Detailed Final Report

1.   Introduction

1.1 Background

The emerging global demand for elasmobranch products have had its effects even in Bangladesh where conservation efforts are hardly addressed due to data deficiency on the studied species. In an earlier study by A.K. Yousuf Haroon (2010), it was assumed that there is no targeted shark fishery in Bangladesh.

But in a recent study by A.B. Haque (2018), reported that large trawlers carrying iron hooks, voyage into the sea in order to hunt megafaunas like sharks and rays since their demand for processed parts are accelerating at an alarming rate globally. This global demand is further encouraging fishermen even in the remotest parts of the world, to scavenge shark and rays solely driven by profit motive. Unfortunately, there is no legal monitoring to generate a trade map by identifying its potential routes. A.B. Haque (2018), also states that all parts of ray and shark fisheries were carefully handled for both domestic and international demand. Additionally, the Bay is data deficient in terms of stock assessment which is a major barrier for proper conservation implications. This study particularly was an attempt to understand the socio-economic status of both traders and fishermen, their fishing practices, their frequency of sightings of the studied species, location where viable population exists, perceptions on the benefits of the specimens, distribution map to locate areas where fishing pressure are highest, a flowchart to illustrate the possible trade chains within the national boundaries, buying and selling prices of sharks and rays products, etc. Field visits to the south-eastern coastal region and structured questionnaire surveys will be conducted amongst stakeholders (traders, fishers, consumers and middlemen) to identify the market chain and landed species composition.

Holistically, this project is an effort to provide a species specific baseline data to identify the trade chain of illegal shark and ray products exported from Bangladesh, which is of utmost importance, since many species designated under CITES Appendix II (Convention on International Trade in Endangered Species of Wild Fauna and Flora, 2018) are found in Bangladeshi waters. This project is the 1st systematic study to identify the trade chain, for helping policy makers with further regulatory measures for effective conservation of elasmobranchs in Bangladesh.

1.2 Study rationale

The second largest shark product market in the world is located in India (Dent and Clarke, 2015). However, Bangladesh being next to India fails to document the emerging market of shark and ray products within its national boundaries. Shark catch data over the past few decades have experienced large fluctuations in Bangladesh from a total of 4085 t between 2004 and 2005, gradually declining to 3933 t in 2008-2009 and increasing again in 2013-2014 to 5648 t in 2013-2014 (FRSS, 2015). Bangladesh is not a very big consumer of shark and ray products and no fin soup is served in the country and yet between 2010 and 2014, no export data was recorded, showing an anomaly in the trade records (Haque et al., 2018). The information is vital for developing a science-based, community informed plan of action for conservation management and enhanced capacity of fishers for sustainable practices. This study provides evidence-based

outcomes for shark and ray conservation to initiate a program for conservation genetics of elasmobranch in Bangladesh**.**

In the broader spectrum of shark and ray conservation, the novelty of the study can be summarized, as follows:

- There is no baseline data on these particular group of species. So, this study is the first of its kind to conduct a thorough survey where some fractions of elasmobranchii have been reported under CITES Appendix II.
- The rising black market of shark and ray trade over the last decade have posed threat to the sustainability of shark ecology and more severely on shallow dwellers which are more vulnerable to by-catch and easy victims of unregulated fishing practices.
- Based on the fishermen perception during the interview sessions, this study focused on finding the ecological importance of the studied species which have inserted new insights into the research that will pave the way for further in-depth studies for these species in Bangladesh.
- Furthermore, data collected in the questionnaire survey of fishermen (e.g. distance travelled, horsepower and depth of fishing, etc.) will enlighten us about the distribution range and thus help in constructing a distribution map. Hence, this study can be considered as a vital reference point for identifying major hotspots for the particular species mentioned.
- Information gathered from traders guided us to establish a flowchart which will give a visual illustration about the trade chain and demand of ray products in various locations across the country to better aid their conservation and evidence-based management.

Lastly, this study is a stepping stone in highlighting some of the major flaws in fishing industry where unregulated and unsustainable fishing practices are posing threats on the marine ecology and as well on the national food security because the primary data suggests that the studied species are vital components of the marine food chain which helps in maintaining the artisanal fish production and marine ecosystem in balance.

1.3 Study Species
This study will focus on elasmobranch species threatened by unregulated trade in Bangladesh. However, special emphasis will be given to sawfishes, hammerheads, devil rays and guitarfishes given their conservation concern globally and regionally.

Although sawfishes (Pristidae) are one of the most threatened chondrichthyan families in the world, current data on their conservation status in the Indian Ocean are limited (Dulvy et al., 2014; Harrison & Dulvy, 2014; Feitosa et al., 2017). Four species of sawfish are believed to have been historically present in Bangladeshi waters (Hoq et al, 2011. Sawfish rostra were reported to be 'all over the beach' of Cox's Bazaar in the 1960s (Anonymous 2010) with a significant decline. A recent study revealed the catch of 24 largetooth sawfish, mostly landed in the south eastern coastal region of Bangladesh (Haque, in prep.) and documented the existing trade without further documentation in details hampering effective conservation measures.

Guitarfishes are the most neglected elasmobranch species in Bangladesh from the conservation perspective and no species-specific data has been collected so far but Haque et al, 2018 reported the existing catch and trade on these species without any regulations. They are globally targeted for their high value of fins and meat which resulted in global population decline and sometimes localized extinction (Jabado, 2018). Understanding the detailed trade and awareness amongst the fishers is cardinal for their conservation in Bangladesh.

