Social Sciences & Humanities Open 10 (2024) 100970

Contents lists available at ScienceDirect

Social Sciences & Humanities Open

journal homepage: www.sciencedirect.com/journal/social-sciences-and-humanities-open

Regular Article

Elasmobranchs small-scale fishery in Guatemala: Socioeconomic aspects and value chain structure

María de los Angeles Rosales-Melgar [a,**], Omar Santana-Morales [a,b], Marian Rodríguez-Fuentes [c], José Alberto Zepeda-Domínguez [d], Juan Carlos Pérez-Jiménez [a,e,*], Elisa Areano-Barillas [a]

[a] Fundación Mundo Azul, Boulevard Rafael Landívar 10-05 Paseo Cayalá, Zona 16, Edificio D1, Oficina 202, Guatemala
[b] Ecología Cielo, Mar y Tierra AC, Ensenada, Baja California, Mexico
[c] Instituto Politécnico Nacional – Centro Interdisciplinario de Ciencias Marinas, Av. IPN S/N Col. Playa Palo Santa Rita, 23096, La Paz, Baja California Sur, Mexico
[d] Universidad Autónoma de Baja California, Facultad de Ciencias Marinas, Carretera Transpeninsular Ensenada, Tijuana No. 3917, Colonia Playitas, C.P. 22860, Ensenada, Baja California, Mexico
[e] El Colegio de la Frontera Sur, Av. Rancho Polígono 2-A, Ciudad Industrial, CP. 24500, Lerma, Campeche, Mexico

ARTICLE INFO

Keywords:
Socioeconomic activities
Sharks and rays
Small-scale fisheries
Fishing management
Central America

ABSTRACT

Small-scale fishing (SSF) stands as a cornerstone of economic activity along Guatemala's coastlines. Fisheries products, including those derived from elasmobranchs, serve as vital sources of income for fishers and dealers. Despite their significance, there remains a paucity of economically characterizing information regarding this fishery. This study provides an overview of the socioeconomic facets and value chain of Guatemala's small-scale elasmobranch fishery, and the country's role in the international market for elasmobranchs listed in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Data were collected through surveys involving fishing actors from 10 coastal communities in the Caribbean and Pacific, and 32 fishing distribution centers and traditional markets across eight departments in Guatemala. CITES statistics were analyzed to assess the country's role in the international market. Fishers cited fishing as their primary source of employment, with an average tenure of 24 years in the activity. The study found that 25% of fishing actors economically depend on elasmobranchs, while 65% indicated that their income relies on finfish, shrimp, and lobster. The value chain was identified to encompass various actors and processes, spanning from capture and distribution (intermediaries) to marketing and retail sites. The average price increase of elasmobranchs along the value chain was USD 1.66/kg, with the highest increase observed for dried salted sharks (USD 2.65/kg) and the lowest for fresh rays (USD 1.12/kg). Guatemala accounts for 2.76% of CITES species exports from Central American countries, exporting skins (55 tons), fins (47.5 tons), and live specimens (1.9 tons) of *Carcharhinus falciformis* and *Alopias pelagicus* between 2018 and 2022, while also being the primary meat importer (65.1 tons), representing 99.78% of total imports in Central America. This suggests that sharks caught in Guatemala do not adequately meet the national demand for shark meat and that special attention is needed to avoid a potential increase in fishing pressure on elasmobranchs.

1. Introduction

Historically, sharks have not been a high priority for commercial exploitation compared to other fishing resources due to their lower economic value in most countries (Jacques, 2010; Stevens et al., 2000). However, they have been important target or by-catch species for their meat, fins, and liver oil since the 1970s (Ellis et al., 2008). In addition, improvements in fishing technology, processing, consumer marketing, expanding human populations, and declining other fish stocks increased the shark's market value (Barbos-Filho et al., 2019).

At the beginning of the twenty-first century, there was a growing concern about the impact of fisheries on elasmobranch populations (Jacques, 2010; Stevens et al., 2000). Elasmobranchs have a K-type life history strategy due to their slow growth rates, low fecundity, and late maturation, requiring careful management to avoid overfishing (Stevens, 1999) since their strategy makes it difficult for their populations to

* Corresponding author. El Colegio de la Frontera Sur, Av. Rancho Polígono 2-A, Ciudad Industrial, CP. 24500, Lerma, Campeche, Mexico.
** Corresponding author.
E-mail addresses: mrosales@fundacionmundoazul.com (M.A. Rosales-Melgar), jcperez@ecosur.mx (J.C. Pérez-Jiménez).

https://doi.org/10.1016/j.ssaho.2024.100970
Received 19 October 2023; Received in revised form 28 May 2024; Accepted 29 May 2024
Available online 7 June 2024

withstand fishing pressure (Castro et al., 1999; Lewison et al., 2004). Dulvy et al. (2021) recently estimated that more than one third (37.5%) of chondrichthyans are threatened, being fishing the main threat.

Increasing concern about the status of chondrichthyans has driven to the protection of threatened species through enacted national and international measures (Organización del Sector Pesquero y Acuícola del Istmo Centroamericano, 2011; Ministerio de AgriculturaGanadería y Alimentación, 2021). For example, in 2008, Guatemala developed its first National Plan of Action (NPOA-Guatemala) to conserve and manage chondrichthyans, recognizing that their fishing has gained social and economic importance (Unidad de Manejo de Pesca y Acuicultura del Ministerio de AgriculturaGanadería y Alimentación, 2008). Also, 153 elasmobranch species are listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora, CITES (2022), for which landings and trade data are required for its implementation.

Small-scale fisheries on Guatemala's Pacific and Caribbean coasts represent one of the few economic activities that generate jobs and provide food to coastal communities. Small-scale fisheries operate using small outboard motored boats of 6–7 m in length. Fishing that targets or by-catch elasmobranch species on both coasts employs longlines and gill nets as the main fishing gears. The main elasmobranch species subject to fishing include the silky shark (*Carcharhinus falciformis*), the scalloped hammerhead shark (*Sphyrna lewini*), and rays of the genus *Hypanus* (Hacohen-Domené et al., 2020; Avalos-Castillo & Santana-Morales, 2021). However, annual catch landings by species are unknown due to the lack of elasmobranch fishing regulations. There is only the report of global shark catches, which varied between 90.7 and 408 tons in 2002–2015 (Food and Agriculture Organization, 2018).

Additionally, although the General Fisheries and Aquaculture Law determines the procedures and requirements for obtaining licenses and permits for fishing, in Guatemala the number of fishers, boasts, and fishing effort are unknown. However, it has been estimated that the number of small-scale fishers is around 20,000, of which approximately 70% operate in the Pacific Ocean, where the highest catches occur (Food and Agriculture Organization, 2018). Lindop et al. (2015) estimated a catch range of 24,721–54,896 tons in the 2000–2010 period, and FAO reported 10,000–38,000 tons in the same period (Food and Agriculture Organization, 2018), indicating a high uncertainty in the landing official records. The lack of certainty in this information affects the production of pertinent official data concerning socio-demographic aspects and the fisheries value chain in Guatemala.

This study aimed to characterize socioeconomic aspects, the value chain of small-scale fisheries catching elasmobranchs in Guatemala, and the country's role in the international trade of elasmobranch species listed in CITES.

