THE POWER
OF THE MIDELMAN:
HOW SEAFOOD TRADING SHAPES FISHER BEHAVIOR AND ITS IMPLICATION ON ECOSYSTEM HEALTH IN THE BAJA CALIFORNIA SUR REGION.

10 ANIVERSARIO CBMC
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GRANT AGREEMENT 20210405

PHASE II

Executive summary

Generating scientific knowledge on fisheries management and seafood market dynamics is critical to improving policies. In this project, we focused on understanding how the seafood trading dynamics shape fishers' behavior and identified the possible implications on the ecosystem health in Baja California Sur. We strengthened our Fisheries Monitoring Program with the foundation's support by extending our study region and sample size. Specifically, we collected information with 80 GPS trackers that monitored 866 fishing trips from June 2021 through March 2022. We built an open-source platform based on 1.4 million records of seafood prices from Mexican markets, which can become a useful tool that helps us understand how to predict and better respond to these changes in prices. The platform will have constant updates as new data becomes available (~daily), and new features will be added as it grows.

We interviewed a diverse set of stakeholders from the seafood trading network in Baja California Sur, mapped their locations, and gathered information to understand their connections. This information will help us describe the complex interactions and identify bottlenecks for conservation and management policies. For example, we identified wholesalers and cooperatives having a central position in the network; this helps understand who influences the network the most. According to our results, middlemen have the most prominent weight in the network. Some cooperatives have a dominant role with diversified connections and relationships with local and international markets. We discuss how these traits can be advantageous for fishery monitoring and management.

We also identified the critical relationships between the actors from a social and an economic point of view. We described how the informal nature of the trading network hinders data transparency and affects the social and economic well-being of the fishers themselves and discussed the potential ecological consequences of these traits.

Highlights

- Middlemen play a central role in the seafood trading network. We believe they can potentially play an important role in monitoring activities within the seafood market in Baja California Sur.
- The informal nature of the seafood trading network has profound socio-economic consequences because a lack of transparency hinders effective management, masking important issues like human rights and free-market violations.
- Informality and lack of knowledge of how markets operate at larger scales result in a revenue loss for fishers, which leads to product devaluation.
- Export to international markets is relevant for Baja California Sur, especially for some species like Huachinango. Foreign markets cause prices to rise, benefiting middlemen more than the fisher disproportionally.
- Dependency on foreign markets is also a weakness when it comes to societal shocks.
- Prices set by the fishers are not always strongly correlated to the ones set by middlemen, which can modify their price margin more easily.
- Price margins between middlemen and retailers can vary largely among species and are higher for illegally caught ones.
- Prices of all fish products increased steeply during the pandemic, but prices for the fishers increased the least.

Introduction

Fishing communities in the southern Gulf of California (GoC) are located in contiguous portions of the coast, fish roughly the same species, have similar socioeconomic characteristics, and sell to similar markets (Basurto et al., 2013), yet they face different challenges that shape the governance system under which they operate. Whether they are located in remote areas, are fishing without the necessary paperwork, operate within or near marine protected areas (MPAs), or simply are forced to depend on one person to sell their product, the reality each community and each fisher faces is relevant if we aim to improve economic and environmental sustainability.

Managing artisanal fisheries is a complex issue (Ramírez-Sánchez 2007; Basurto et al., 2013), and ineffective management can lead to environmental degradation (Sala et al., 2004), which can leave local communities vulnerable (Basurto et al., 2017). In Mexico, fisheries regulations, policies, and enforcement are directed at fishers. However, an important aspect of the fisheries economy usually ignored is the trading relationships between fishers and buyers. Middlemen operate these relationships, taking advantage of an economic system that is not well known or regulated (Pedroza et al., 2013). By understanding how artisanal fisheries are interconnected and how strong the influence of the middlemen on fishers is, we can improve fisheries management and conservation practices.

With the support received through Grant 20210405, the CBMC has been able to build upon two previous projects we have developed in Baja California Sur. The first was a research project funded by CONACyT in 2017 (Cota-Nieto et al., 2017) to characterize the seafood trade channels in Magdalena Bay. As one of the most productive regions in the state, this information was critical in helping understand how stakeholders could improve fishing activities and management.