The endangered hammerheads are caught in the waters of Bangladesh indiscriminately. They are caught in all life stages from pregnant females to very young pups and juveniles. An ongoing landing site study conducted between 2016-2017 revealed catch of thousands of individuals from on landing site only and one of the biggest catch of elasmobranchs in Bangladesh (Haque, in prep.). The trade on meat, head, skin, fresh and dried meat existed nationally and internationally.

Out of 11 species of *Mobula* rays seven have been reported from Bangladesh (Haque, unpubl data.). Globally the population of these species has declined due to indiscriminant by-catch and targeted catch and for the demand of the gill rakers. We have encountered the trade in mobulid gill rakers (Haque et al., 2018) as an emerging business in Bangladesh and the trade will decline the population within no time.

This project emphasized on the benefit of all sharks and rays caught in Bangladesh and enter the domestic and international trade specially the following:

Table: 1 List of elasmobranch species reported in Bangladesh

Sl. No.	Family	Species	Common Name	CITES listing	IUCN status	National protection[1]
1	Sphyrnidae	*Sphyrna lewini*	Scalloped Hammerhead	APP.II	EN (2007)	Schedule I
2	Rhincodontidae	*Rhincodon typus*	Whale Shark	APP.II	EN (2016)	Schedule I
3	Carcharhinidae	*Carcharhinus brevipinna*	Spinner Shark		NT (2005)	NP[2]
4		*Carcharhinus leucas*	Bull Shark		NT (2005)	NP
5		*Carcharhinus sorrah*	Spottail Shark		NT (2007)	Schedule I
6		*Carcharhinus amblyrhynchoides*	Graceful Shark		NT (2005)	NP
7		*Galeocerdo cuvier*	Tiger Shark		NT (2005)	Schedule I
8		*Scoliodon laticaudus*	Spadenose Shark		NT (2005)	Schedule I
9		*Carcharhinus amboinensis*	Pigeye Shark		DD (2005)	NP
10	Hemiscylliidae	**Chiloscyllium burmensis**	Burmese Bambooshark		DD (2008)	NP
11	Myliobatidae	*Mobula mobular*	Giant Devil Ray	APP.II	EN (2014)	NP
12		*Mobua kuhlii*	Shortfin Devil Ray	APP.II	DD (2007	NP
13		*Aetomylaeus maculatus*	Mottled Eagle Ray		EN (2006)	NP
14		*Rhinoptera javanica*	Javanese Cownose Ray		VU (2006)	NP
15		**Rhinoptera jayakari**	Oman Cownose Ray		-	NP
16	Gymnuridae	*Gymnura poecilura*	Longtail Butterfly Ray		NT (2006)	Schedule II
17	Dasyatidae	*Neotrygon indica*	Blue-spotted maskray		-	NP
18		*Pateobatis uarnacoides*	Bleeker's Whipray		VU (2004)	NP
19	Glaucostegidae	*Glaucostegus granulatus*	Sharpnose Guitarfish		VU (2006)	Schedule I
20		*Glaucostegus obtusus*	Widenose Guitarfish		VU (2006)	NP
21		*Glaucostegus typus*	Giant Shovelnose Ray		VU (2003)	NP

[1]Wildlife (protection and security) Act, 2012, Bangladesh
[2]Not protected

2. Goals and Activities

2.1 Aims and Goals

The project aimed at identifying and documenting the market chain of shark and ray products from targeted and non-targeted catch, landing, processing till ready for domestic use and export to black markets internationally. This study has identified the different stakeholders (e.g. fishers, traders, retailers, middle man, collectors, processing centre owners, workers and consumers) and analyzed their motivation to trade and consume on such products and how to minimize the impacts with active involvement of them. The transportation and export routes of different products (National domestic use to International use) has been mapped to further inform decision making in shark and ray conservation in Bangladesh.

With the collected data, the most threatened species of sharks and rays in the Bay of Bengal, Bangladesh region with a map of most exploited region has been unveiled, paving the way for prioritizing conservation needs for further work in terms of species and habitat.

The most important achievement of the project has been gaining the trust of fishers and traders to involve them in the next phase data collection from the Bay and pioneering sustainable management of the species. A conservation narrative has been initiated keeping the importance and capacity of the locals to change the paradigm of top-down conservation actions.

Some key achievements of the project:

- **Achievement 1.** Identification the market chain and different stakeholders involved in shark-ray trading
- **Achievement 2.** Identification of the most traded species and make a comprehensive species composition in the landing sites
- **Achievement 3.** Developing a network of fishers and locals to collect data on most threatened species (e.g. Sawfsh).

2.2 Activities and Timescale

The main activities of the project are listed below including a timeline. Some of the activities will overlap with each other as they have been conducted simultaneously.

2.2.1 Identification of market chain (October 2018 - June 2019)

The project identified the market chain of all products that are being processed and marketed according to the demand nationally or internationally. This activity was implemented by identifying all stakeholders and interviewing and documenting all trade aspects from value to the perception of the traders and their motivation using structured questionnaires. Elderly fishers and traders were the key informants for in depth interviews on the subject matter. Traders and wholesale buyers were surveyed through snow ball sampling and random opportunistic informal interviews. Different stakeholders (buyers, sellers or middlemen) were asked question for a period of 1 hour about the type of products available, their processing, preservation prices, selling and buying prices of various kinds of shark and ray products.

2.2.2 Training of locals and students to collect landing data (October-December, 2018))

Local students and processing centre workers were trained to collect data on everyday landing of sharks and rays with photographs for the team to analyse later to understand the species composition in landing sites and traded species.

