure 11 includes shrimp export from fisheries and aquaculture in the Central America region; it shows that El Salvador's exports of shrimp experienced a considerable reduction in 2011 and currently the country exports the least amount of shrimp in the region.

The white leg shrimp is the most important commercial specie being captured by industrial shrimp vessels; this specie had a global export value of approximately \$25 million in 2019. However, competition for the white shrimp market is very high and dominated by aquaculture. In the region El Salvador sits as the country with the least quantity being captured and exported.

It is also important to consider the production and the capability of the industry to fulfill the market demand. For now, these factors are very difficult to assess, since the data collection system is very limited and unreliable; data collected is not verified and there seems to be no reliable assessment that gives an estimation of the TAC. All these important factors could be addressed with the development of fisheries management strategies that contemplate the objectives of increasing the profit and opening access to new markets.

5.7.2 *Standards*

Currently, El Salvador's shrimp fishery industry is certified by NOAA and the country is allowed to export shrimp to the U.S market, however, there are other requirements that are not being fulfilled for the industry and CENDEPESCA.

The NOAA-SIMP model requirements form (see Table 3) to export the product to the U.S establishes the minimum requirements to export to the U.S market, yet some of the information is not being collected by CENDEPESCA. The same happens with the European Union Regulation 1005/2008 – Catch Documentation Scheme (CDS) requirements. This could be partially worked around with the implementation of a logbook that incorporates requirements included in the referred form models. As mentioned above, while many considerations and requirements need to be considered to fulfil export to the U.S and E.U markets, it is still important to emphasize the necessity of implementing the standards that could open opportunities to access new markets.

Lastly, it is important to note that El Salvador already exports tuna to the EU, in compliance with European Union Regulation 1005/2008 – Catch Documentation Scheme (CDS), which involves a catch certification system. However, this process relies on the traceability systems of individual companies to meet the standards and international regulations, which are granted to foreign companies operating in special economic zones and are not applicable to trawl net fisheries. Nonetheless, the authorities have experience with such systems that could be applied when implementing similar measures for other markets.

6 CONCLUSION

The National Policy of Fisheries and Aquaculture of El Salvador 2015-2030, recognizes some challenges that CENDEPESCA is currently facing, but it seems that issues are wider than those considered in the policy. These specific issues are summarized here: the lack of a scale system to weigh the catches; the use of an outdated data collection system; deficiencies in monitoring, control, and surveillance activities, especially regarding landings and transshipments, and the lack of dedicated monitoring programs for stock assessment.

El Salvador currently lacks a fisheries management plan for its shrimp fishery. However, there are existing guidelines that could be utilized to develop an effective plan. These guidelines commonly emphasize the need for clear, well-defined objectives, framed around specific outcomes and measurable benefits. Additionally, the plan must include the management measures selected to achieve these objectives.

The National Fisheries and Aquaculture Policy of El Salvador emphasizes the lack of commitment of the fisherman to responsibly exercise their activity. Analyzing the gaps in the management system, co-management was found to be a tool that has been commonly used to address the majority of problems identified in the Salvadoran shrimp fisheries, such as: poor data, low credibility of data; inappropriate harvest regulations; low legitimacy of regulations; inadequate enforcement; and overfishing. However, it has been mentioned that co-management give better results when the fishermen own the fisheries, like in an ITQ system that requires the issues of a TAC. Costs associated with co-management strategies also need to be considered, especially to evaluate the effectiveness of the strategy.

Regarding catch and production, it is possible, as recommended by the research division, a reduction in the effort needs to be made. For this to be evaluated correctly; the implementation of a data collection system and program monitoring the resource needs to be implemented, and scientific recommendation needs to be a priority consideration in the development of the management strategy. To minimize the impact on the companies and owners, other fisheries could be explored, still, this approach needs to be carefully considered in the authority's strategy.

Another important consideration is the implementation of traceability systems that offer benefits such as improved supply chain quality, efficiency, transparency, security, and safety, enabling organizations to comply with regulations, combat illegal fishing, and make decisions.