Our findings showed where the seafood produced by fishers from the three communities in Magdalena Bay was being sent to. We were able to see which species were preferred by consumers in each of those market destinations.

The second project is our 2020 grant 20200452, which focuses on the San Basilio-Loreto region and through which we were able to describe how the seafood trading network influences fisher behavior there. Again, findings showed how seafood produced in this small region was distributed, with differences in destination based on the species.

Overall, the support provided to our team has increased our knowledge and understanding of how local trade networks are connected to larger networks that cover national and, in some cases, international scales.

Quantifying what and how much seafood is being sold to other states and exported to other countries is a challenge, but quantifying the impact traders and buyers have been critical if we wish to ensure healthy livelihoods for coastal communities dependent on fishing.

When buyers choose the distribution routes for the seafood consumers will have available, they influence the market price (what consumers pay) and, therefore, the price paid to fishers.

Knowing the seafood trade system has weak governance, unchecked and unsustainable practices may be incentivized (both in trading and fishing), leading to overfished stocks and undervalued products. Support for the second phase of our study has allowed us to create a more robust representation of the seafood trading network in Baja California, and further understand how the relationships among stakeholders influence everyone's behavior.

Objective

Given the importance fishing has in Baja California Sur, understanding fish trading middlemen's impact on artisanal fisheries will help improve fishing practices and management. We hope that mapping the complex seafood network contributes to increasing the availability of relevant information needed for resource management and conservation programs.

Methods

Monitoring programs for species and economic activities have become important to establish adaptive management that guarantees long-term sustainability. The use of technology to design innovative monitoring programs allows the integration of a variety of information and stakeholders, which increases the probability of success and adoption of such programs. The activities funded through this grant build upon our findings in Phase I and use the same methods to broaden our scope. However, we adjusted depending on the interactions and trading dynamics identified in the expanded study area.

A. Fisheries dynamics and characteristics

I. Fisheries monitoring

We have worked in different coastal communities since 2009, monitoring fishing activities, and fishers and scientists work together to generate information on fishing production, fishing effort, intensity, profits, and costs (economic valuation). Our program combines traditional monitoring methodologies with technology such as GPS data loggers to facilitate data generation and analysis. As a result, we have successfully gathered data that has made it possible to identify fishing zones, fishing intensity, priority species for conservation, and critical habitats.

Data collected through this program has made it possible to complete estimates of the economic benefits generated through several activities. This collaboration has helped build a large collection of biological, fishing, economic and ecological information, contribute to improving the management of resources in northwestern Mexico, and prompted discussions on zoning and spatial planning.

In collaboration with fishers, we generate and integrate two types of fisheries information: (a) geospatial data, generated through GPS data loggers (also called trackers) that are used during fishing trips and which includes the coordinates (latitude, longitude), speed (km/h) and duration of each fishing trip (h); and (b) socioeconomic and fisheries data recorded by fishers in their fishing logs. This data includes the target species, the total catch (kg), the price per kilogram (pesos) of their catch, fuel used (liters), the fishing gear used, and the general characteristics of the vessel (engine, length of the boat).

Both types of data are compiled in their respective databases but analyzed jointly to allow a detailed description of the fishing dynamics in each community, both spatially and in terms of productivity.

II. Seafood trade network: Interviews and access to public data

The strategy for conducting the interviews was based on exponential discriminative snowball sampling (Etikan, 2016), in which each of the interviewees provides a new potential interviewee. Based on the type of activity, we decided to interview people from three different stakeholder groups: (I) wholesalers who could describe their local and external connections; (II) cooperatives that could provide insight into their customers; and (III) retailers who could provide information on their suppliers. To ensure we had a good representation of the connections in Baja California Sur's seafood commercialization network, we made a query using the Google search engine through a web scraping process to find the businesses related to fishing and seafood sales in La Paz, Loreto, and Los Cabos. We filtered results by confirming their existence and used this final list as a reference for conducting the interviews.

We designed a questionnaire for each of the three stakeholder groups, which included the following sections:

Wholesalers: Company's characteristics, species sold & general market description, commercial relationships, infrastructure, and processing.
Cooperatives: Organization's characteristics, fisheries they target & general descriptions, alternative activities, commercial relationships, infrastructure.
Retailers: Company's characteristics, commercial relationships, species sold.