2.2.3 Landing data collection check and improvement (October 2018-May 2019)

The morphological and biological data collected from the landing site of the four study areas enlightened this research with in depth understanding of elasmobranchs' physiology, their size, weight, gender, disc width, tail length and life stages in Bangladesh's catch pattern.. Volunteers were appointed to collect data from the landing sites for a period of 15days, every month, since the starting date. The research team visited the landing and processing sites every month twice (10 days each month) for collecting biological data and check if the local data collectors are generating good set of data and improve during the timeline.

2.2.4 Establishment of a network of fishers and locals to collect data on most threatened species

It is cardinal to build trust amongst locals and try and understand their perspective to collect such sensitive data on undocumented trade which can be illegal as well. This is also important to pursue any conservation action plan and sustainable management for such fisheries. They need to be a big part of it for effective conservation and making a narration for conservation pioneered and conducted by the fishers and traders themselves. The relationship and the trust can only be built under the circumstances of continuous visits and knowledge sharing. This technique is the 1st step to achieve success in any community led conservation action.

3.   Methodology

3.1 Overview
Working with and extracting information from shark and ray traders is a vastly challenging endeavor. They are, concerned about losing their income because of fishing restrictions from conservation efforts. On the other hand, they are also concerned about the depletion of marine fisheries. The traditional wisdom for marine conservation has been to think of the fishermen and traders as a problem or hindrance to conservation. However, a stakeholder inclusion approach can be extremely beneficial to both conservation efforts and the people who depend on marine fisheries. It is important for the fishermen to understand that conservation efforts are aimed to sustain Shark and Ray populations, as well as, marine fisheries in general. There has been very little scientific study on the undocumented and unregulated trade of Sharks and Rays. Therefore, this study has chosen a more inclusive trust building approach – incorporating fishermen and traders into the project, conducting regular field visits and interviews. During the two years of working with the local fishermen and trader community, we have developed a good relationship with them.

The need to cross validate collected data and taking interviews, as well as, opportunities of encountering new data on potential flagship species (e.g.: sawfish, hammerhead sharks and guitarfish which are all endangered species) necessitate regular field visits.

Key Informant Interviews are needed to unravel the historic trend of shark and ray fisheries in Bangladesh. On the other hand, building awareness from early on is very beneficial to our overall goals. Hence, we have planned to reach out to civil society, policy makers and the scientific community and provide awareness raising content such as published posters, documentary videos and booklets.

3.2 Study Areas
Regular field visits were made to four crucial areas lying in the southeastern edge of Bangladesh. Cox's Bazar, Chittagong, Saint Martins and Teknaf. These areas are considered to have the biggest shark processing centers in Bangladesh as revealed by previous studies. These sites were chosen based upon their geographical location along the southeastern coasts of Bangladesh which acts as representative of 4 major sea basins in Bangladesh. Moreover, these areas are considered to be potential hubs for shark landing and trading as reported earlier on scientific journals, reports, research, newspapers, etc.

For investigating trade chains and collecting socioeconomic data of fishermen, the study activities will be concentrated in fish markets and fishing villages located in these four potential areas in the Southeastern Bangladesh where shark and ray fisheries are particularly prevalent.

- Cox's Bazar : It is the world's longest sea beach located at 21.583333°N 92.016667°E. Kolatoli town, where the landing site is located is bounded by Bakkhali River on the north and east, with Bay of Bengal in the west ("Cox's Bazar," n.d.).
- Chittaong: Located at 22°22′0″N 91°48′0″E, the city sits on the bank of the river Karnaphuli between the Chittagong Hill Tracts and the Bay of Bengal. Officially known

as Chottogram, it is a major coastal city and financial center of south-eastern Bangladesh. The port of Chittagong is the principal maritime gateway of the country. Chittagong port is the busiest international seaport on the Bay of Bengal and the third busiest in the South Asia region.