In terms of accessing new markets for shrimp exports, El Salvador faces intense competition from other countries in the region, such as Ecuador and Mexico, which have well-established international markets. While El Salvador's industrial shrimp fisheries are certified by NOAA, they still lack a comprehensive management plan, a traceability system, and a stock assessment program—key requirements for entering U.S. and EU markets. These shortcomings are the primary barriers preventing El Salvador from exporting shrimp to higher-value markets.

Lastly, despite the significant effort and investment required to address the issues identified within the management system and industry operations, it is important to emphasize that these efforts, though time-consuming, will ultimately enhance the authority's efficiency and control over the resource. Moreover, it could create opportunities to access higher-value markets, translating into increased revenue for vessel owners. While careful consideration must be given to selecting the best implementation strategy, initial costs may be offset by donor-funded

projects or programs, and long-term expenses could be sustained through access fees, licensing fees, and taxes generated from the industry.

7 RECOMMENDATIONS

To CENDEPESCA:

- In the short term:
 - Develop and implement the use of a logbook for the trawl net vessels.
 - Organize and prioritize the MCS activities for the trawl net vessels, especially with regard to landings and transshipments.
 - Standardize a form for reporting the transshipments.
 - Implement a stock assessment plan for the different shrimp species.
- In the mid-long term:
- Develop a Statistical System Development Plan considering the guidelines provided by FAO and traceability standards.
- Implement a scale system in the authorized landing ports.
- Develop a Fisheries Management Plan for the shrimp fisheries with co-management arrangements with stakeholders. Any such plan must follow the guidelines proposed by FAO and should consider the National Policy of Fisheries and Aquaculture for El Salvador 2015-2030.

To the Industry:

- Improve the traceability of the product following the guidelines of the GS1 standards.
- Evaluate the current fishing technology being used.
- Evaluate the possibility of diversifying the fisheries to other species.

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10 APPENDICES

10.1 Appendix 1: Number of vessels, owners, and jurisdiction for the sampling

COMPANY/OWNER	VESSEL NAME	JURISDICTION
INDUSTRIAS DE SERVICIOS MARITIMOS SA DE CV	FAMAR IV	ACAJUTLA
	FAMAR V	ACAJUTLA
	FAMAR I	ACAJUTLA
	FAMAR II	ACAJUTLA
	FAMAR III	ACAJUTLA
EL PEZ DORADO SA DE CV	SAN AGUSTIN	LA UNION
	SANTA TERESA	LA UNION
EL PEZ DORADO SA DE CV	WILD CHILD	LA UNION
JOSE FAUSTINO SANCHEZ CRUZ	GAMBERETTO	LA UNION
	DON OMAR	LA UNION
JOSE MANUEL DEL CID UMANA	PEINE FINO	LA UNION
	EL DELFIN	LA UNION
JOSE VICTOR ROSALES FUENTES	MATAPALO II	LA UNION
	LAMATEPEC II	LA UNION
MARGARITA SANCHEZ CRUZ	OROMONTIQUE II	LA UNION
	SAN MIGUEL I	LA UNION
EDGAR ALEXANDER VENTURA SALVADOR	LIBERTAD	PUERTO BARILLAS
	DIEGO II	PUERTO BARILLAS
JAIME FLORES BENITEZ	SAN JAIME	PUERTO BARILLAS
	SAN JAIME II	PUERTO BARILLAS
MARIA VICENTA FLORES	SANTA FE	PUERTO BARILLAS
MARISCOS SANCAL SA DE CV	GABRIEL	PUERTO BARILLAS
WALTER ANTONIO PLATERO SILVA	ATOCHE	PUERTO BARILLAS
BRISAS DEL MAR SA DE CV	FLAMINGO	PUERTO EL TRIUNFO
	SAN CHAMBA	PUERTO EL TRIUNFO
CARLOS ANTONIO ALVARADO	PEPITO	PUERTO EL TRIUNFO
	SANTA ELENA	PUERTO EL TRIUNFO
EPROMAR SA DE CV	SAN LUCAS	PUERTO EL TRIUNFO
	LEON DORADO	PUERTO EL TRIUNFO
INVERSIONES AMAYA SA DE CV	SAIDITA	PUERTO EL TRIUNFO

