CHAPTER 5
POST-HARVESTING UTILIZATION AND TRADE OF ELASMOBRANCH

5.1 Introduction

Elasmobranchs play a significant role in culture and the economy in various regions of the world. as a source of income and dietary protein through fisheries catch and trade Bonfil (1994), Additionally, they produce income through tourism (Gallagher and Hammerschlag, 2011). Nevertheless, the worldwide decrease in elasmobranch populations is a matter of concern for both species conservation and socio-economic reasons. The decline of elasmobranchs, which are apex and meso-predators, can have significant ecological consequences. This might have far-reaching effects on the overall health of marine ecosystems and the livelihoods that depend on them (Dulvy et al., 2000; Myers et al., 2007; Ferretti et al., 2010). Overfishing is an alarming threat to sharks and rays worldwide, resulting in rapid decreases in population and an increased risk of extinction for 36% of ray species and 31.2% of shark species evaluated on the IUCN Red List of Threatened Species (Dulvy et al., 2021). The k-selected life history of elasmobranchs, characterized by slow growth, late maturity, and low fecundity, makes them highly susceptible to fishing mortality and reduces their ability to recover from population decline. This poses challenges for achieving sustainable harvests of elasmobranchs (Barker and Schluessel, 2005; Ward-Paige et al., 2012; Worm et al., 2013). The decline in elasmobranch populations globally is mostly attributed to fisheries, which either target these species or catch them unintentionally (Stevens et al., 2000; Dulvy et al., 2008; Dulvy et al., 2014). On the opposite side of the range, sharks and rays are frequently relied upon by coastal people for their livelihood, food security, and cultural identity. Additionally, they have a role in national economies through fisheries and trade (Leeney et al., 2018; Booth et al., 2019; Glaus et al., 2019). However, there is a lack of data and awareness in numerous regions, which hinders the proper management of these resources. There is a lack of detailed information regarding the utilisation trends in catching elasmobranchs (sharks, rays, and skates) and the socio-economic factors that influence these fishing activities. This knowledge is necessary in order to develop policies that may effectively support management measures tailored to the distinctive environment. (Barrowclift et al., 2017; Tyabji et al., 2022).

The utilization of sharks, rays, and their products has been documented for ages in different communities and regions across the globe (Vannuccini, 1999). The

utilization of shark and ray trade has shown a consistent upward trajectory in recent years, reaching a value of more than 4.1 billion dollars from 2012 to 2019 (Niedermüller et al., 2021). Traditionally, certain coastal communities across India, particularly in Kerala, Lakshadweep, and Maharashtra, consumed fresh, salted, and dried shark meat as a staple food, especially among the poor (Day, 1889; Frej and Gustafsson, 1990). According to Day (1889) and Frej and Gustafsson (1990), shark flesh was regarded as nutritious nourishment for women postpartum. Additionally, Akhilesh et al. (2011) found that ray meat was consumed during celebrations in Kerala. Harpoon fisheries were also present in Andhra Pradesh and Lakshadweep for catching Mobulids (family Mobulidae) specifically for the purpose of consuming their meat domestically (Pillai, 1998). From 1950 to 1980, in response to the increasing global demand for shark products, targeted shark fisheries developed in Tamil Nadu, Andhra Pradesh, and the Andaman Islands (Hanfee, 1996; Tyabji et al., 2018). This demand also indirectly created opportunities for local and international markets for various products, including dried, fresh, salted, or frozen meat for consumption, liver oil, skins used for leather, jaws used as ornaments, and cartilage and gill plates used for medicinal purposes (Vannuccini, 1999; Akhilesh et al., 2011; Hanfee, 1996). During the 1960s, a meat market emerged in Tamil Nadu, India, (Frej and Gustafsson,1 990), where the focus was on hunting Whale sharks (*Rhincodon typus*) and gulper sharks (*Centrophorus* spp.). It is important to note that currently Whale sharks are officially protected under the Indian Wildlife Protection Act of 1972. Over time, more marketplaces emerged throughout the country in response to local, regional, or global need. India did not start commercially using Mobulids until late 2007. This happened because a market for gill plates formed and targeted fisheries were developed in the states of Gujarat, Maharashtra, Kerala, and Tamil Nadu (Nair et al., 2015). The growing mechanization of fisheries has resulted in a corresponding rise in fishing effort in these specific fisheries. In summary, the excessive utilization of sharks and rays resulted in a significant decrease in the documented amount of these species being caught in both coastal and offshore fishing operations by the end of the 2000s (Bonfil, 1994; Devaraj and Vivekanandan, 1999; De Young, 2006).