- Saint Martin's Island: It is a small island with an area of 8km^2 and 6km in length. It is situated in the northeastern part of Bay of Bengal forming the southernmost part of Bangaldesh with co-ordinates at 20°36′47″N 92°19′36″E. It is the only coral island in Bangladesh which makes it geographically and biologically unique marine zone ("St. Martin's Island" n.d.).
- Teknaf : Teknaf is an upazila of Cox's Bazar with an area of 388.68 km². It is named after Naf River which forms the eastern boundary of the region located at 20.8667°N 92.3000°E. The region is flourished with riverine estuary and the estuarial sediments to support diverse ecosystems ("Teknaf," n.d).
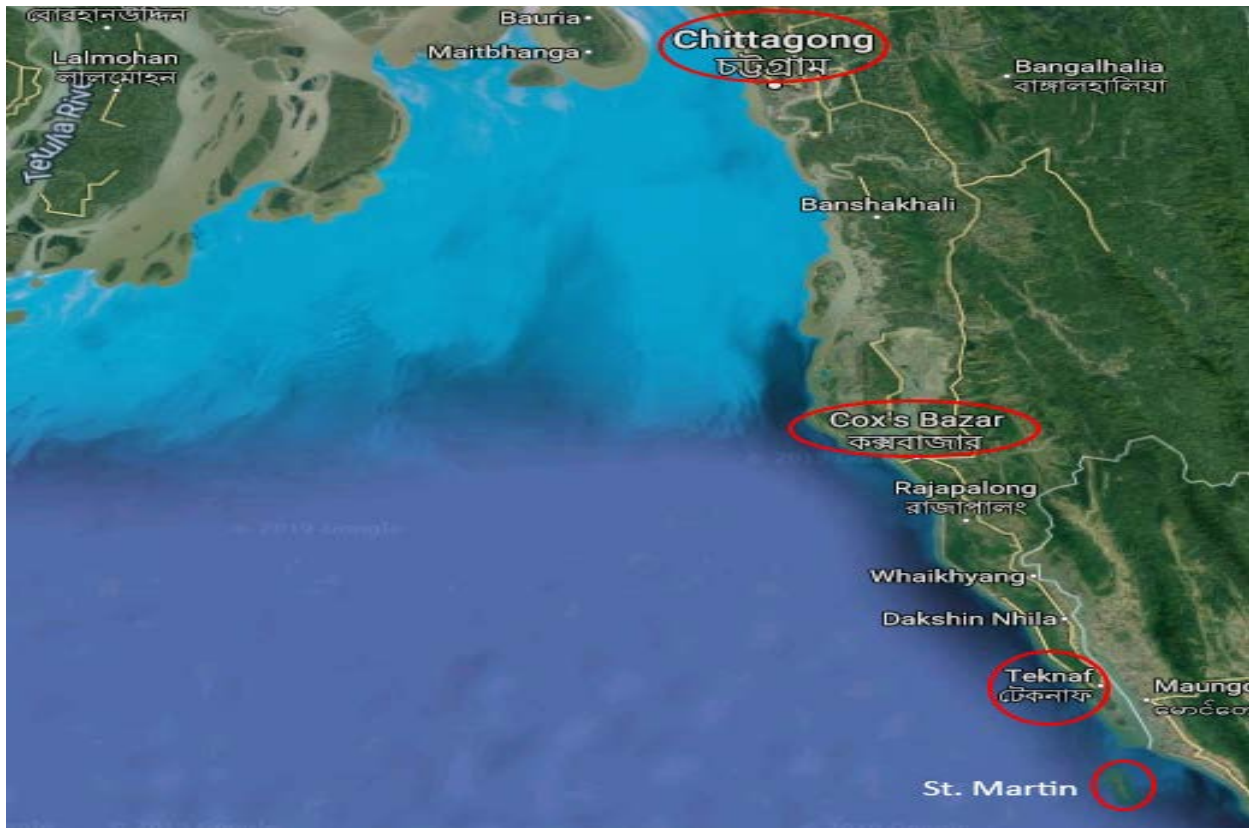

Figure 1: Map showing the geographic locations of the study areas

Semi-structured interviews were conducted among the fishermen communities in few fishing villages. Below is a table with a list of villages where these interviews took place:

Table 2: Names of villages in each surveyed Areas with their respective GPS coordinates

Village Names	Area	GPS Locations
Nuniar Chara	Cox's Bazar	21° 27' 25.58" N, 91° 58' 00.33" E.
Tuitta para	Cox's Bazar	21° 26' 53.11" N, 91° 58' 09.11" E.
Mudir Chara	Mosheskhali, Cox's Bazar	21° 37' 27.72" N, 91° 56' 41.29" E.

Gola chipa	St. Martins	20° 37' 58.60" N, 92° 19' 37.53" E.
Kurer Mukh	Teknaf	20° 51' 33.52" N, 92° 15' 54.84" E.
Mundar Dhil	Teknaf	20° 49' 55.98" N, 92° 16' 50.89" E.
Harir Chora	Teknaf	20° 49' 12.44" N, 92° 17' 14.14" E.
South Kattali	Chittagong	22.350901, 91.772077
Fishing Harbour	Chittagong	22.314725, 91.826622

4.   Results

The findings from the research highlights some key information regarding the fishing pressure, fisher's perception, trade routes and the number of sharks landed in the landing centers of Cox's Bazar, St. Martin's, Chittagong and Teknaf. Bangladesh being next to India (i.e. second largest shark product market) fails to document the emerging market of shark and ray products within its national boundaries, hence this study is a steppingstone in highlighting some crucial threats due to unsustainable fishing practices and trade.

4.1 Fishing pressure exerted by surveyed fishermen

Fishers in the Bay of Bengal extract fish resources from 40 m depth to 200 m depth, exhausting around 32440 km^2, Bangladeshi waters. Different types of boat cruise the bay which are classified as shallow water artisanal boat exercising in waters up to 40m deep, mid-water trawlers at depths of 40m to 200m and long-liner trawlers cruising from 200m to the end of Exclusive Economic Zone (EEZ) (Shamsuzzaman, Xiangmin, Ming, & Tania, 2017; Islam et al., 2017); however, this study classifies the boats according to their horsepower and maximum fishing distance travelled. The artisanal boats are both motorized and non-motorised, accommodating an array of fishing gears including drift gill nets, set-bag nets, long-lines and trammel nets (FRSS, 2016); only 242 registered trawlers are allowed to fish in these zones of Bangladeshi waters (MoFA, 2014) but an estimated 67,669 unauthorised fishing vessels (of which 51% were non-motorized boats), were also in operation currently (Shamsuzzaman, Xiangmin, Ming, & Tania, 2017). These artisanal fishers mostly target Hilsa (Tenualosa *ilisha),* Rupchanda (Pampus *chinensis)*, Shrimp (Caridea), Loitta (Harpadon *nehereus*), Bailla (Awaous *guamensis*), sharks and rays and many more marine fishes. The industrial fisheries in this region operate solely from Chittagong, where large commercial trawlers use trawl nets for bottom and mid-water trawling (FRSS 2016) which scavenges anything that follows its path. In 2016, at least 32 industrial shrimp trawlers and 152 trawlers targeting demersal fishes were registered to operate in the Bay of Bengal and waters off Bangladesh (FRSS, 2014). Previous studies estimated that, at least 21,726 motorised vessels and 23,963 un-motorised vessels were already engaged in artisanal fisheries along the coasts of Bangladesh in 2012-2013 (FRSS 2014). The increasing rate of IUU fishing in Bangladesh and all other ocean waters, are disrupting the stability of marine ecosystem both locally and globally.