Interviews with retailers, wholesalers, and seafood markets in La Paz were conducted between November 1 to 10, 2021, by the CBMC. Interviews in Loreto were completed with the help of EcoAlianza between January and February 2022. Interviews in Loreto and Los Cabos were conducted by telephone since we were still dealing with high COVID-19 infection rates, limiting in-person activities. Municipal and state authorities were contacted to request financial information about Baja California Sur's fishing sector, including data on seafood volumes sold in municipal markets. However, it was only possible to obtain information from the municipality of La Paz, and it was not updated.

B. "Big Data" prices and market trends monitoring system of fishery products.

To monitor indicators that can inform fishery market trends in Mexico and the effect of societal stressors like pandemics, climate changes, and financial crises, we built a tool showcasing seafood prices, products, and origins in Mexico's main markets. Data was obtained through web-scraping, which automatically collects large amounts of information available on the internet to be further analyzed. This process is often called the "Big Data" strategy, where large chunks of information are obtained from the web and then made available for analysis and visualization.

From the Ministry of Economy National System of Information and Market Integration (or SNIIM for its acronym in Spanish), we obtained a database of prices of every product present in the most important fish markets in Mexico. The SNIIM is a service of the Ministry of Economy to provide information on wholesale prices of agricultural, livestock, and fishery products traded in domestic and international markets. The web scraping process allowed us to build a dataset with daily resolution since 2000, which reports the price of different species on sale in Baja California Sur (BCS) and other states where the seafood is being traded. An automated web scraper tool automatically updates the database daily and shows changes in prices for each species in an open-access dashboard.

Data was filtered first by destination and then using Baja California Sur as the product's origin to identify the markets where seafood products from B.C.S. are sold. This information complemented the network analysis (described below) by showing the main destination markets for the seafood originating from BCS.

For a complete list of the survey questions, see attachments.

C. Data Analysis

I. Fisheries monitoring

Spatial information: The data generated during each fishing trip is downloaded from the GPS tracker using the CanWayTM 1.1.12 software, allowing viewing of the route on Google Maps, thus guaranteeing the exclusion of anomalous data. Files are then exported to .csv format compatible with GIS software. Each .csv file is edited using RStudioTM 1.4.1103 software to digitize them. Spatial data routes are imported into a GIS using the ArcGISTM 10.8.1 software to transform them and calculate the distance traveled on each trip using the 'ModelBuilder' tool.

The fishing areas are identified using the movement of the panga (maneuver) or fishing task (specific for each fishery), the speed of the boat, and local empirical knowledge. Once a fishing area is identified, it is digitized by representing it as a point (centroid of a line). To estimate the area used by the fishermen for each fishery, we used the 'Directional Distribution' and the 'Aggregate Points' tools; to calculate the area of overlap between fishing areas or between fishing and other activities, we used the 'Analysis Tools' tool module.

Economic valuation of fisheries: Fisheries data is associated with its respective spatial fishing trip route through the file name (alphanumeric code). To identify the most economically important fishing areas and represent them in a map, we use the 'Kernel Density' tool in ArcGISTM 10.8.1 software. Previously, an analysis was carried out to know the catch by fishing zone's value (in pesos), which will be used as a population field. The classification method used is that of a standard deviation (as interval size) to determine the three-class ranges (high, medium, and low) in the area distributions.

II. Seafood trade network: Interviews

After the interviews were conducted, a Google forms template was developed to compile the information obtained from the surveys. This form had the same sections as the surveys, so it was possible to build the databases with the raw data, which was later cleaned and sorted to facilitate its analysis. The network analysis was performed using the Commercial Relationships section data in the surveys completed in Phases I and II. We used RStudio 2021.09.0 and the packages Tidyverse 1.3.1 for data wrangling; edgelist and Igraph 1.2.10 were used for the network analysis itself.