Although there is a much of this information on the exploitation and utilization of sharks and rays in many states across India, the Gujarat remains a location that has received little attention in terms of research, utilisation trend and has a lack of recorded

capture data. The fisheries in Gujarat are varied and make significant contributions to shark landings along the northwest coast, including Daman & Diu and Maharashtra (Kizhakudan et al., 2015). Moreover, this sector exhibits a diverse range of human attributes, with migrant fishermen being recruited from peninsular India by dealers and boat owners to engage in fishing activities. The state's fisheries are influenced by the presence of well-established infrastructure, convenient access to markets, and export facilities. This chapter seeks to evaluate the utilization and socio-economic significance of the elasmobranch fishery, in comparison to the overall occupations of fishermen and merchants.

5.2 Materials and Methodology

Interviews survey

A survey was carried out during the routine field trips from 2021 to 2023. In order to gain a comprehensive understanding of the elasmobranch fishery and its utilization and trade throughout the Gujarat coast, specific fishing harbours and landing sites were chosen as the focus of the study. These were chosen based on recommendations from fishermen, government officials, and the existing literature. The decision was made to exclusively concentrate the investigation on elasmobranch fishes. Given that fishing is a pursuit predominantly engaged in by males, all participants in the study were male. The selection process was determined by the existence of fishermen and traders in these regions. Additionally, informants were requested to recommend other individuals whom they believed possessed information about elasmobranch fishery. A survey was conducted through individual interviews to prevent any influence from other participants and ensure the integrity of the replies.

The researcher conducted purposive sampling to select fisherman and traders who were directly or indirectly involved in elasmobranch fishery, Interviews were scheduled at a mutually convenient time for the participants (Newing, 2010). Each interview had a duration of 20 to 30 minutes, however occasionally it extended up to 1 hour. The questionnaire included open-ended questions that allowed respondents to freely introduce new themes and offer additional information about shark and ray fishing. The interviews began by informing potential respondents that this study was an autonomous scientific inquiry, unconnected to any government or fishery management organizations. The study focused on elasmobranch species in the Arabian sea, assured participants that their identity would not be documented, unless they willingly provided their names. Strict confidentiality was also guaranteed. We conducted interviews with all identified traders engaged in the processing and trade of sharks and rays at our chosen sampling sites along the Gujarat coast. The interviews were carried out in Gujarati in fish landing centers, trader's offices, and processing facilities.

The study utilized semi-structured questions, which were adapted from previous studies (Jabado et al., 2015; Barrowclift et al., 2017), to specifically focus on elasmobranchs in the local context.

The survey was divided into four sections:

(1) Demographics and experience,

(2) Fishing practices and interactions with sharks and rays,

(3) Utilization and trade of products, and

(4) Awareness and perceptions of existing regulations

Those with traders were modified to only include questions on

(1) Demographics and experience

(2) Utilization and trade of products

(3) Awareness and perceptions of existing regulations

During the interview, a guide on identifying elasmobranch fish (Jabado and Ebert, 2015; Last et al., 2016; Dash et al., 2017; Kizhakudan et al., 2018; Jabado, 2019) was utilized to ensure appropriate species identification. This was necessary because fishermen often refer to species by local names, which might vary between different communities. In addition, the inclusion of pictures depicting shark and ray species from outside the local area served as a means to assess the accuracy of the respondents' answers (Singleton et al., 1993). Illustrations of gear were utilized to verify the specific types of gear employed in the fishery. Additionally, a map of the Indian coastline was included to pinpoint the locations of fishing sites (Moore et al., 2010). This offered a comprehensive summary of the broad regions that are fished. Interviews were halted after the information and knowledge obtained from the participants reached a point of convergence (Beebe, 2001). This happened when most of the conversations and themes started to repeat, and it was probable that there would be little new information obtained regarding the fishery. (Francis et al., 2010). Although the number of interviews conducted does not constitute a representative sample of the entire fisherman population in Gujarat, the study still provided sufficient information to gain initial insights into the elasmobranch fishery as perceived by Gujarati fishermen and traders. It also helped determine whether these fishermen had observed particular trends in the abundance of elasmobranch fish.