In the conducted surveys, it has been observed that fishing practices vary according to their location, standard of living, trawler capacity, fishing sites, etc. Teknaf and St. Martin's have mostly reported daily fishing practices with small sized boats with horsepower no more than 25hp and storage capacity limited to 4000kg with maximum area of 35.22 km. Findings show the percentage of respondents who reported fishing in each season. Noteworthy is that, almost none of the fishermen fish during the summer (during Kal Baishakhi, a local name given for regional cyclones). Due to government ban and unfavorable weather conditions, fishing in June, July and October are completely ceased. Contrarily, overexploitation of marine species, mostly megafaunas like sharks and rays are also targeted due to the rising international demand for their various parts. This shows that if the existing fishing pressure continues to increase exponentially then the future for these giants in the sea remains highly uncertain with even low levels of artisanal fisheries. According to the study, fisheries in the Bangladeshi part of the Bay of Bengal are highly complex, unreported, dynamic and opportunistic. The information is vital for developing a science-based,

community informed plan of action for conservation management and enhanced awareness of traders and fishers regarding these taxonomically challenged species having prolonged gestation period and very low reproductive potential. Hence, these marine mega-faunas are susceptible to even low opportunistic bycatch and more threatened by targeted fisheries. This calls for an immediate action plan for the conservation of sharks and ray species in Bangladeshi waters.

4.2 Elasmobranch Trade Networks

Traders and wholesale buyers were surveyed through snowball sampling and random opportunistic informal interviews. Different stakeholders (buyers, sellers or middlemen) were asked question for a period of 1 hour about the type of products available, their processing, preservation prices, selling and buying prices of various kinds of elasmobranch products. The flowchart 4.2 shows that the fresh meat of sharks and rays (whole body) bought from the landing sites are either taken to small scale processing locations (meat died on thatched roofs) or large-scale processing centers. From both the locations the specimens are locally distributed to the tribal communities (Burmese, Rakhain) and from the big centres it is regionally distributed to areas in the north eastern parts of Bangladesh. The tribal communities of Rajshahi, Rangpur, Khulna and Barisal districts are potential consumers of elasmobranch products, therefore traders from these areas often visit Cox's Bazar, Teknaf, Chittagong or St. Martins, in search of their dry meat. One key informant, Md. Amin from St. Martins, reported that ethnic communities of North Bengal use sharks and ray products to make talismans for good fortunes. In fact, these indigenous communities also make tonics or potions which they direly believe cure diseases and also help females to conceive children. Another trader from Chittagong (Shundangshu Jonodash) reported that gill rakers, skin, fins, liver, bones, etc. of very large sharks and rays have no domestic demand and are exported with high prices to the countries such as Myanmar, Thailand, Hong Kong and China. Noteworthy is that, rarely any parts of sharks and rays are discarded even ears, tails, intestines and livers are sold at a disposable rate to local tanneries or fish feed industries.
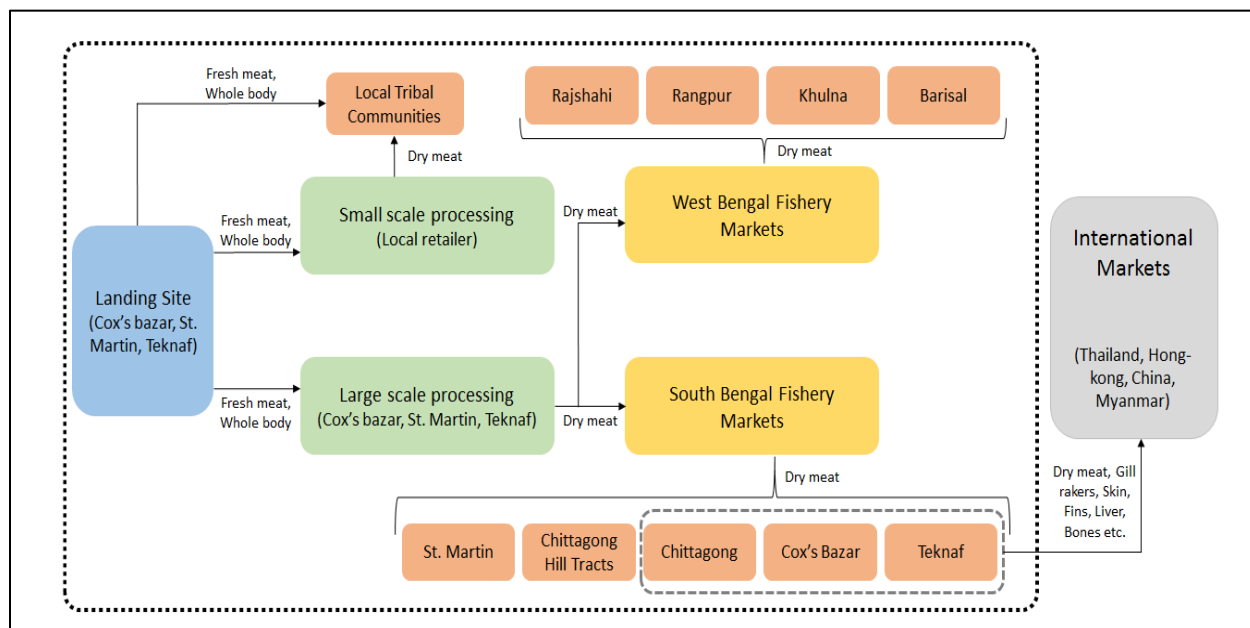