	SKY	PUERTO EL TRIUNFO
JOSE ALEXANDER MORALES MORAN	DON ORFILIO	PUERTO EL TRIUNFO
JOSUE NOE ESTRADA REYES	SAN MARCOS	PUERTO EL TRIUNFO
LARREYNAGA MORENO SA DE CV	CESAR JUNIOR	PUERTO EL TRIUNFO
MARDOQUEO AMAYA SEGOVIA	MIS NIETOS	PUERTO EL TRIUNFO
	SANTA JULIA	PUERTO EL TRIUNFO
	DIPRO MARSÁ	PUERTO EL TRIUNFO
	SAN DIEGO	PUERTO EL TRIUNFO
	MACHO MAN	PUERTO EL TRIUNFO
MARINOS DEL GOLFO SA DE CV	SANTA SOFIA	PUERTO EL TRIUNFO
MELIDA EDITH RAMOS DE BRAN	MARIA ELENA	PUERTO EL TRIUNFO
PESCA DEL PACIFICO SA DE CV	SAN MARTIN	PUERTO EL TRIUNFO
PESDEMAR SA DE C V	PROTEO	PUERTO EL TRIUNFO
	JIQUILISCO II	PUERTO EL TRIUNFO
	SAN FELIPE I	PUERTO EL TRIUNFO
	ESTRELLA DE MAR	PUERTO EL TRIUNFO
	GAVIOTA I	PUERTO EL TRIUNFO
	GRACIAS A DIOS	PUERTO EL TRIUNFO
	ARAUSAL	PUERTO EL TRIUNFO
	AMANECER	PUERTO EL TRIUNFO
PESQUERA DEL PACIFICO SA DE CV	SAN JOSE	PUERTO EL TRIUNFO
	DON BOSCO	PUERTO EL TRIUNFO
	ISABELA III	PUERTO EL TRIUNFO
PROVEEDORES MARITIMOS DEL PACIFICO SA DE CV	USULUTAN II	PUERTO EL TRIUNFO
REPARACIONES MARITIMAS SA DE CV	CHAPARRASTIQUE	PUERTO EL TRIUNFO

10.2 Appendix 2. Guideline for authors and reviewers of qualitative studies (Malterud, 2001).

<p>Aim Is the research question a relevant issue? Is the aim sufficiently focused, and stated clearly? Does the title of the article give a clear account of the aim?</p>
<p>Reflexivity Are the researcher's motives, background, perspectives, and preliminary hypotheses presented, and is the effect of these issues sufficiently dealt with?</p>
<p>Method and design Are qualitative research methods suitable for exploration of the research question? Has the best method been chosen with respect to the research question?</p>
<p>Data collection and sampling Is the strategy for data collection clearly stated (usually purposive or theoretical, usually not random or representative)? Are the reasons for this choice stated? Has the best approach been chosen, in view of the research question? Are the consequences of the chosen strategy discussed and compared with other options? Are the characteristics of the sample presented in enough depth to understand the study site and context?</p>
<p>Theoretical framework Are the perspectives and ideas used for data interpretation presented? Is the framework adequate, in view of the aim of the study? Does the author account for the role given to the theoretical framework during analysis?</p>
<p>Analysis Are the principles and procedures for data organisation and analysis fully described, allowing the reader to understand what happened to the raw material to arrive at the results? Were the various categories identified from theory or preconceptions in advance, or were they developed from the data? Which principles were followed to organise the presentation of the findings? Are strategies used to validate results presented, such as cross-checks for rivalling explanations, member checks, or triangulation. If such strategies are not described in this section, they should appear as validity discussions later in the report.</p>
<p>Findings Are the findings relevant with respect to the aim of the study? Do they provide new insight? Is the presentation of the findings well organised and best suited to ensure that findings are drawn from systematic analysis of material, rather than from preconceptions? Are quotes used adequately to support and enrich the researcher's synopsis of the patterns identified by systematic analysis?</p>
<p>Discussion Are questions about internal validity (what the study is actually about), external validity (to what other settings the findings or notions can be applied), and reflexivity (the effects of the researcher on processes, interpretations, findings, and conclusions) addressed? Has the design been scrutinised? Are the shortcomings accounted for and discussed, without denying the responsibility of choices taken? Have the findings been compared with appropriate theoretical and empirical references? Are a few clear consequences of the study proposed?</p>
<p>Presentation Is the report easy to understand and clearly contextualised? Is it possible to distinguish between the voices of the informants and those of the researcher?</p>
<p>References Are important and specific sources in the field covered, and have they been appropriately presented and applied in the text?</p>