Data analysis*:* We conducted a translation of all replies into English, categorized open-ended responses for exploratory analysis, and using Microsoft Excel to analyze the data in terms of percentages.

5.3 Result

5.3.1 Demographics of Fishers and Traders

In total, 64 interviews (n=48 fisherman and n= 16 traders) were conducted in Veraval (n = 22), Mangrol (n = 11), Porbandar (n = 11), Okha (n = 14) and Jakhau (n = 06) regions of the Gujarat. These locations varied from small harbour with basic structures (Jakhau) to locations where developed facilities were available (Veraval). All fisherman ranging in age from 21 to 65 years old (mean = 41 ± 10.6) (Fig. 5.1). Fishermen in the middle age groups (41–50 years old and 51–59 years old) accounted for more than a third of the sample (52%) while younger age groups (21to 30 years old) accounted for only (18.75%) of the sample. The majority of fisherman interviewed were Gujarati, but they are coming from different district of Gujarat.

The fishermen stated that they learned fishing skills from childhood till the age of 30. All respondents (100%) in this study had a family tradition of fishing. They learned their fishing abilities from their fathers or close relatives, as they all came from fisherman households. The respondents demonstrated extensive knowledge of the Arabian Sea water and its marine resources. Among the surveyed fishermen, 41.7% had more than 25 years of fishing experience, while the remaining 58% had between 1 and 24 years of experience. The range of fishing experience varied from 1 to 50 years, with a mean of 21.5 ± 11.6 years (Fig. 5.2). A majority of the examined fishermen (54.1%) began their fishing activities during their childhood, before to reaching the age of 20.

While all traders ranging in age from 32 to 65 years old (mean = 32 ± 8.6) (Fig. 5.1). With experience ranging from 10 to 40 years (average = 22.25 years ± 8.7) (Fig. 5.2). 5 traders were fisherman – turned traders, whereas 11 came from a family of traders.

The all of these fishermen and traders earned their living from fishing only was because fishing was the primary occupation for all fishermen. Majority of the fishermen operated mechanised boat for their fishing activities while occupying various positions on the boat. The majority of respondents (62.5%) are captain of the boat.
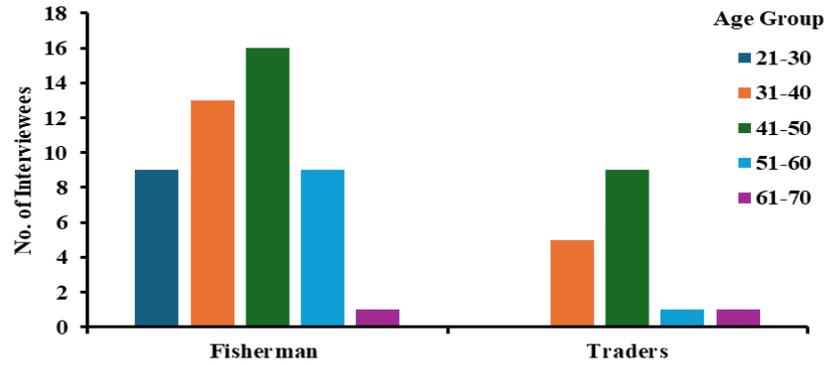
Figure 5.1: The age of interviewees showing the number of respondents in each category
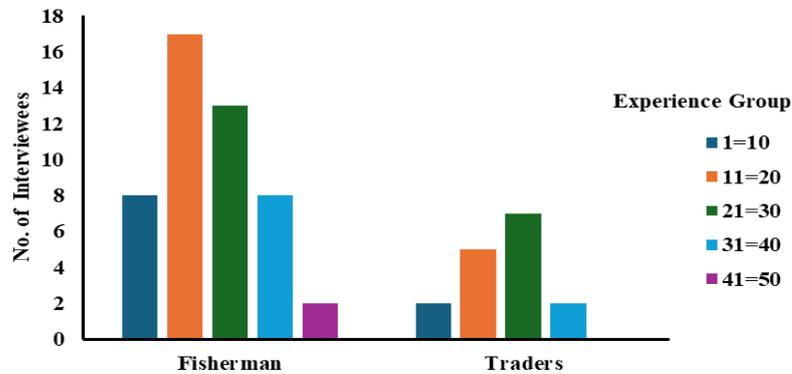