2. Materials and methods

2.1. Study area

Guatemala is a country in Central America, bordering the Caribbean Sea between Belize and Honduras, with 148 km of coastline, and the Northern Pacific Ocean between Mexico and El Salvador, with 254 km of coastline (Ramírez Yela & Ortiz, 2019; Hacohen-Domené et al., 2020). This study was carried out in ten fishing communities on both coastlines of Guatemala. The communities studied on the Pacific coast were El Jiote, Las Lisas, and Sipacate, and on the Caribbean coast were El Quetzalito, Santa Maria del Mar, Livingston, Buena Vista, Barra Cocoli, San Juan, and Barra Sarstun.

On the Pacific coast, the El Jiote is located in the municipality of Pasaco, department of Jutiapa; it is part of the Las Lisas-La Barrona marine-coastal wetland, dominated by mangrove forests and estuarine formations. Las Lisas is part of the wetland located in the municipality of Chiquimulilla, department of Santa Rosa. Agricultural, tourist, and fishing activities are carried out in both communities. Finally, Sipacate is located in the department of Escuintla, within the Sipacate-Naranjo National Park, where commercial and subsistence fishing activities occur. The park is 20 km long and 1 km wide, with mangrove forests, lagoons, and beaches (CONAP & PNUD, 2017).

On the Caribbean coast, El Quetzalito is located in the municipality of Puerto Barrios, Department of Izabal, within the Punta de Manabique Wildlife Refuge, in the area known as Barra Motagua (Hacohen-Domené et al., 2020). The main economic activities in the area are fishing and agriculture. Santa María del Mar is located in Puerto Barrios, Izabal, and its main economic activity is fishing. The communities of Buena Vista, Barra Cocoli, San Juan, and Barra Sarstun belong to the municipality of Livingston, Izabal, and are part of the Rio Sarstun Multiple Use Area (Fig. 1).

In addition, the study considered 32 fishing distribution centers and traditional markets distributed across eight departments in Guatemala: Izabal, Zacapa, Chiquimula, Jalapa, Guatemala, Chimaltenango, Sololá, and Quetzaltenango, where products of elasmobranchs are marketed.

2.2. Data collection

Two types of surveys were conducted; the first focused on actors linked to the catching process (boat owners, captains, assistants, fishers); the second was conducted among actors involved in the value chain (fishers, intermediaries, merchants, and retailers) (Supplementary material). Informed consent was obtained from all study interviewees. For the estimation of the role of Guatemala in the international market of CITES species, the CITES statistics were analyzed (Full CITES Trade Database download available (version 2023.1); CITES Secretariat and UNEP-WCMC, 2022).

2.2.1. Surveys to fishing actors participating in the catching process

In November and December 2021, semi-structured in-person surveys were conducted to obtain qualitative and quantitative information according to the methodology proposed by Bernard (2017) on the socioeconomic aspects of the fishing actors involved in the small-scale fisheries of elasmobranchs. These fishing actors were classified as boat owners (also dedicated to fishing), boat captains, and assistant to fishers. It is important to highlight that elasmobranchs are mostly a component of the by-catch in the surveyed communities; this has been documented by Avalos-Castillo and Santana-Morales (2021) and Hacohen-Domené et al. (2020).

The survey covered socioeconomic and demographic aspects, and characteristics of small-scale fisheries. Before using the information-gathering tool, the purpose of the survey was explained to the participants. During the fieldwork, 242 surveys were applied to fishing actors from ten fishing communities, three on the Pacific coast and seven on the Caribbean coast.

The fishing communities included in this study were selected based on their fishing activities and the dynamics of the fishing fleets. These communities were deemed to have continuous fishing activities throughout the year, recording elasmobranchs in their catches. The fishing actors who participated in the surveys were volunteers and did not receive incentives for participating. Individual surveys were held in places convenient for fishing actors, following the methods proposed by Piovano et al. (2012).

2.2.2. Surveys to fishing actors regarding the value chain

From February to May 2022, 65 semi-structured interviews were conducted, according to the methodology proposed by Adams (2015), with fishing actors involved in the elasmobranch fishery value chain, including fishers, intermediaries, merchants, and retailers. Qualitative information was collected, including species caught, preservation methods, presentation types, characteristics of the fishing activity, and commercial relationships. The approach used for the value chain structure was following Rosales et al. (2017), who describe a value chain analysis for small-scale fisheries.

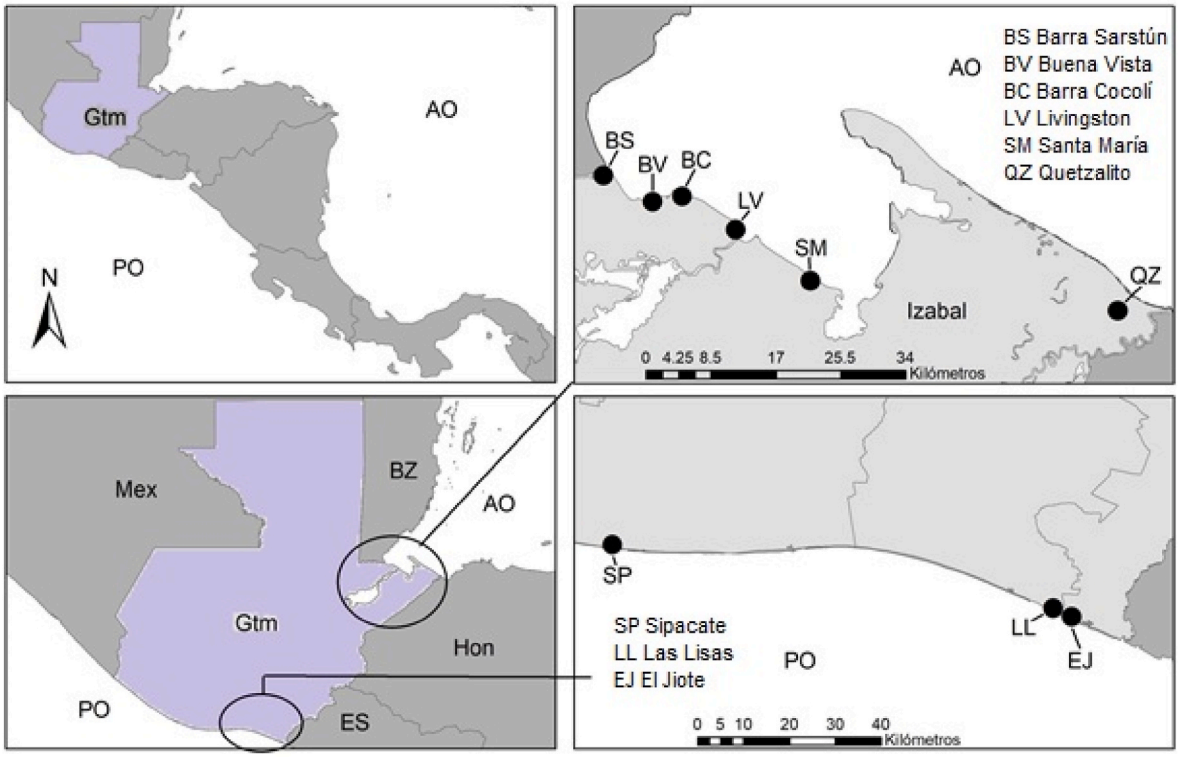

Fig. 1. Map of the study area showing the three communities in the Pacific and seven in the Caribbean of Guatemala.