We plotted the network to identify the relationships between stakeholders, calculated the Degree of Centrality (number of edges each node has; the higher the degree, the more central the node is) (Golbeck, 2013); Betweenness (measures the extent the user falls on the shortest path between other nodes in the network) (Hansen et al., 2020); Closeness (how long it takes for information to spread from a given node to other nodes in the network) (Jedari et al., 2021); and Eigenvector (influence a node has on a network) (Fletcher & Wennekers, 2017).

III. "Big Data" prices and market trends

The data downloaded from the web scraping process were organized in a unique database. Data were reviewed to identify potential errors in the download process; then, we calculated historical (i.e., over the entire period) average values for each species' price to compare daily prices. We also calculated minimum and maximum everyday prices for each species and indicated the place (state) where the market and the price was recorded.

Results

A. Fisheries dynamics and characteristics

I. Fisheries monitoring

We strengthened CBMC´s fisheries monitoring program in La Paz, La Ventana Bay, Magdalena Bay, San Basilio, and La Partida Island (Figure 1). The participation of the fishing communities has been essential for the information to be disseminated and used by different users, stakeholders, and academics. Our database includes spatial, fishing, and monitoring information used to generate fishing intensity analysis, economic valuation, and fishing zones or areas used. Our methodology guarantees transparency throughout the process, from data collection to guaranteed access to the generated and analyzed information.

Results from our monitoring efforts during this project can be seen in Table I below. Our historical database of the Fishing Monitoring Program contains 95,007 records corresponding to 56,115 trips monitored with GPS trackers spanning from 2009 through March 2022. This information is available through dataMares.

Figure1. General representation of fishing areas where artisanal fishing fleets operate.

Table I. Description of the information collected from June 2021 through March 2022 for each community

COMMUNITY	#TRACKERS	#MONITORED TRIPS	#OF TARGET SPECIES	#OF SITE VISITS
MAGDALENA BAY	63	141	101	3
SAN BASILIO	7	121	29	2
LA PARTIDA ISLAND	5	254	56	3
LA VENTANA BAY	5	88	1	3

II. Seafood trade network

We were able to complete 27 interviews: 5 in Loreto (in addition to those achieved during Phase I of this project); 22 in La Paz. We identified 34 stakeholders (15 fishers and 19 middlemen) within the seafood distribution network in Loreto, La Paz, Los Cabos, and Bahia Magdalena who were divided into two major categories: fishers (person/cooperative who directly extract the products from the sea) and middlemen (person/company who trades fished products). In some cases, these major roles overlapped, i.e., cooperatives acting both as fishers and middlemen. We surveyed the cooperative both as fishers and as middlemen when this occurred. The local fish shops (pescaderías) are the final selling point in local markets, and they were categorized as retailers (Figure 3).

In La Paz, retailers in the three municipal markets were interviewed, and we were able to interview ten cooperative representatives. Independent fishers or permit holders complement possible differences in trading behavior within our sample. Major wholesaler companies in the state (5) were also interviewed.

We were able to identify 110 trade connections within B.C.S.'s seafood network, with most of these established by a long-term business relationship. We found the markets in Loreto and La Paz somewhat separated, except for one middleman connecting the two areas and a few nodes in Loreto that have customers in La Paz (Figure 4). Both markets in Loreto and La Paz have two targets: export to other states or countries (USA mainly); and local markets. There are fewer cases where cooperatives from Loreto supply La Paz and vice versa, whereas we found more actors in Los Cabos connected with both Loreto and La Paz markets.

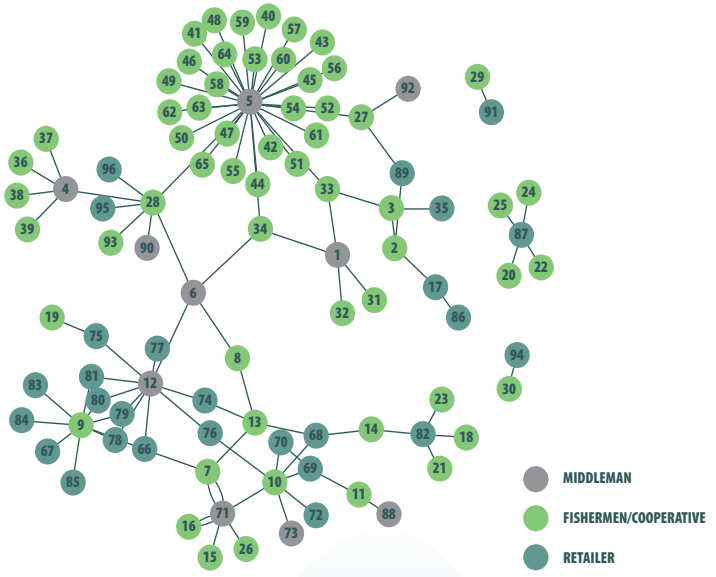

Figure 3. Stakeholder roles in the seafood distribution network.