Figure 5.2: Interviewee years of fishing experience showing the number of respondents in each category

5.3.2 Fishing Gear and Techniques

All fishers reported targeting multiple species throughout the year including Tunas, Sardines, Ribbon fish, Cuttle fish, Squid, Grouper fish, Dolphin fish etc. 56.25% of fishers operated only one fishing gear. 60.4 % fisherman stated that Sharks were dominantly caught in gillnets and hook & line, whereas rays were mainly caught in trawl nets (89.6%).

5.3.3 Knowledge of Sharks and Rays: Identification of Elasmobranchs

Fisherman and traders could not differentiate between morphologically similar species from the family Carcharhinidae (e.g., blacktip shark (*Carcharhinus limbatus*)

and *Carcharhinus sorrah*,), *Brevitrygon* species (e.g., *B. walga* and *B. imbricata*), *Himantura* sp. (e.g., *H. uarnak* and *H. undulata*) and *Rhinobatos* species (e.g., *R. punctifer* and *R. annandalei*). However, they could identify species based on unique morphological characteristics, such as the head shape of hammerhead sharks (family Sphyrnidae), snout shape of the *Glaucostegus obtusus*), broad rounded snout and spotted colouration of bowmouth guitarfish (*Rhina ancylostomus*) and colouration and patterns of tiger shark (*Galeocerdo cuvier*) and Shortfin meko (*Isurus oxyrinchus*) and had local names for them.

5.3.4 Fishing Periods and Seasons

The fishing season in this region typically spans around nine out of twelve months each year. During this period, fishermen are active, taking advantage of the favourable conditions. However, July stands out as a challenging month when the catch is not sufficient to justify the effort and expenses, leading to significantly reduced fishing activities or a complete halt. In July and August month fishing is completely stop due to the seasonal fishing banned by Government of Gujarat. All most all fisherman stated that the peak season for fishing occurs during September - October (93.7 %) and February – March (91.6 %). These months are characterized by abundant fish stocks, providing ample opportunities for substantial catches. During peak season, the fishing activities ramp up significantly, with boats frequently venturing out to sea. Each fishing boat typically accommodates a crew of six to nine individuals, including the captain. Fishing trips during the season can last anywhere from 15 to 25 days. The long trips are aimed at maximizing the catch per outing, making the most of the favourable fishing conditions and minimizing the downtime between trips.

5.3.5 Population trends and perceived causes of declines of Elasmobranchs

Fishermen were asked whether they thought elasmobranch fishes had increased, decreased, or remained the same in terms of abundance over the last 10 years, A general decline in abundance was noted by all the fishermen. Respondents (72.9% fisherman; 56.25% traders) reported shark declines due to overfishing and increasing number of fishing boat. 90% fisherman stated that common small size shark e.g, *Scoliodon laticaudus* are still getting abundantly. Fisherman and traders from Jakhau also stated that *B. walga* population is maintained and getting abundantly during peak season.

Fishermen (54.2%) and Traders (43.7%) stated that in the region typically achieve a regular and consistent catch, of *S. laticaudus*, *Chiloscyllium* sp., *C. falciformis*, *Rhizoprionodon* sp. *R. punctifer*, *R. annandalei*, and *Brewitrygon walga*, these species are commonly found in the waters. However, there are certain species that are caught very rarely and in significantly lower quantities. These include *Himantura* sp., *R. ancylostomus*, *Alopias* sp. *Neotrygon* sp., and *R. laevis*.