10.3 Appendix 3: Set of questions

QUESTIONS FOR THE CENDEPESCA

Administration and Management

- What is your personal name, institution, and office?
- How many people (inspectors, data collectors, administrators) are being involved in the industrial shrimp fishery operation?
- Which are the current management measures implemented to secure the sustainability of the resource?
- Are the current management measures supported by scientific advice or precautionary approach?
- Are there any inspections being conducted to the vessels or landing sites? If so, explain the requirements that need to be fulfilled.
- Is there a form for transshipment and landings?
- Are the transshipments at sea being inspected or monitored by CENDEPESCA fisheries officers?
- Does the inspections at sea and landing sites are being conducted under a policy framework? If so, explain briefly.
- Is there a scale system being used to weight the landings? If not, how the landings data is being collected? Are there any mechanisms implemented for catch traceability? If so how is being registered and what species are covered?
- In your opinion what aspect, situation or phenomena do you think it hinders and limit the shrimp fishery industry the most?

Vessels and fishing gears

- What information is being collected about the vessels?
- Is there information about the fishing gears being collected? If not, explain briefly.

Data collection

- What data regarding the catch is being collected? and what is the procedure to collect it and store it?
- Is the data collected following a guideline or scientific recommendations?
- How the data collected is being processed and published?
- Is the data collected being used to compare with the stock assessment?

Stock assessment

- What is the current focus of the research division and the current work plan and/or policy that guidelines the research?
- Is scientific advice being provided to the General Director for implementation of new management measures for the resource? If so, briefly explain.
- Is there a stock assessment program for the shrimp species targeted by the industrial sector? If not, briefly explain the reasoning or difficulties.
- Is there a Total Allowable Catch (TAC) issued for the industrial shrimp fishery? If so, is it based on the stock assessment?

- Is there an Individual Quota (IQ) being issued or effort system for industrial shrimp vessels?

Exports and standards

- Is the production being processed at an approved and registered fishing processing plants?
- What standards the industry fulfill to export the product to other markets?
- In your opinion in which area do you think the industry needs support from the authority to be able to access better markets?

QUESTIONS FOR THE INDUSTRIAL SHRIMP FISHERY SECTOR

Value chain

- What is your personal name, company name, vessels name and registration number?
- Can these vessels be categorized into different groups? If so; which group are we covering now?
- How many people is being employed per fishing trip as part of the fishing crew?
- What are the main target species and bycatch species with commercial value?
- What is the quantity of target species and bycatch species per trip?
- What landing sites are being used to unload the product and how often the landings are being made?
- Is there a scale system at landing sites implemented by CENDEPESCA?
- Are the transshipments at sea being done following the General Law for Promotion and Management of Fisheries and Aquaculture? If not, explain briefly.
- Are the transshipments being monitored by CENDEPESCA inspectors?
- How you register traceability of the product?
- How is the product being processed and transported?
- Does the product sell on local market or exported?
- What is the export price and the import country?
- What is the average price for shrimp at landing site species and the value of bycatch species?

Vessel and gears

- What is the vessel length and horsepower?
- What type of trawl net is being used by the vessels?
- What is the length size of the net?
- What is the mesh size?
- What is the material of the doors and the weight?
- Is there any type of fishing excluding device being used?

Inspections and management.

- Are there any inspections from CENDEPESCA being done in any of the phases of the operation?

- Are you getting inspections at sea? If so, are you explained about the procedure and about the framework of the inspection?
- Would you agree on CENDEPESCA implementing a TAC/IQ system?
- What is your personal opinion on the current management measures implemented by CENDEPESCA?
- In your personal opinion what aspect, situation or phenomena do you think it hinders and limit the shrimp fishery industry the most?