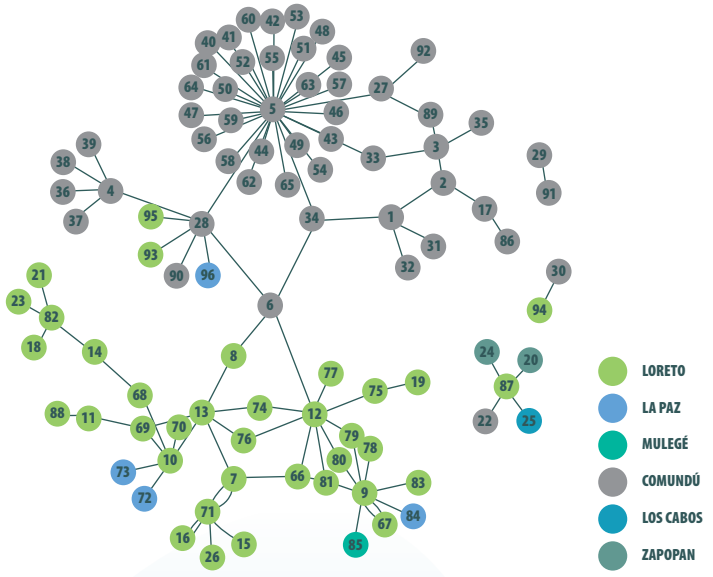

Figure 4. Stakeholder roles in the seafood distribution network and location.

While we could not survey Los Cabos due to continuous pandemic restrictions that limited fieldwork in the area, we could detect the influence this group of stakeholders has when present within the trade network. This leads us to believe that the Los Cabos area is also somewhat disconnected from Loreto and La Paz, thus supplying its local market or importing/exporting the seafood they consume.

We used the desk time at our disposal due to the travel restrictions to generate results not planned initially within this project by analyzing network relationships between the state of Baja California Sur and Mexico over time and among other markets in Mexico as preliminary analysis for further research we wish to undertake in the future. Finally, we analyzed how much prices increased because of the pandemic.

III. "Big Data" prices and market trends

We built a "Big Data" economic monitoring system through web scraping. We created a database with an estimated 1.4 million records, including product name, date (daily resolution), product's origin, price, and category (finfish, crustaceans, mollusks, fileted) spanning from the year 2000 to March 2022. We will continue to update this database daily. To validate some of the data we obtained through the internet, we surveyed local municipal markets every week to gather information on price variation.

The data reports prices of fish products from 28 states; however, some markets are better represented than others because of the sampling effort from the SNIIM operators. Markets within states that are not seafood producers are labeled as "destiny markets" and the origin of each product monitored is available in the dataset. After the pandemic, a significant price increase of several seafood products is evident in the time series.

Critical aspects of an "informal" market: how the central role of the middlemen influences the trade network.

Fishers in Baja California Sur tend to have few fixed buyers providing a reliable revenue stream but creating a complex social context. An informal market, with arrangements, transactions, and contracts established by verbal agreements, can lead to a product's devaluation where the fishers incur the economic loss. Furthermore, it is common for fishermen to ask middlemen (i.e., buyers) for loans to be able to go fishing in exchange for "in-kind" payment, which further traps them in a vicious cycle. Such a dynamic is familiar even among cooperatives themselves. Additionally, fishers may find it challenging to find alternative buyers as their product quickly devalues over time since most do not have efficient refrigeration infrastructure, thus often do not have the option of selling or offering their product to other buyers. The transactions occur with no contracts or previously agreed price for the sale. The considerable stress generated by these factors can exacerbate illegal, unreported, or unregulated fisheries.