The survey began with fishers, who represented the first link in the value chain of fishery products, followed by intermediaries from the same community or other communities; this method was followed on both coasts. For example, fishers from El Quetzalito, in the Caribbean, were chosen based on the presence of elasmobranchs in their catches throughout the year, except in the close season from May to August for sharks and from July to September 15 for rays (Ministerial Agreement No. 90-2023); there is not a closed season for elasmobranchs in the Pacific coast. Later, the surveys moved to the intermediaries of Puerto Barrios in the Izabal Department, as intermediaries represent the second link in the value chain. Afterward, surveys were applied to merchants, mainly from Guatemala City, where the demand for seafood products is the highest in the country. Finally, the market locations of seafood retailers were selected based on the survey results with fishers and intermediaries. Surveys were conducted in 32 markets in eight departments where intermediaries distribute fishing products. These surveys determined which marketing channels are used for the products extracted from Guatemala's Caribbean and Pacific coasts. The fishers and intermediaries to be surveyed were selected by Blue World Foundation staff, since the staff has interacted with them during many years of collecting data in fishing ports. The merchants and retailers were selected by visiting the seafood markets. Additional intermediaries, merchants, and retailers were selected using the snowball sampling method following Goodman (1961).

2.3. Data handling and analysis

Data confidentiality and anonymity of each participant were assured by omitting each respondent's name and contact information. The ethical and technical details described by Fontana and Frey (2005) and Prell (2012) were followed for the survey design, calibration, and application. Both surveys were face-to-face and no longer than 45 min, and the instrument formats were structured to ensure that most responses could be analyzed. Once the surveys were conducted, all information was digitized in Microsoft Excel for analysis.

3. Results

3.1. Socio-demographic characteristics

The average age of the fishing actors (N = 242) involved in the small-scale fishing of elasmobranch is 44 years (men: 17–78 years; women: 29–67 years). The families of these actors are usually nuclear (e.i., mother, father, and kids) and are composed of an average of five people. Additionally, 36% responded that they cohabitated with their partners without being married, while 34% were legally married, and 28% were single. Overall, 76% are primarily responsible for the economic contributions to their families; fishing is their primary source of employment (56%), and agriculture and livestock are secondary activities (42%); two percent did not answer. On average, the fishers have spent 24 years fishing.

Regarding housing, 75% owned their houses, and solid materials (i.e., concrete blocks, cement floors, metal sheets) were the most common. Approximately 54% have cement floors, while 19% have earthen or wooden floors. In addition, 69% responded that the walls are built mainly with concrete blocks. Finally, 64% of respondents had tin roofs, although wood, cement, concrete, and palm fronds were also used.

Most fishing actors have essential services such as electricity (88%), freshwater (93%), and drainage (50%) (Table 1). However, only 50% of homes have drainage connected to a public network, and the other 50% discharge its sewage water directly into the sea, coastal areas, or septic tanks. Most of them have different durable consumer goods such as televisions (79%), stoves (23%), and washing machines (8%), and also have electronic devices such as computers (50%) or cell phones (80%). As a result of the COVID-19 pandemic, the use of cell phones increased to maintain contact with intermediaries and for children to participate in online classes. Only 23% have passed a primary school, 27% have at least one approved primary grade, and 16% have no studies.

Table 1
Summary of socio-demographic characteristics of the fishing actors of the Pacific and Caribbean coasts of Guatemala (n = 242).

Characteristics	Categories	Respondents (N)	Percentage (%)
Ages (Year)	<27	46	19
	27–47	118	49
	47–67	68	28
	>67	10	4
Sex	Men	225	93
	Women	17	7
Marital status	Single	68	28
	Cohabitating	87	36
	Married	82	34
	Divorced	5	2
Educational status	Illiterate	39	16
	Primary level	136	56
	Secondary level	65	27
	University	2	1
House structure	Cement floor	131	54
	Concrete block walls	167	69
	Tin roof	155	64
Electricity facilities	Yes	213	88
	No	29	12
Freshwater facility	Yes	225	93
	No	17	7
Electronic devices	Computer	121	50
	Cell phone	194	80
Internet service	Yes	123	51
	No	119	49

3.2. Socioeconomic and fishery characteristics

Elasmobranchs fishing off the coasts of Guatemala is conducted mainly by small-scale fishers and occurs mainly incidentally. The fiberglass fishing vessels used for small-scale elasmobranch fishing vary in length from 8 to 10 m and are powered by outboard motors (40–75 Hp). These vessels are crewed by 2–3 fishers, who make between 4 and 5 fishing trips per week. Longlines (surface and bottom set) constitute the most used fishing gear in targeted elasmobranch fishing, while incidentally caught sharks are mainly caught with gillnets.

Fishing activities along the Pacific coast involve night operations lasting for 12 h. Surface longlines are used as fishing gear, with four to 8 km of the main line made of polyethylene with 400–500 hooks. Previously, the "eagle claw" hook was used, but more recently, circle hooks (#13-16) are used, with skipjack tuna (*Katsuwonus pelamis*) as the most common bait for this fishery. By-catch of elasmobranchs in finfish fishing is also recognized, which uses trammel nets to catch them. Additionally, there is by-catch of other pelagic species, such as marlin (Istiophoridae), swordfish (*Xiphias gladius*), tuna of the genus *Thunnus* spp., and sailfish (*Istiophorus platypterus*).

On the Caribbean coast of Guatemala, shark capture is carried out with mid-water longlines and gillnets placed at depths up to 100 m deep. Ray fishing is carried out mainly with bottom longlines as part of a multi-specific fishery targeting demersal finfish such as catfish (*Arius* spp.) and snappers (*Lutjanus* spp.), commonly using tarpon fish (*Megalops atlanticus*) as bait. The fishery of rays is carried out mainly in the community of Livingston and, to a lesser extent, in the communities of Santa Maria del Mar and Barra Cocoli. The by-catch of elasmobranchs is carried out mainly during the shrimp fishery using trawl nets and in the target fishery for finfish using gillnets.

The average operational costs reported for the small-scale fisheries of Guatemala's Pacific and Caribbean coasts was USD 82.00/fishing trip, including, in order of importance, gasoline, engine oil, food, bait, and ice. Engine fuel accounts for approximately 68% of the operating costs for this activity, and food accounts for 14%. This trend remains consistent between the dry and rainy seasons. In addition, the fishers' income from selling their products covers primarily operational costs, while the remainder supports their families. The average income by crew members was USD 75.00/fishing trip in the high season (i.e., Lent) and USD 18.00/fishing trip in the low season. Approximately 84% of respondents said they had no fishing-related debts, whereas 14% of fishers said they had. Finally, it was recorded that shark catches are more profitable than ray catches based on the sale prices for meat (Table 2); however, in some communities, rays have higher importance, such as in Santa María del Mar in the Caribbean Sea and Sipacate in the Pacific.

According to the surveys, 93% of interviewees were men, and only 7% were women. Although both men and women participate in all fishing activities, men show the most significant participation in the activities of capture (74%) and administration of earnings after the fishing product is sold (57%). Moreover, women participated more in product cleaning and processing (21%), followed by commercialization (17%).

Women on both coasts of Guatemala conduct processing activities, such as cleaning fishing products. On the Pacific coast of Guatemala, the amount paid to men and women per 100 kg of eviscerated product is USD 3.20, whereas, in the Caribbean, this amount ranges from USD 6.50 to 13.00. Women engaged in the sale of fishery products are hired by business owners and paid daily, weekly, or monthly. Women and men who work Monday through Sunday from 7:00 a.m. to 4:00 p.m. earn an average of USD 9.60 daily. On the Pacific coast, women (mainly youth) clean fishing boats and receive an average payment of USD 4.50 per boat.