Figure 2a: Process flow showing the possible trade routes of elasmobranch species and its processed parts
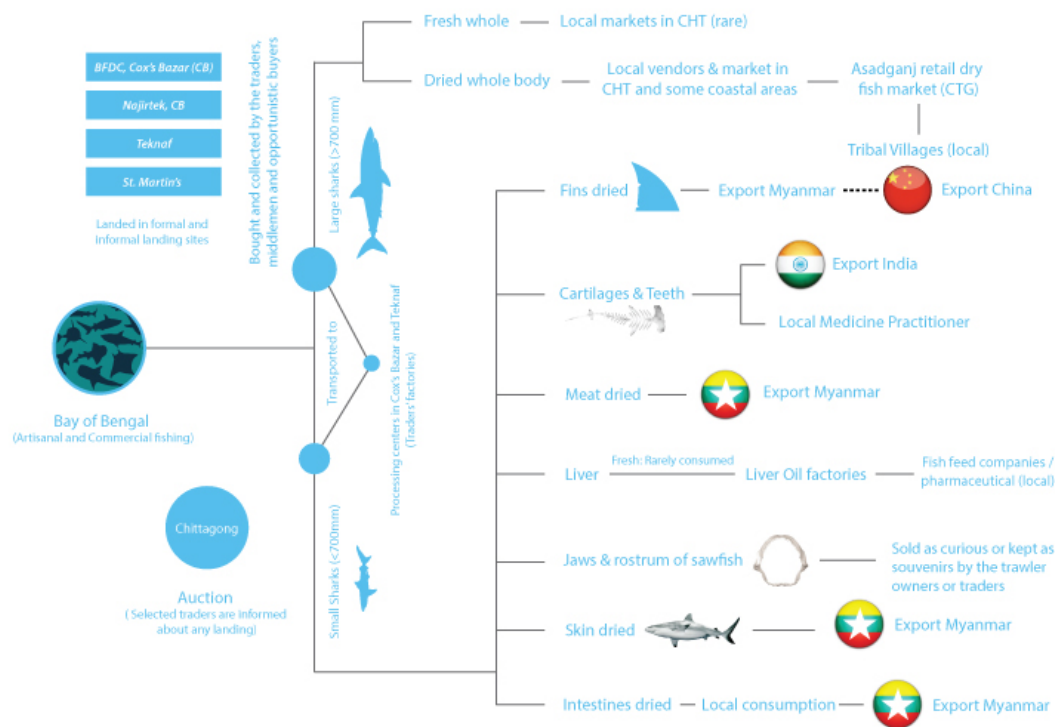
Figure 2b: Process flow showing the possible trade routes of elasmobranch species and its processed parts

4.3 Fishermen perception on decreasing trend of elasmobranch species

During the survey each fisherman were asked few questions for better perceptions on the population trends of sharks and rays considering some common reasons. All the reasons illustrated on the chart 4.4.1 show broader terms for numerous other similar reasons. The common terms were sorted according to the answers given by the 469 respondents among which 200 were targeted for myliobatiformes (*Mobula* rays, eagle rays, cownose rays), 200 were targeted for guitarfish and 69 for all species belonging to the elasmobranch group during the questionnaire survey. Some of the major decreasing reasons are:
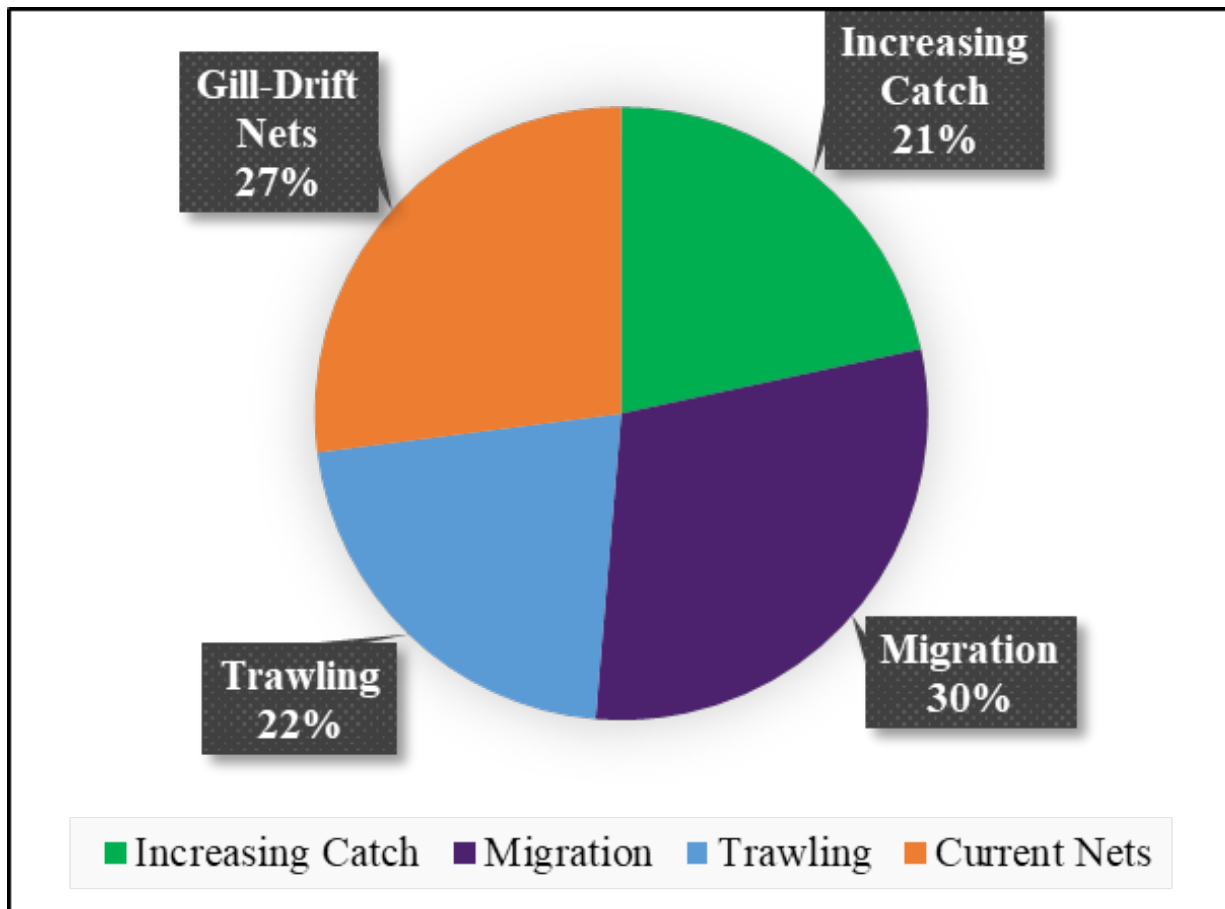
Figure 3: Percentage of respondents mentioning each reason of elasmobranch population decrease