Securing traditional contracts with specific volumes is difficult since the fisher usually wants to sell his entire catch. The middlemen decide what to buy, and there is no prior commitment to purchase the product. Middlemen are at a significant advantage once the transaction is agreed up. Protection mechanisms, education, and more transparency in price must be implemented to (i) protect fishers from potentially abusive relationships and (ii) increase fishers' ability to negotiate fair prices and working conditions.

Even with this being a predominantly informal market, it is surprisingly stable. Most of the people interviewed say they have maintained relationships for many years. In this context, particularly relevant stakeholders are large wholesale companies that handle large volumes of seafood products. The relationship between a fisher or a cooperative and a single middleman is preferred as it simplifies logistics and minimizes costs.

All databases generated through this project are available upon request to CBMC or dataMares.

Wholesalers that are exporters to other countries (mainly USA) play critical roles within the network and are very influential. These wholesalers have great purchasing power since all the local middlemen and some cooperatives are connected to them because of their capacity to handle large volumes and place them in seafood markets in Tijuana or in the United States. This group of stakeholders can do this because they have the necessary infrastructure to transport the seafood. They are the final middleman within Mexican territory, and some are connected to beyond Mexico.

Setting the price

Negotiating a price is a collaborative exercise in which several factors come into play. These factors are logical assumptions like profit margins, perceived product quality, and supply and demand. Others are personal or societal factors like trust, personal relationships, long-term business relationships, etc. There is no formal reference point in B.C.S.'s seafood trading network to set prices for each product, except for some species destined for export. Interviewees explained that the price is set by fishers and middlemen bargaining a price that benefits them all with a fair margin of profit is set.

Some members of large cooperatives and middlemen mentioned they set a price they know won't create conflicts with other stakeholders. They also explained how they consider the targeted consumer and try to keep competitive prices compared to other proteins available like beef and chicken. In B.C.S., it is still a cheaper source of protein, and fishing is an important livelihood for many communities, both in rural and urban areas.

Finally, most of the fishers and middlemen interviewed mentioned that prices rarely change, with prices to consumers increasing only on important holidays like Christmas and Easter. Understanding how fish products are (or should be) evaluated is critical, as product devaluation can have unforeseen ecological consequences as species can be targeted because of their market price, prompting fishers to increase fishing efforts to generate larger catch volumes without considering that the supply (i.e., target species) is a limited resource.

The seafood markets network in Baja California Sur and beyond

We were able to identify where seafood products from Baja California Sur are going in Mexico by coupling our surveys data with the databases gathered through the webscraping process. Seafood from BCS reaches 12 states: Jalisco, Sinaloa, Nuevo León, Baja California, Michoacán, Guanajuato Querétaro, Estado de México, Puebla, Chiapas, Oaxaca, Ciudad de México (Figure 2). La Nueva Viga in Mexico City, is the largest seafood market in all of Mexico so it is no surprise that seafood from BCS consistently appears, followed by Zapopan in Jalisco, and Monterrey in Nuevo León.

Figure 2. Map of states where seafood from Baja California Sur is sold.

However, B.C.S.'s seafood has not been consistently sent to these markets over time, and the number of destination markets has decreased, with only La Nueva Viga remaining a constant destination (Figure 6). Data after 2020 have been affected by the pandemic, which influenced sampling efforts, but the sampling effort remained consistent throughout the other years, which validates the robustness of the data.

Some interviewees also mentioned these market trends and described how most of the product currently leaves the country for the United States, especially finfish (e.g., Huachinango) through Tijuana. The products also highlight the geographical shift, where finfish are decreasing in Mexican markets as mollusks (Almejas) increase. Crustaceans show a similar pattern, with most products going to foreign markets where profits are more significant (Figure 7).