3.3. Value chain in small-scale fisheries

Twenty-five percent of fishers indicated they depend on elasmobranch fishing to generate economic income. In addition, 65% of fishers indicated that their income depends on other fishing products such as finfish, shrimp, and lobster. From the information collected through the surveys, we identified the dynamics of the elasmobranch trade and the structure of the value chain. Trade of fishing products in Guatemala occurs throughout the year. However, Lent season is the period where the highest profits are obtained. As a result, fishers operate continuously from October to March, attempting to catch as much as possible to sell the fishing products at the best price. After Lent, prices drop, varying according to the species' abundance and the demand for fishing products.

The structure of the elasmobranch value chain from the Caribbean coast is described as an example. The value chain comprises different stages: extraction by fishers, purchase by intermediaries, distribution by merchants, and sales by local retailers. For example, although fishers sell fishing products to different intermediaries, intermediaries distribute them to merchants of different cities, and merchants distribute them to retailers of the same or other cities (Fig. 2). Moreover, the linkage among actors, as depicted in Fig. 2, varies depending on the season and the abundance of the fishing product.

The initial link involves fishers, who are tasked with extracting fishing products. The subsequent link involves intermediaries, whose

Table 2
Average price (USD/kg) paid by intermediaries to fishers by forms of preservation and presentation of fishery products of Guatemala.

Product	Preservation/presentation	Average price (USD/kg)
Elasmobranchs		
Shark	Fresh/Fillet	0.88
Shark	Dried Salted/Fillet	0.59
Ray	Fresh/Fillet	0.29
Ray	Dried Salted/Fillet	0.41
Finfish		
Snook	Fresh	1.18
Snappers	Fresh	0.82
Red snapper	Fresh	0.35
Crustaceans		
Lobster	Fresh	2.65
Shrimp	Fresh	2.65

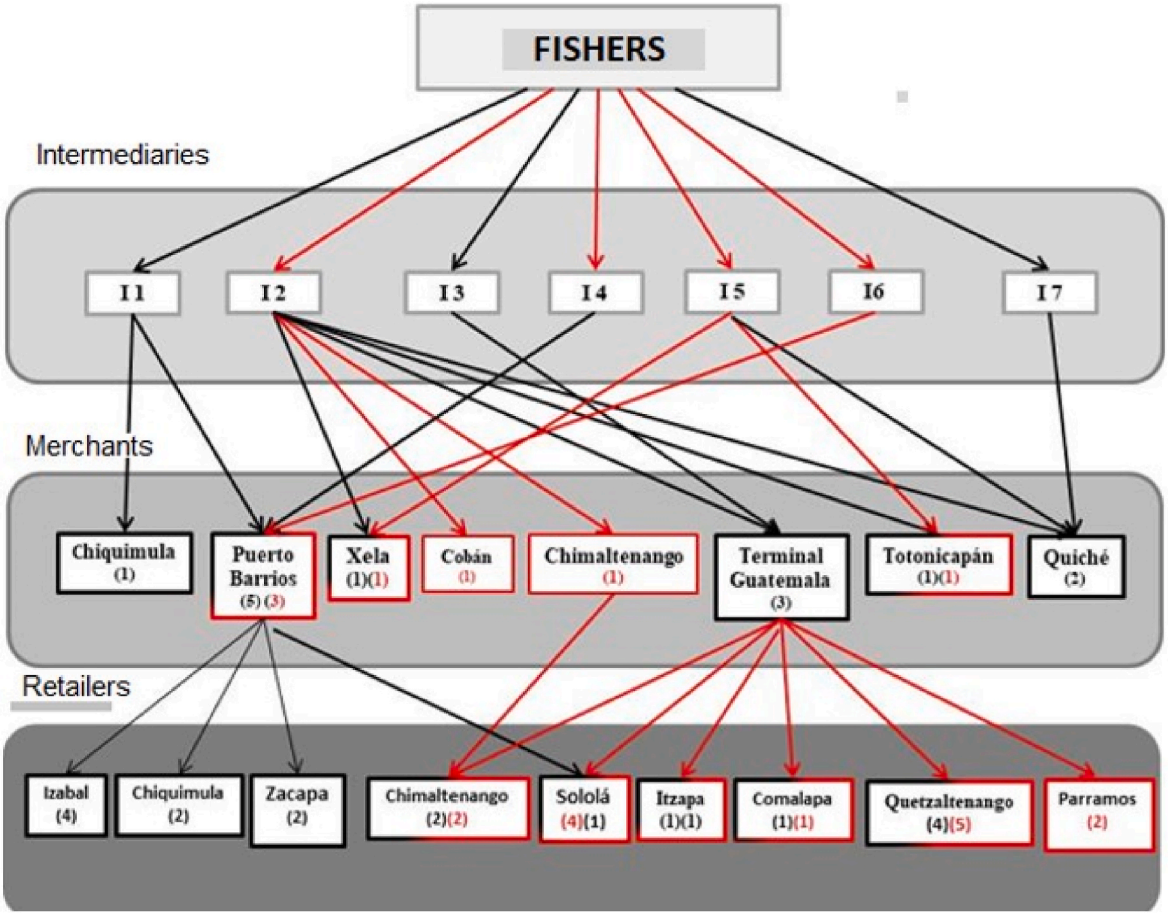

Fig. 2. Structural model of the value chain and marketing of the Guatemalan Caribbean small-scale fisheries. The different stages identified from the interviews are represented by capture (fishers), purchase (intermediaries), distribution (merchants), and sales (local retailers). Actors and connections comprise the value chain of elasmobranch fishery (highlighted in red) and finfish (highlighted in black). The numbers for intermediaries (in rectangles) corresponded to the survey number, and the number in parentheses for merchants and retailers denotes the count of identified actors in each category. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

primary role is to transport the fishing products. These intermediaries possess extensive knowledge of both the market and fishing communities, and they are responsible for identifying locations with abundant fishing products to fulfill the demands of buyers and traders. The third link comprises merchants, who maintain commercial relationships with customers. The final link encompasses retailers, who sell and market the fishing products in small quantities to consumers at affordable prices. While a similar structure is observed on the Pacific coast, it is less intricate due to the proximity to Guatemala City, the primary hub for seafood demand in the country. However, the limited number of communities surveyed from the Pacific coast in this study restricts a more comprehensive description.

Intermediaries paid fishers less than USD 1/kg for shark meat and less than USD 0.5/kg for ray meat. Crustaceans and certain finfish, such as snook, commanded higher prices (Table 2). Prices for sharks and rays increased when intermediaries sold them to retailers. Notably, dried salted shark fillets fetched the highest price at USD 1.47/kg compared to other finfish species (Table 3). In seafood markets, prices for sharks and rays experienced a substantial increase, with dried salted shark fillets commanding the highest price at USD 3.24/kg and fresh shark fillets the lowest at USD 2.06/kg. Furthermore, dried salted shark fillets maintained the highest price at USD 3.24/kg compared to finfish and mollusks (Table 4). On average, intermediaries paid fishers USD 0.54/kg for sharks and rays, with retailers paying intermediaries an average of USD 0.89/kg (reflecting a USD 0.35/kg increase), and seafood markets selling them at USD 2.2/kg (reflecting a USD 1.31/kg increase). Overall, elasmobranch prices increased by USD 1.66/kg, with dried salted sharks experiencing the highest increase at USD 2.65/kg and fresh rays the lowest at USD 1.12/kg (Table 5 and Fig. 3).

Table 3
Average price (USD/kg) paid by retailers to intermediaries by forms of preservation and presentation of fishery products of Guatemala.