5.3.6 Awareness and Perceptions regarding Regulations

All fishermen were aware of prohibited areas for fishing, and they have clarity on the boundary of fishing zone. Also, all fisherman and traders were aware of the yearly 45-day seasonal shark fishing ban from 15th July to 31st August. All fishermen know about banned line fishing which is implemented by Government of Gujarat for maintain sea floor ecosystem. Six Fisherman (12.5%) incorrectly believed that both targeted fishing and retaining bycatch of all sharks was banned. All fisherman and traders were aware that sawfishes and whale sharks were protected and catching that species is illegally fishing practice. 87.5% traders commented about the export ban for jaws, and shark fins, only one trader stating that fins are currently sold in black markets. All traders mentioned there were no bans on ray products and liver oil. When asked about who give you the information regarding fishing rules, regulation and awareness about selective fishing, all fisherman and traders stated that information received directly from the officials of the respective fishing departments of District.

5.3.7 Trade and product utilization

5.3.7.1 Profitability of fishing Elasmobranchs

More than half of fisherman (72.91%) noted the difficulty of relying on profits from shark and ray fishing due to the low catch because of declines in shark and ray populations, and low market value. All fisherman mentioned that they did not prefer to fish for torpedo sp. Because they have very low market value and not sell for human consumption. However, some fisherman (15%) and traders (18.75%) stated that they get much profit from medium size shark. Traders from Jakhau stated that they have good facility of storage and transport, so they get good profit from ray fish export. Every traders confirmed that they have the necessary equipment, workforce, convenient access to storage and processing facilities, transportation and export capabilities, as well

as strong connections to markets outside Gujarat, in order to benefit from the shark and ray fishery. Three traders (18.75) reported that significant quantities of sharks and rays could be sold at a higher rate. Trading sharks is challenging due to the stringent rules and permissions required for their commerce in India. Respondents reported that trading rays was comparatively simpler due to their high availability, limited regulations, and growing demand for their products, including fresh and dried meat.

5.3.7.2 Elasmobranchs meat

All fisherman mention that they don't prefer consuming elasmobranch fish meat, due to their taste and texture. Non-preference for sharks and rays stemmed from the smell, tough skin, and difficulty of cooking. However, during local fish market visit it is observed that some of the people buy and consuming *Scoliodon laticudus* because its small size and white meat. Rarely observed selling of rays and skate fish meat. Two fisherman (4.1%) from Veraval also mentioned that the Bengali and south Indian people in the town consume and buy sharks and stingrays relatively more than other communities.

All fisherman stated that elasmobranch fishes caught as bycatch and were directly sold sell elasmobranch fishes to traders, who then segregate the catch based on quality and quantity. The process involves washing the fish, cutting them into pieces, and salting them. The salted fish are kept for 2-4 days before being sundried and packed. Most of the dry shark and ray fish are transported to Tamil Nadu and Kerala (68.75), while whole individual ray fish are specifically transported to West Bengal (18.75%).

Traders (18.75%) mention that Whole fresh shark prices ranged from 90-140 INR/Kg within 1 m total length to 180-210INR/kg of more than1 m total length. Whole fresh rays were sold for 90–110 INR/kg and whole skates price ranges between 25-40 INR/individual. From all skates' fish *Rhinchobatus laevis* get highest price ranges between 130-180 INR/Individual. Two fishermen stated that that juvenile scalloped hammerhead sharks were perceived to give exceptional strength when consumed and were more expensive (130-170 INR/kg).

5.3.7.3 Shark and Ray fins

In the local community, there is no utilization and consumption of shark fin. Shark fin trade is illegal in India is well-known among all traders, also there is no market demand for shark fins at the local level. Despite this local adherence, a non-significant amount of shark fin is transported to South India, where the demand persists.