For decreasing trend,

- Species Migration: Among the four major reasons for species declination, species migration has the highest ratio (30%). Fishermen informed that the sound of cargo ships and their frequent shipment in the nearby ports, are forcing elasmobranch species to shift their habitat or in many cases become locally extinct.
- Drift-Gill Nets: These marine megafaunas are extremely vulnerable to use of unregulated nets such as current nets (27%). Even the mesh size of some floating and submerged nets pose threat to the survival of the sharks and rays since their large gills or size get easily entangled to this type of nets.
- Trawling: Offshore trawling and dredging of sea floor captures anything that follows their way. Hence, trawling carrying trawl nets contributes almost 22% among all other reasons.
- Increasing Catch: Many fishermen also claimed that sharks and rays are being targeted by large sized fishing boats that go far as Myanmar borders. According to the surveyed fishermen, there exist a viable population of elasmobranch harboring in or near Bangladeshi waters. However, due to unregulated fishing practices and lack of monitoring, such populations fail to continue its breeding resulting in huge population declines. Moreover, the difference between 'increasing catch' (21%) and 'trawling' (22%) are just by 1 unit, which shows both the reasons should be addressed with equal importance next to migration and current nets.

5. Discussion

5.1 Community based conservation practices
To develop a sustainable fishing community, it is of utmost importance to assess the socio-economic status of all the stakeholders engaged in the fishing industries. In developing nations like Bangladesh, community outreach with school children, fishers, traders, local NGOs and government officials should be initiated to promote conservation awareness for underrepresented elasmobranch species. The use of traditional ecological knowledge (TEK) along with modern techniques by prospective conservationists will help build a concerned community aiming towards a sustainable future in marine fisheries. Particularly, this research helped to build networks with stakeholders at different stages of the elasmobranch catch and trade. Potential traders and fishers were identified for conducting workshops on live release and habitat mapping in the future phases.

Primarily, a small portion of the fishers will be trained and appointed as citizen scientists to promote elasmobranch conservation in all over Bangladesh. It is necessary to aware the fishers and fish traders that if these majestic marine creatures belonging to the elasmobranch group cease to exist then it will have adverse effects on national food security since the studied species are vitals components of the marine food chain which helps in maintaining the artisanal fish production. Hence, well thought action plans must be prepared to promote legal monitoring system and consciousness. The perceived knowledge of the fishers on fishing pressure and traders on trade routes may not be scientifically proven yet they do provide us with an estimation of the overall scenario about the elasmobranch species and their understanding in the surveyed fishing communities of Bangladesh. Even socio-ecological data on elasmobranch trade helped us to map the supply chain of potential products and their prices in both national and international markets. The findings from questionnaire survey depicts that there is a rising black market of shark and ray trade over the last decade which have posed threat to the sustainability of shark ecology.

Information gathered from traders guided us to establish a distribution flow chart of various products of shark and ray parts, which gives a visual illustration about the trade chain and demand of elasmobranch products to better aid their conservation and evidence-based management.

5.2 Products and Trade

Products of elasmobranch species are sold both fresh and dried with hardly any discarded parts. Often, they are the results of the emerging target shark fisheries adding supply chain value to the global demand of shark products either for aesthetic purposes or superstitious beliefs. Key informants during the survey told us stories about their involvement in shark trade and their various categories of customers. Many of the processed parts such as dried meat are locally consumed by indigenous communities (Local consumers) as source of protein or diet tradition. Some are consumers in disguise of apothecaries (Kabiraj) from North West Bengal who believe that certain parts of shark and rays species help to cure certain diseases. Others are mostly foreign traders and consumers from Myanmar, China, Thailand, Hong kong etc. Since there are no strict regulatory law on elasmobranch species, therefore their trade remains a mystery as they are mostly traded in waterways which are comparatively hard to report and monitor given the country fails to implement proper catch quotas within the territorial boundaries of Bangladeshi waters. However, traders and fishers should be included in government decision making to compensate for the small

portion that they earned from shark fisheries. The illegal and undocumented trade routes must be identified to insert catch restrictions of elasmobranch species and to do that, this study was a first attempt to create a baseline data for future in-depth studies encompassing all the coastal areas of Bangladesh.