Fishery product	Preservation/presentation	Average price (USD/kg)
Elasmobranchs		
Shark	Fresh/Fillet	1.06
Shark	Dried Salted/Fillet	1.47
Ray	Fresh/Fillet	0.47
Ray	Dried Salted/Fillet	0.59
Finfish		
Snook	Fresh	1.29
Snappers	Fresh	0.94
Mackerel	Fresh	0.35
Mackerel	Dried Salted	1.47
Grouper	Fresh	0.35
Cubera snapper	Fresh	0.35
Catfish	Dried Salted	1.41
Corvina	Dried Salted	0.41
Sardine	Dried Salted	0.43
Mojarra	Fresh Frozen	0.71
Crustaceans		
Lobster	Frozen	3.24

Table 4
Average price (USD/kg) by forms of preservation and presentation of fishery products marketed in the main seafood markets of Guatemala.

Fishery product	Preservation/presentation	Average price (USD/kg)
Elasmobranchs		
Shark	Fresh/Fillet	2.06
Shark	Dried Salted/Fillet	3.24
Ray	Fresh/Fillet	1.41
Ray	Dried Salted/Fillet	2.1
Finfish		
Snook	Fresh	2.59
Snapper	Fresh	1.47
Mackerel	Fresh	1.12
Catfish	Fresh	1.18
Corvina	Fresh	2.36
Mojarra	Fresh	1.18
Crustaceans		
Lobster	Fresh	5.01
Shrimp	Fresh	2.36
Shrimp	Fresh/Jumbo	3.54
Crab	Fresh	1.97
Mollusks		
Octopus	Fresh	1.88
Squid	Fresh	1.00

Table 5
Price change (USD/kg) of elasmobranch products through the value chain.

Product	Fishers to intermediaries	Intermediaries to retailers	Seafood markets	Total increase
Shark (fresh)	0.88	1.06 (+0.18)	2.06 (+1.0)	1.18
Shark (dried salted)	0.59	1.47 (+0.88)	3.24 (+1.77)	2.65
Ray (fresh)	0.29	0.47 (+0.18)	1.41 (+0.94)	1.12
Ray (dried salted)	0.41	0.59 (+0.18)	2.1 (+1.51)	1.69
Average	0.54	0.89 (+0.35)	2.2 (+1.31)	1.66

3.4. The role of Guatemalan in the international market of elasmobranchs

Among Central American countries, Guatemala accounts for 2.76% of CITES species exports, totaling 104.5 tons, which include skins (55 tons), fins (47.5 tons), and live specimens (1.9 tons) of *Carcharhinus falciformis* and *Alopias pelagicus* between 2018 and 2022. The combined global exports from Central American countries from 2014 to 2022 amount to 3781.6 tons, primarily consisting of species from the families Carcharhinidae (96.4%), Alopiidae (2%), Lamnidae (0.84%), and Sphyrnidae (0.77%), along with 244 specimens or pieces from the families Sphyrnidae (N = 170), Potamotrygonidae (N = 40), Myliobatidae (N = 20), and Pristidae (N = 14). Costa Rica leads in exports with 90.5% (3424 tons), followed by El Salvador with 4.95% (187.4 tons), Guatemala with 2.76% (104.5 tons), and Nicaragua and Panama each accounting for less than 1% (Table 6 and Fig. 4A). Meat (40.9%) and bodies (31.7%) constitute the largest share at 72.6%, followed by skins (14.7%), fins (11.9%), and other categories such as unspecified items, specimens, live animals, and tails, each representing less than 1% (Fig. 4B).

Global imports from Central American countries between 2017 and 2022 amount to 65.3 tons. Guatemala stands out with almost one hundred percent (99.78%), while Costa Rica and El Salvador contribute less than 0.5%. Specifically, Guatemala imports 65.1 tons of meat (40.1 tons) and bodies (25 tons) of *C. falciformis* from Costa Rica, along with 65 live specimens of *Potamotrygon motoro* from Colombia and El Salvador.

4. Discussion

In Guatemala, fishing finfish and elasmobranchs constitutes an economic activity that generates employment opportunities and sustains the food supply for coastal communities (Hacohen-Domené et al., 2020). However, the exploitation status for most of Guatemala's fishery resources remains poorly understood due to the absence of a permanent monitoring and evaluation program for fisheries (Food and Agriculture Organization, 2018). Surveys conducted in ten coastal communities of the country revealed that 90% of the fishers reported deriving their income from high-value finfish species, lobster, shrimp, and, to a lesser extent, elasmobranchs. This aligns with the findings of Vieira and Tull (2008), which suggest that elasmobranch catches represent a minor proportion of the total catch along the Guatemalan coasts. Furthermore, the importation of shark meat from CITES-listed species indicates that elasmobranch catches in Guatemala are insufficient to meet the demand for shark meat. However, the domestic consumption of elasmobranch meat represents a significant gap on a global scale (Dent & Clarke, 2015). Assessing the national demand for shark meat could assist in devising management strategies to mitigate increased fishing pressure on Guatemala's coasts.

In Guatemala, small-scale fishers typically have low levels of formal education, like in other nations of Latin America, such as El Salvador, Costa Rica, Panamá, Ecuador, Colombia, and México (Beltrán-Turriago, 2001; Luna-Raya et al., 2016). Many have not completed primary school or received no formal education (Food and Agriculture Organization, 2018). According to the Fishing and Aquaculture Sector Organization of the Central American Isthmus (Organización del Sector Pesquero y Acuícola del Istmo Centroamericano, 2012), in 2011, there were 18,600 small-scale fishers across the Caribbean and Pacific coasts and inland waters in Guatemala. Of these, 68% had completed primary education, while 21% had no formal education. The current study revealed that 23% of fishing participants had completed primary school, while 16% had no formal academic qualifications. Most fishers lack education due to their economic circumstances; they typically have low incomes that restrict their access to formal education. Consequently, many begin fishing at a young age to contribute to their family's income, as documented in other Latin American countries (Beltrán-Turriago, 2001). Therefore, the socioeconomic realities of fishers play a significant role in driving fishery exploitation.

The current study showed that most women engaged in the fishing industry occupy unequal positions within fishing-dependent coastal communities. Women's involvement predominantly revolves around processing tasks, such as product cleaning and commercialization. This exclusionary dynamic stems from a set of norms and values that reinforce traditional gender roles, thereby dictating a division of labor based on sex (Méndez-Cárdenas et al., 2013). A comparable scenario is observed among women residing in coastal regions across Central America (Boix-Morán et al., 2016).

For the Pacific coast of Guatemala, 17 shark species and 16 ray's species are subject to fishing activities. Based on fisheries monitoring, the species with the highest capture include the silky shark (*Carcharhinus falciformis*), the hammerhead shark (*Sphyrna lewini*), and more recently, the longtail stingray (*Hypanus longus*) (Avalos-Castillo & Santana-Morales, 2021). Therefore, it can be assumed that they contributed to an important fraction of the expenses and incomes of this fishery. In addition, *C. falciformis* represents the highest percentage of the Guatemalan CITES elasmobranch species exports of skins and fins.

The elasmobranch trade in the Guatemalan Pacific and Caribbean regions begins with the fishers, constituting the first link in the value chain. It then progresses through intermediaries and merchants, before reaching the retailers, marking the fourth link. Fishers primarily sell elasmobranch meat in fresh or dry-salted forms. The average price estimated in this study (USD 1.66/kg) is lower than that reported by Okes and Sant (2019) at USD 4.34/kg. Okes and Sant (2019) note that prices vary based on species, product presentation, merchant, and meat

Fig. 3. Elasmobranch products in the seafood markets of Guatemala: A) trunk shark meat, B) shark meat slices, C) whole small shark, and D) shark and ray dried and salted.