5.3.7.4 Shark Liver oil

Fishermen sell their caught sharks to a processing unit, where the sharks undergo several steps of processing. Initially, the shark livers are extracted and placed in open tanks for extended fermentation under sunlight. Meanwhile, the rest of the shark bodies are cut into pieces for salting. Over time, the fermentation process causes the oil to separate and rise to the surface of the tanks. This oil is then collected into barrels, which are used primarily for boat varnishing. One trader (6.25%) mention that Each barrel, containing 180 litters of oil, is valued at 20,000 and annually his processing unit produces approximately 5 to 6 barrels of this oil.

5.3.7.5 Other products

Five traders (31.25%) mentioned that very small-sized, low-quality, and degraded elasmobranch fish are sold to the fish meal industry, where they are processed into fish meal for aquaculture feed.

5.4 Discussion

The demographic profile of fishers and traders in Gujarat's coastal regions reveals a traditional and highly specialized community. The average age of fishermen, 41 years, and their extensive experience underscore the generational nature of the occupation, reflecting a deep-rooted cultural heritage. This demographic trend aligns with studies by Berkes et al. (2000) and Coulthard (2008), which emphasize the role of traditional ecological knowledge passed down through generations. The predominance of middle-aged fishermen and the lower participation of younger age groups (18.75% aged 21-30) suggest potential future challenges in sustaining the fishing workforce, a concern echoed in other fisheries-dependent communities globally (Coulthard, 2008).

The traders, with an average age of 32 years and a blend of those from fishing and trading families, indicate a diversification of roles within the fishing industry. The transition from fishing to trading among some individuals highlights adaptive strategies within the community to cope with changing economic and environmental conditions.

The post-harvesting utilization of elasmobranchs (sharks, rays, and skates) in Gujarat involves various traditional practices, economic challenges, regulatory frameworks, and market dynamics.

5.4.1 Processing and Product Utilization

In Gujarat, the primary post-harvest processing involves salting and Drying process for the export majorly dry shark and rays' fishes also whole shark individual to the south Indian state Tamil Nadu and Kerala while Ray exported to west Bengal, and the extraction of shark liver oil, which is fermented under sunlight and collected for use in boat varnishing. This practice is mirrored in Andaman Islands where shark liver oil is used for boat varnishing and for cosmetic (Tyabji et al., 2022). Similarly, in Japan, shark liver oil is used in the production of squalene, a high-value compound utilized in cosmetics and pharmaceuticals (Castro, 2011) These parallels highlight the importance of the economic value of shark by products across different regions.

5.4.2 Consumption Preferences

Cultural preferences significantly impact the consumption of elasmobranch meat in Gujarat. The general avoidance of shark and ray meat due to its taste and texture contrasts with niche markets for smaller sharks among specific communities. In Tamil Nadu, and Kerala similar cultural preferences dictate shark and ray fish consumption habits. This preference has been observed in several coastal communities worldwide including in many countries across the Indian Ocean (Vannuccini, 1999) Internationally, in countries like Iceland, shark meat is consumed as a traditional dish, *hákarl*, despite its strong ammonia smell, highlighting the influence of cultural norms on consumption (McGee, 2004). The limited market for ray and skate meat in Gujarat, influenced by local culinary traditions, Conversely, in parts of Europe, rays and skates are considered delicacies, fetching higher market prices and driving demand (Serena, 2005).

5.4.3 Utilization of By-products

The sale of low-quality elasmobranch fish to the fish meal industry in Gujarat is a critical aspect of post-harvest utilization. This practice ensures minimal waste and provides an additional revenue stream. Similar utilization of low-value fish for fish meal production is observed in Karnataka and globally in countries like Peru, where fish meal is a significant export product (FAO, 2016; James et al., 2016). Efficient byproduct utilization supports local economies and reflects a broader trend in fisheries aiming to maximize the value of all catches.

5.4.4. Regulatory Awareness and Compliance

The high level of awareness among fishermen and traders regarding fishing regulations, including prohibited areas, seasonal bans, and protections for certain species, indicates effective communication and enforcement by local authorities. However, misconceptions about bans on bycatch and the illegal trade of shark fins highlight the need for continuous education and clarification of regulations.