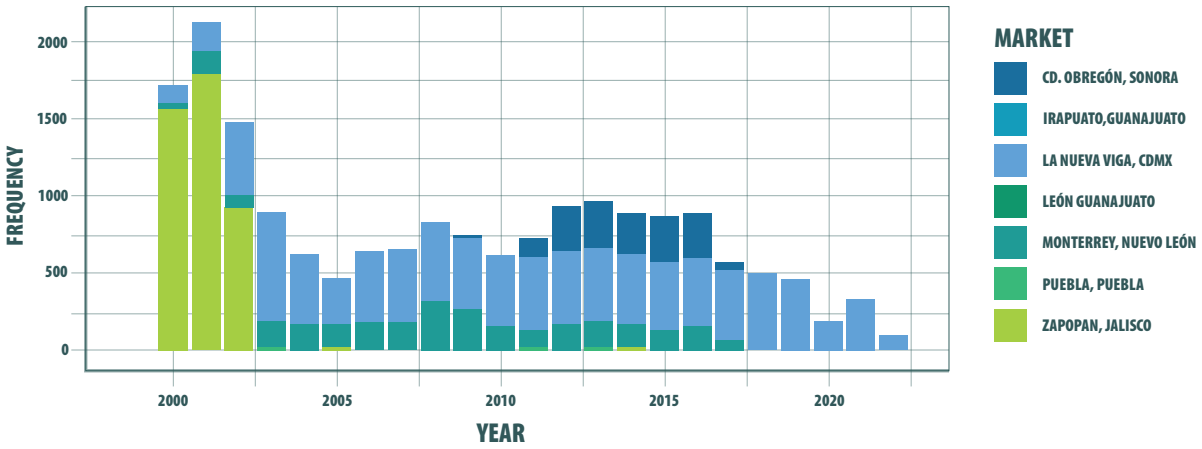

Figure 6. Frequency of a fishery product from B.C.S. appearing in markets in different Mexican states.

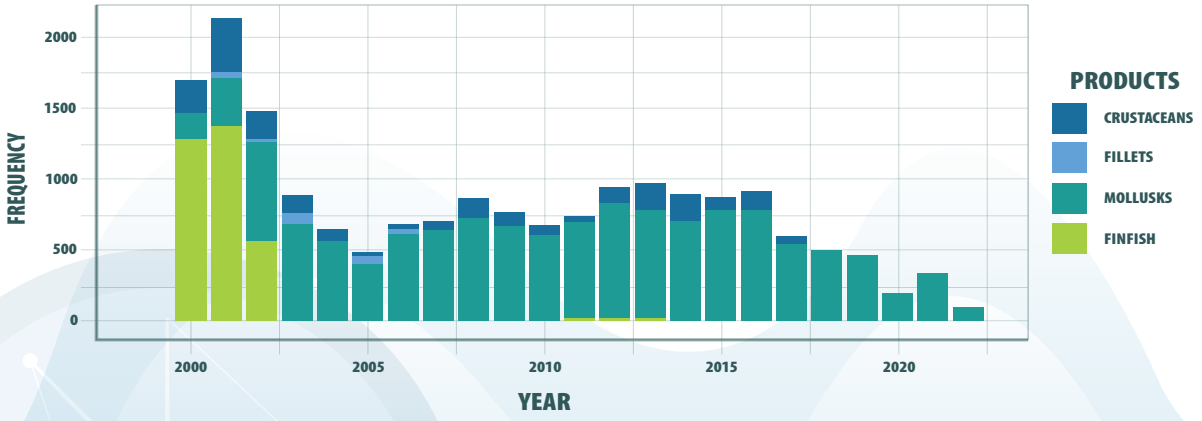

Figure 7. Frequency of product from B.C.S. appearing in markets in different Mexican states

Conclusions

• In Baja California Sur's seafood network, wholesalers carry the most significant weight because they have many connections to other stakeholders in the network.

• Some stakeholders play multiple roles, switching from producers (fishers) to middlemen (a cooperative buying from other cooperatives or individuals), which may allow them to diversify the relationships they have and increase the number of connections within the network.

• In general, fishing cooperatives tend to have few buyers that provide a steady income and result in delicate and complex social structures.

• Aligning exporters to participate in fisheries management is one of the biggest challenges. With demand for export products remaining high and constant, buyers' price for these species is very attractive to fishers, which may increase fishing efforts directed to these species and jeopardize the population's health.

•Fishers genuinely are interested in managing their resources sustainably. However, not everyone is aligned with this idea, especially when market prices incentivize illegal and unreported fishing.

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