Table 6
Exports from Central American countries by elasmobranch families in CITES in the period of 2018–2022. Exports are reported in tons and number of specimens or pieces.

Family	Global	Costa Rica	Guatemala	Nicaragua	Panama	El Salvador
Tons						
Alopiidae	76.6	52.5	5.3	11.9		6.8
Charcharhinidae	3644.3	3370.2	99.2	9.8		165.1
Lamnidae	31.7	0.1		0.2	31.4	
Sphyrnidae	29.1	1.7		11.2	0.7	15.5
Total	**3781.6**	**3424.4**	**104.5**	**33.2**	**32.1**	**187.4**
Percentage		**90.55**	**2.76**	**0.88**	**0.85**	**4.95**
No. of specimens or pieces						
Sphyrnidae	170	70			100	
Pristidae	14			1	13	
Myliobatidae	20	20				
Potamotrygonidae	40					40
Total	**244**	**90**		**1**	**113**	**40**

quality. Typically, white meat with superior consistency, such as that from hammerhead or silky sharks, commands higher market value. Conversely, as observed in this study, ray meat fetches a lower price compared to sharks, primarily due to differences in color and consistency. Furthermore, insufficient infrastructure in surveyed fishing communities to maintain the cold chain for processing and preserving the product influences fishery product prices. Consequently, fishers often resort to trading their products to intermediaries under

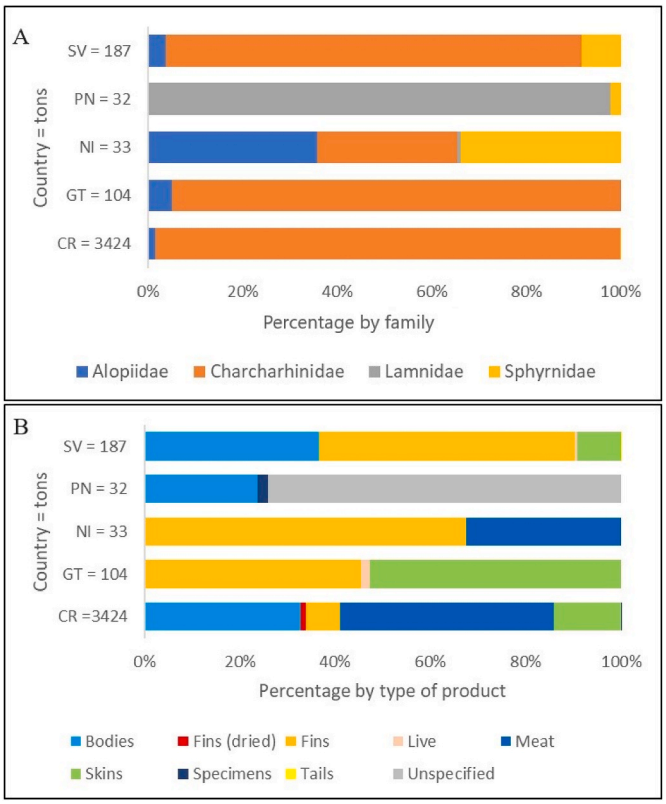

Fig. 4. Guatemala's role among the Central American countries in exporting elasmobranch CITES species. Percentage of exports by elasmobranch family (A) and by type of product (B) from El Salvador (SV = 187 tons), Panama (PN = 32 tons), Nicaragua (NI = 33 tons), Guatemala (GT = 104 tons), and Costa Rica (CR = 3424 tons).

disadvantageous conditions, leaving little room for price negotiation, as has been documented by Crona et al. (2010) and Food and Agriculture Organization (2018). Similar conditions have been documented by Salas et al. (2007) in Latin American countries, where fishers have limited power to influence the fish market due to a greater dependence on intermediaries.

Intermediaries can serve as a bottleneck within the system, obstructing direct market access for fishers and impeding the flow of information in both directions (from production to market and vice versa). For instance, they may exert influence over fishing activity through microeconomic relationships with fishers, resulting in social and ecological ramifications. Social implications encompass a "poverty trap" for fishers and an exclusive sales commitment to the intermediary. This is a common feature of many fisheries, also documented by Chuenpagdee et al. (2011) for small-scale fisheries in Latin American countries, Coronado et al. (2020) for the Mexican octopus fishery, and Purcell et al. (2017) for the western Pacific sea cucumber fishery. Conversely, ecological implications may arise from incentives to escalate fishing pressure, altering the extraction patterns of target species, particularly during periods when species are naturally more susceptible to environmental fluctuations (Crona et al., 2010; Kininmonth et al., 2017). This underscores the necessity of identifying and engaging intermediaries in management strategies to foster sustainable fisheries, given their pivotal role in linkages and the feedback mechanisms they facilitate.

Retailers are responsible for selling the product to the ultimate consumer, primarily within the markets across various departments of Guatemala. According to Mezzalira, Gasall, Garlock, and Anderson (2022), the trade of shark meat is currently linked to an increase in imports and exports. This surge may stem from stricter regulations on finning, which have incentivized the integral utilization of sharks and exposed the resource to a new source of demand. Consequently, despite a decline in the global market for shark fins, the demand for shark meat is anticipated to exacerbate the overexploitation of sharks in inadequately managed fisheries. Hence, it is crucial to comprehend the significance of shark meat demand in Guatemala to prevent a rise in fishing pressure.

Moreover, it is noteworthy that products derived from elasmobranchs in Guatemala, such as fresh and dry salted fillets, primarily consumed during Lent, are frequently mislabeled or sold under alternative names in the markets (Carvalho et al., 2017), a phenomenon also observed in Mexico (Munguia-Vega et al., 2022). The mislabeling of fish products is a widespread issue in Guatemala, often done intentionally for economic gain by substituting species of lesser value, such as sharks and rays, for others. This practice hampers the identification of the species being traded and whether they are protected or classified as vulnerable (Zeller, Graham, & Harper, 2011). To tackle this problem, it is imperative to implement transparent traceability systems that enable effective tracking and tracing of products throughout the fishery value chain (Leal et al., 2015; Shehata et al., 2019).

In recent decades, there has been widespread overexploitation of sharks to meet the demands of both domestic and international markets for various products, including meat and dried fins (Dulvy et al., 2014). Recognizing the urgency of the situation, twelve of the world's most vulnerable shark species were listed on the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) to regulate the international trade of products like meat and dried fins (Cardeñosa et al., 2018). Currently, 153 elasmobranch species are listed in CITES Appendix II, underscoring the responsibility of Guatemalan Customs officials and CITES authorities to ensure the legal and sustainable trade of these species. Although CITES statistics suggest a limited involvement of Guatemala in the international elasmobranch market, it is imperative to systematically monitor shark meat demand within the country and the exportation of skins and fins to gain a better understanding of these species' contribution to both national and international markets.

5. Conclusions

The results of this study indicate that small-scale fisheries, including those catching elasmobranchs, serve as a significant source of income for fishers in Guatemala's coastal regions. The study found that 25% of fishing actors economically depend on elasmobranchs, while 65% indicated that their income relies on finfish, shrimp, and lobster. Despite identifying the primary links in the fishing value chain, there are still significant information gaps hindering the quantitative analysis of the fishery, particularly in terms of economic indicators such as cost/benefit ratios. Therefore, future research endeavors should prioritize building trust with intermediaries, merchants, and retailers to obtain reliable, accurate, and comprehensive information on the fishery value chain. The average price increase of elasmobranchs along the value chain was estimated at USD 1.66/kg, with the greatest increase observed for dried salted sharks and the lowest for fresh rays. Guatemala accounts for 2.76% of the Central American countries' exports of CITES-listed species, with a total of 104.5 tons, and stands as the primary meat importer in Central America. This suggests that sharks caught in Guatemala do not adequately meet the national demand for shark meat. Assessing the national demand for shark meat could assist in devising management strategies to mitigate increased fishing pressure on Guatemala's coasts, particularly considering that threatened species such as *C. falciformis* and *A. pelagicus* are among the caught and traded species.