Data collection

- What data regarding the landings and catch is being collected?
- Is data from the bycatch being collected by species?
- Is any data or information about the discards being collected?
- What is the procedure to collect it and store it?
- Is the data collected provided to CENDEPESCA? If so, explain how the data is presented?

Exports and standards

- Is the production being processed at an approved and registered fishing processing plant?
- What standards the industry already fulfill to export the product to other markets?
- In your opinion in which area do you think the industry needs support from the authority to be able to access better markets?

10.4 Appendix 4. Project description and interview considerations to be provided to the participants.

Project description and interview considerations.

Rational

The industrial shrimp fishery sector is interested in improving the operation regarding traceability of the product and accommodation of facilities to process the shrimp with the objective of selling the product to better markets and increase the revenue of the activity.

The industrial shrimp fishery has been also very hard to assess in recent years mainly due to incomplete historical data, and the absent of sampling and data collection program. Current management measures implemented were established using precautionary approach with poor scientific advice recommendation. The latest surveys recommend the necessity to implement data collecting programs to improve the quality of data for stock assessment and management to improve the management system, data collection and traceability of the product that might give the industry an opportunity to access better markets and allow the CENDEPESCA to have a better understanding and control of the activity.

Purpose of the project

Describe the current state of the industrial shrimp fishery in El Salvador and compare them with reliable fisheries management systems to provide recommendation to the CENDEPESCA and the industrial shrimp fishery sector on improvements in the management of the shrimp fishery that needs to be adopted to open the possibility to access better markets. This data is not available and thus need to be recorded.

Methodology and focus group.

The data for the study will be gathered from three different sources: with interviews to key actors in the CENDEPESCA and the shrimp industry, data analysis from the Directorate of Fisheries, other relevant sources, and relevant reports from the CENDEPESCA.

The methodology and interview aspects and confidentiality were developed following international academic standards and guidelines with the purpose to collect information regarding: the management system, the quota/TAC, vessel description, fishing gears, fishing operation, landings, selling price at local market, and the data collection system and reports, such standards and guidelines that can be found in:

Brinkman, S., & Kvale, S. (2015). *InterViews, leaning the Craft of Qualitative Research interviewing*. United States of America: SAGE.

Creswell , J. W. (2009). *Research design, qualitative, quantitative and mixed methods approaches*. California: SAGE Publications, Inc.

Malterud, K. (2001). Qualitative research: standards, challenges, and guidelines. *The Lancet*, 483-488.

Malterud, K., & Guassora, A. D. (2015). Sample Size in Qualitative Interview Studies: Guided by Information Power. *Qualitative Health Research*, 7.

Ravitch, S. M., & Carl, N. M. (2021). *Qualitative Research*. United States of America: SAGE.

Confidentiality

Due to different ethical issues that can arise from qualitative methods such as interviews in which participants statements from a private interview setting may appear in public reports, precaution need to be taken to protect participants' privacy (Brinkman & Kvale, 2015).

Thus, in accordance with Ravitch & Carl (2021) one key consideration while conducting the interviews will be to keep anonymity of the participants. Therefor a study code will be used in place of the respondent's name or other identifying information. A list linking names and codes will be secured separately from interview notes and will be destroyed at the conclusion of the project.

After each interview is transcript to a word file, it will be sent via email to the participants asking for confirmation about the transcript, to confirm that the documented data is truthful to their answers.

Benefits

The collaboration of the participants is vital for the success of the study that aims to improve the management system used on the resource and gather and document important information that can be used to assess specific aspects of the operation, thus providing important advice and recommendation for both the industry and the CENDEPESCA.