Funding

The Summit Foundation and Shark Conservation Fund supported this study.

CRediT authorship contribution statement

María de los Angeles Rosales-Melgar: Writing – review & editing, Methodology, Data curation, Conceptualization. **Omar Santana-Morales:** Writing – review & editing, Formal analysis, Data curation, Conceptualization. **Marian Rodríguez-Fuentes:** Methodology, Data curation. **José Alberto Zepeda-Domínguez:** Writing – review & editing, Writing – original draft, Formal analysis. **Juan Carlos Pérez-Jiménez:** Writing – review & editing, Visualization, Supervision. **Elisa Areano-Barillas:** Writing – review & editing, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

We appreciate the support of the stakeholders (including fishers, intermediaries, and retailers) from the Pacific and Caribbean coastal communities of Guatemala for participating in the surveys. We also extend our gratitude to Nut Chávez and Pedro Córdova for their assistance in analyzing the study's data, Carlos Humberto Mazariegos for his assistance with graphical visualization, and Andrea Lievana for editing the document. A thoughtful thank is made to Karen Sapón, Diana Torres, Jhoseline Mijangos, María de los Angeles Cabrera and Andry Chávez, students from Centro de Estudios del Mar y Acuicultura (CEMA), for their support in conducting the surveys.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ssaho.2024.100970.

References

Adams, W. (2015). Conducting semi-structured interviews. In K. E. Newcomer, H. P. Hatry, & J. S. Wholey (Eds.), *Handbook of practical program evaluation* (pp. 493–505). https://doi.org/10.1002/9781119171386.ch19

Avalos-Castillo, C., & Santana-Morales, O. (2021). Characterization of the artisanal elasmobranch fisheries off the Pacific coast of Guatemala. *Fishery Bulletin, 119*(1), 3–9. https://doi.org/10.7755/FB.119.1.2

Beltrán-Turriago, C. S. (2001). Promoción de la ordenación de la pesca costera. 2. Aspectos socioeconómicos y técnicos de la pesca artesanal en El salvador, Costa Rica, Panamá, Ecuador y Colombia. In *FAO Circular de Pesca. No. 957/2* (p. 71). Roma: FAO, 2001.

Bernard, H. R. (2017). *Research methods in anthropology: Qualitative and quantitative approaches. 6ª eddition. Towman & Lttlefield.* Arizona State University.

Boix-Morán, J., Franco-Arenales, I., & Morales-Molina, S. (2016). Participación social de las mujeres dentro de las unidades productivas de la pesca artesanal en el Pacífico Suroriental de Guatemala. *Dirección General de Investigación, Universidad de San Carlos de Guatemala*, 95.

Cardeñosa, D., Fields, A., Babcock, E., Zhang, H., Feldheim, K., Shea, S., Fischer, G., & Chapman, D. (2018). CITES-listed sharks remain among the top species in the contemporary fin trade. *Society for Conservation Biology, 11*, Article e12457. https://doi.org/10.1111/conl.12457

Carvalho, D., Guedes, D., Trindade, M., Coelho, R., & de Lima Araujo, P. (2017). Nationwide Brazilian governmental forensic programme reveals seafood mislabelling trends and rates using DNA barcoding. *Fisheries Research, 191*, 30–35. https://doi.org/10.1016/j.fishres.2017.02.021

Castro, J., Woodley, C., & Brudek, R. (1999). A preliminary evaluation of the status of shark species. In *FAO fisheries technical paper. No. 280* (p. 72). Rome: FAO.

Chuenpagdee, R., Salas, S., Charles, A., & Seijo, J. C. (2011). Assessing and managing coastal fisheries of Latin America and the caribbean: Underlying patterns and trends. In S. Salas, R. Chuenpagdee, A. Charles, & J. C. Seijo (Eds.), *Coastal fisheries of Latin America and the Caribbean* (pp. 385–401). FAO Fisheries and Aquaculture Technical Paper. No. 544. Rome, FAO. 2011.

CITES Secretariat and UNEP-WCMC. (2022). *A guide to using the CITES Trade Database.* Version 9. Geneva, Switzerland, and Cambridge, UK.

Consejo Nacional de Áreas Protegidas (CONAP) and Programa de las Naciones Unidas para el Desarrollo (PNUD). (2017). *Humedales para la reducción del riesgo de desastres.* https://www.gt.undp.org/content/guatemala/es/home/presscenter/articles/2017/02/02/humedales-para-la-reducci-n-del-riesgo-de-desastres.html.

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). (2022). The CITES species. Available at: https://cites.org/eng/news/cites-cop19-%E2%80%93-end-of-week-1 (Accessed March 10, 2023).

Coronado, E., Salas, S., Cepeda-González, M. A., & Chuenpagdee, R. (2020). Who's who in the value chain for the Mexican octopus fishery: Mapping the production chain. *Marine Policy, 118*, Article 104013. https://doi.org/10.1016/j.marpol.2020.104013

Crona, B., Nyström, M., Folke, C., & Jiddawi, N. (2010). Middlemen, a critical social-ecological link in coastal communities of Kenya and Zanzibar. *Marine Policy, 34*(4), 761–771. https://doi.org/10.1016/j.marpol.2010.01.023

Dent, F., & Clarke, S. (2015). State of the global market for shark products. In *FAO fisheries and aquaculture technical paper No. 590* (p. 187). Rome: FAO.

Dulvy, N. K., Fowler, S. L., Musick, J. A., Cavanagh, R. D., Kyne, P. M., Harrison, L. R., , … Livingstone, S. R., et al. (2014). Extinction risk and conservation of the world's sharks and rays. *eLife*. https://doi.org/10.7554/eLife.00590

Dulvy, N. K., Pacoureau, N., Rigby, C. L., Pollom, R. A., Jabado, R. W., Ebert, D. A., , … Fernando, D., et al. (2021). Overfishing drives over one-third of all sharks and rays toward a global extinction crisis. *Current Biology, 31*(21), 4773–4787. https://doi.org/10.1016/j.cub.2021.08.062

Ellis, J., Clarke, M., Cortés, E., Heessen, H., Apostolaki, P., Carlson, J., & Kulka, D. (2008). Management of elasmobranch fisheries in the North Atlantic. In A. I. L. Payne, A. J. Cotter, & E. C. E. Potter (Eds.), *Advances in Fisheries Science. 50 years on from Beverton and Holt* (pp. 184–228). Oxford: Blackwell Publishing. https://doi.org/10.1002/9781444302653.ch9.

Fontana, A., & Frey, J. (2005). The interview: From neutral stance to political involvement. In N. K. Denzin, & Y. S. Lincoln (Eds.), *The SAGE handbook of qualitative research* (pp. 695–727). Thousand, Oaks, California: Sage Publications Ltd.

Food and Agriculture Organization (FAO). (2018). Diagnóstico del sector de la pesca y la acuicultura en Guatemala. In *Ciudad de Guatemala* (p. 64). Licencia: CC BY-NC-SA 3.0 IGO.

Goodman, L. A. (1961). Snowball sampling. *The Annals of Mathematical Statistics, 32*, 148–170. https://www.jstor.org/stable/2237615.

Hacohen-Domené, A., Polanco-Vásquez, F., Estupiñan-Montaño, C., & Graham, R. (2020). Description and characterization of the artisanal elasmobranch fishery on Guatemala's Caribbean coast. *PLoS One, 15*(1), Article e0227797. https://doi.org/10.1371/journal.pone.0227797

Jacques, P. (2010). The social oceanography of top oceanic predators and the decline of sharks: A call for a new field. *Progress in Oceanography, 86*, 192–203. https://doi.org/10.1016/j.pocean.2010.04.001

Kininmonth, S., Crona, B., Bodin, Ö., Vaccaro, I., Chapman, L. J., & Chapman, C. A. (2017). Microeconomic relationships between and among Fishers and traders influence the ability to respond to social-ecological changes in a small-scale fishery. *Ecology and Society, 22*(2), 26. https://doi.org/10.5751/ES-08833-220226

Leal, M. C., Pimentel, T., Ricardo, F., Rosa, R., & Calado, R. (2015). Seafood traceability: Current needs, available tools, and biotechnological challenges for origin certification. *Trends in Biotechnology, 33*(6), 331–336. https://doi.org/10.1016/j.tibtech.2015.03.003

Lewison, R., Crowder, L., Read, A., & Freeman, S. (2004). Understanding impacts of fisheries by-catch on marine megafauna. *Trends in Ecology & Evolution, 19*, 598–604. https://doi.org/10.1016/j.tree.2004.09.004

Lindop, A., Ixquiac-Cabreara, M., Zylich, K., & Zeller, D. (2015). *A reconstruction of marine fish catches in the Republic of Guatemala*. Working Paper Series (#2015-41), Fisheries Centre. Vancouver, Canada: University of British Columbia.

Luna-Raya, M. C., Cruz González, F. J., Tovar Ávila, J., Castillo Géniz, J. L., Santana Hernández, H., Corro Espinosa, D., Lizárraga Rodríguez, A. A., & Brito Chavarría, M. (2016). Aspectos sociodemográficos y económicos de los pescadores de tiburón en el Pacífico mexicano. In J. L. Castillo Géniz, & J. Tovar Ávila (Eds.), *Tiburones mexicanos de importancia pesquera en la CITES* (pp. 73–83). México: Instituto Nacional de la Pesca.

Méndez-Cárdenas, G., Mungía-Gil, A., Mungía-Gil, M. T., & Méndez-Cárdenas, S. (2013). El conocimiento local sobre el cambio climático de mujeres y hombres pescadores en la costa de Yucatán. *Veredas, 27*, 199–220.

Mezzalira, B., Gasall, M., Garlock, T., & Anderson, J. (2022). Market incentives for shark fisheries. *Marine Policy, 139*, Article 105031. https://doi.org/10.1016/j.marpol.2022.105031

Ministerio de Agricultura, Ganadería y Alimentación (MAGA). (2021). *Acuerdo ministerial No. 280-2021*.

Munguia-Vega, A., Terrazas-Tapia, R., Domínguez-Contreras, J. F., Reyna-Fabian, M., & Zapata-Morales, P. (2022). DNA barcoding reveals global and local influences on patterns of mislabeling and substitution in the trade of fish in Mexico. *PLoS One, 17*(4), Article e0265960. https://doi.org/10.1371/journal.pone.0265960

Okes, N., & Sant, G. (2019). *An overview of major shark traders, catchers and species.* Cambridge, UK: TRAFFIC. https://www.traffic.org/site/assets/files/12427/top-20-sharks-web-1.pdf.

Organización del Sector Pesquero y Acuícola del Istmo Centroamericano (OSPESCA). (2011). Plan de Acción Regional para la Ordenación y Conservación de los Tiburones en Centroamérica (PAR-TIBURON). In *Grupo Técnico Regional de Tiburones (GTRT) de la Organización del Sector Pesquero y Acuícola del Istmo Centroamericano (OSPESCA)*.

Organización del Sector Pesquero y Acuícola del Istmo Centroamericano (OSPESCA). (2012). *Encuesta Estructural de la Pesca Artesanal y la Acuicultura en para las Comunidades Pesqueras Guatemaltecas* (p. 39).

Piovano, S., Bascinao, G., & Giacoma, C. (2012). Evaluation of a by-catch reduction technology by fishermen: A case study from sicily. *Marine Policy, 36*(1), 272–277. https://doi.org/10.1016/j.marpol.2011.06.004

Prell, C. (2012). *Social network analysis: History, theory and methodology* (p. 272). Sage Publications Ltd..

Purcell, S. W., Crona, B. I., Lalavanua, W., & Eriksson, H. (2017). Distribution of economic returns in small-scale fisheries for international markets: A value-chain analysis. *Marine Policy, 86*, 9–16. https://doi.org/10.1016/j.marpol.2017.09.001

Ramírez Yela, S. M., & Ortiz, J. R. (2019). Océanos y ecosistemas marino-costeros. In E. J. Castellanos, A. Paiz-Estévez, J. Escribá, M. Rosales-Alconero, & A. Santizo (Eds.), *Primer reporte de evaluación del conocimiento sobre cambio climático en Guatemala* (pp. 170–191). Guatemala: Editorial Universitaria UVG.

Rosales, R. M., Pomeroy, R., Calabio, I. J., Batong, M., Cedo, K., Escara, N., Facunla, V., Gulayan, A., Narvadez, M., Sarahadil, M., & Sobrevega, M. A. (2017). Value chain analysis and small-scale fisheries management. *Marine Policy, 83*, 11–21. https://doi.org/10.1016/j.marpol.2017.05.023

Salas, S., Chuenpagdee, R., Seijo, J. C., & Charles, A. (2007). Challenges in the assessment and management of small-scale fisheries in Latin America and the Caribbean. *Fisheries Research, 87*, 5–16. https://doi.org/10.1016/j.fishres.2007.06.015

Shehata, H. R., Bourque, D., Steinke, D., Chen, S., & Hanner, R. (2019). Survey of mislabelling across finfish supply chain reveals mislabelling both outside and within Canada. *Food Research International, 121*, 723–729. https://doi.org/10.1016/j.foodres.2018.12.047

Stevens, J. (1999). Variable resilience to fishing pressure in two sharks: The significance of different ecological and life history parameters. In J. A. Musick (Ed.), *Life in the slow lane: Ecology and conservation of long-lived marine animals. American Fisheries Society Symposium 23* (pp. 11–15).

Stevens, J., Bonfil, R., Dulvy, N., & Walker, P. (2000). The effects of fishing on sharks, rays, and chimaeras (chondrichthyans), and the implications for marine ecosystems. *ICES Journal of Marine Science, 57*, 476–494. https://doi.org/10.1006/jmsc.2000.0724

Unidad de Manejo de Pesca y Acuicultura del Ministerio de Agricultura, Ganadería y Alimentación (UNIPESCA-MAGA). (2008). *Plan de Acción Nacional para la Conservación y Ordenación de Tiburones. Guatemala*.

Vieira, S., & Tull, M. (2008). Restricting fishing: A socioeconomic impact assessment of artisanal shark and ray fishing in Cilacap. *Bulletin of Indonesian Economic Studies, 44*, 263–288. https://doi.org/10.1080/00074910802169020

Zeller, D., Graham, R., & Harper, S. (2011). Reconstruction of total marine fisheries catches for Belize, 1950-2008. In M. L. D. Palomares, & D. Pauly (Eds.), *Too precious to drill: The marine biodiversity of Belize* (Vol. 19, pp. 142–151). Fisheries Centre Research Reports.