10.5 Appendix 5: Interviews audio recording control

Interviews audio recordings control								
Date	Participant number	Method	Participant	Cluster	Media	File name	Time	Transcript status
2.21.2023	1	Interview	IN001	Industry	Zoom	IN001.1	36:14	Completed
2.24.2023	1	Interview	IN001	Industry	Zoom	IN001.2	25:38	Completed
2.24.2023	2	Interview	IN002	Industry	Zoom	IN002.1	40:31	Completed
2.28.2023	3	Interview	IN003	Industry	Zoom	IN003.1	37:37	Completed
3.7.2023	4	Interview	IN004	Industry	Zoom	IN004.1	31:05	Completed
3.8.2023	5	Interview	IN005	Industry	Zoom	IN005.1	36:07	Completed
3.8.2023	5	Interview	IN005	Industry	Zoom	IN005.2	29:59	Completed
3.8.2023	6	Interview	IN006	Industrty	Zoom	IN006.1	34:58	Completed
3.18.2023	7	Interview	IN007	Industrty	Zoom	IN007.1	47:26	Completed
2.21.2023	1	Interview	CP001	CENDEPESCA	Zoom	CP001.1	17:01	Completed
2.21.2023	1	Interview	CP001	CENDEPESCA	Zoom	CP001.2	21:26	Completed
2.24.2023	2	Interview	CP002	CENDEPESCA	Zoom	CP002.1	26:23	Completed
3.1.2023	3	Interview	CP003	CENDEPESCA	Zoom	CP003.1	28:23	Completed
3.2.2023	4	Interview	CP004	CENDEPESCA	Zoom	CP004.1	48:10	Completed
3.2.2023	5	Interview	CP005	CENDEPESCA	Zoom	CP005.1	13:51	Completed
3.2.2023	6	Interview	CP006	CENDEPESCA	Zoom	CP006.1	29:55	Completed
3.3.2023	7	Interview	CP007	CENDEPESCA	Zoom	CP007.1	23:37	Completed
3.3.2023	4	Interview	CP004	CENDEPESCA	Zoom	CP004.2	10:49	Completed
3.3.2023	8	Interview	CP008	CENDEPESCA	Zoom	CP008.1	30:34	Completed

10.6 Appendix 6: Information form for trip/vessel in the shrimp fishery.

MINISTERIO DE AGRICULTURA Y GANADERIA		DIRECCIÓN GENERAL DE DESARROLLO DE LA PESCA Y LA ACUICULTURA		FORMULARIO DE INFORMACIÓN POR VIAJE / BARCO EN LA PESQUERÍA DE CAMARÓN		ESTADÍSTICAS PESQUERAS	
GOBIERNO DE EL SALVADOR		MINISTERIO DE AGRICULTURA Y GANADERÍA		REPORTAR INFORMACION EN LIBRAS			
I- INFORMACIÓN GENERAL		Formulario Cam					
Nombre de la Empresa: _____		Mes del reporte: _____		Puerto: _____			
Pesquería: _____							
II- INFORMACIÓN DEL VIAJE DE PESCA		III- DESEMBARQUE		SIN CABEZA		ENTERO	
Nombre del Barco: _____	Días de Viaje _____	Blanco					
No. De Registro _____	Días de Pesca _____	Café					
Fecha de Zarpe: _____	No. De Lances _____	Rojo					
Fecha de Arriba _____	Combustible (Gls.) _____	Camaroncillo					
IV- INFORMACIÓN DE PRODUCCIÓN DE PLANTA							
CALIBRES	BLANCO		CAFÉ		ROJO		
	Sin Cabeza	Estimado	Sin Cabeza	Estimado	Sin Cabeza	Estimado	
U-7							
U-8							
U-9							
U-10							
11-15							
16-20							
21-25							
26-30							
31-35							
36-42							
43-45							
46-50							
51-60							
61-70							
71-80							
81-90							
91-100							
101-110							
111-120							
121-131							
Sin Clasificar							
Pelados							
Que. Quemados							
TOTAL							
V- INFORMACIÓN DE LA FAUNA DE ACOMPAÑAMIENTO "FAC"							
ESPECIES	SIN CABEZA	ENTERO					
Tortuga			Observaciones: _____				
Langosta			_____				
Jaiba			_____				
Otros Crustaceos			_____				
Calamar			Responsable de proporcionar la información:				
Caracol			F: _____				
Otros Moluscos			Nombre: _____				
Bonitos y Otros Atunes			Fecha: _____				
Pescado							