5.3 Challenges and future directions

Maximizing conservation outcomes of sharks and rays' fisheries requires understanding where and when geographical restrictions can provide highest benefits. Selecting areas to mark as shark and ray focused marine reserves can be one way of addressing systematic conservation. However, the nature of fishing practice in cases such as Bangladesh is quite complex and dynamic. In developing and agro-based countries like Bangladesh, fishing sector contributes significant portion to the nation's economic growth, estimated to be around 4.43 per cent to GDP (Bangladesh Ministry of Fisheries and Livestock, 2012). Fisheries in Bangladesh directly or indirectly employ approximately 9.6% (15million) people of a total population of 155million. 15% of total protein intake comes from 60% of fish meat which constitutes as a large part of national diet in Bangladesh (Bangladesh Bureau of Statistics, 2011a; Belton et al., 2011; Hussain, 2010). Not only food source, fish is also a major part of Bangladesh's culture with 73% of rural households involved in aquaculture (Alam and Dey, 2011; World Bank, 2017a). Both inland and maritime fisheries of Bangladesh are mostly artisanal where maritime fishing accounts for only 17.27% (Bangladesh Ministry of Fisheries and Livestock, 2014). Therefore, to restrict catch and trade on elasmobranch species require bottom-up approach where each stakeholder will be equally and rationally compensated for their opportunity cost of releasing the catch. Strategic and cost-effective incentives should be settled through filtering and understanding the social dimensions of success. Prospective action plans should include both subjective and objective indicators because stakeholder participation and behavior influence social sustainability. To address such issues, the local stakeholders must be aware of the importance of sharks and rays (marine top predators) in the marine ecosystem, international and national law and also about their taxonomic vulnerabilities.

6. Conclusion

Unreported and unregulated shark and ray fisheries are exerting immense pressure on the viable population of these giants in the Bay of Bengal. As mentioned earlier, there is no baseline data on many CITES designated elasmobranchs in Bangladesh, hence this study is the first of its kind to do a species-specific research on these vulnerable group of elasmobranch species. The study primarily focused on evaluating the existing fishing pressure and community dependence on sharks and rays' products. Additionally, the study also focused on the potential trade routes of elasmobranch products through intensive interviews with the trader and prevailed in identifying threatened shark and ray species from landing site data.

In order to develop a concrete and comprehensive understanding on elasmobranch species, studies must be assessed over several years for more scientific and evidence-based action plans and policies. The nine months survey period is not enough for future predictions and conservation efforts. This research considered only four study areas for primary data collection, which is inadequate to get a comprehensive understanding of existing fishing pressure and potential trade market of elasmobranch species at a national scale. More in-depth studies are required to completely understand the biology and identify their probable hotspots. Both morphological and phylogenetic data over multiple years are recommended to understand and identify the species accurately. Alternative livelihood and community outreach with school children, fishers, traders and government officials are exclusively required with introduction of soft regulatory measures before strict policies. There remains much hope if effective collaborative measures are established among the BOBLME countries to relentlessly monitor and regulate any attempt to do harm to these CITES species at a regional scale. Hence, this study is a steppingstone in opening windows of opportunity to do more evidence-based research on sharks and rays in Bangladesh.

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APPENDICES

Appendix I
Survey Questionnaire for Fisher

Interviewer's Information

Name	
Location & (GPS)	
Date	

Respondent Information (personal)

Name	
Age	
Sex	
Present residence	
Duration in present residence	
Origin	
Position in boat	
When did you move	
Why did you move	
Education	
Occupation	
Secondary occupation	
Income from secondary occupation (monthly)	

Main Income

Salary		
Profit		
Per trip	Per month	Per year
Are you the only person who incomes for your family?		
If not, what your other family members do as livelihood?		
Are you involved in any type community participation?		

Fishing Gears & Practices

Fishing season	Annual/except for monsoon/Only winter
How many times a month you go for fishing:	
How many days per trip?	
Do you go for daily fishing?	

Is there a specific time you catch fish?	
Where do you go for fishing?	
Origin with GPS	
Direction:	
Distance:	
Time of travel:	
In which depth do you fish:	

Gear

What is the primary fishing gear:				
Stretched mesh size	Normal mesh size	Length	Depth	Sub-merged/floating
Operation of gear:				
Soak time		How many times a day		When
What is the secondary fishing gear:				
Long line Yes/No/often	If yes, Hook no.		Length of line	
Soak time		How many times a day		When
2/3 big hooks (often)				
Y	N	Often		

Trawler/Boat

Trawler length	
Width	
Wooden/Steel	
Engine (HP)	
Number of fishers	
Number of laborers	
Storage capacity	
Cost of Trawler	
Cost of Net	
Cost of hook	
Cost per trip	
Owner of net and boat	

Target species

Target 1	
Target 2	
Target 3	
Target 4	
Target 5	
Others	

Mobula **Rays information**

Number of *Mobula* species	
How do you know?	
Can you Identify?	

*show the pictorial guide

Species	Yes	No	Not Sure	Weekly/Monthly/Annual catch
1.Mobula japanica				
2.Mobula kuhlii				
3.Mobula Mobular				
4.Mobula tarapacane				
5.Mobula thurstoni				
6.Mobula eregoodootenkee				
7.Mobula birostris				
8.Mobula alfredi				
9. Mobula rochebrunei				
10. Mobula munkiana				
11. Mobula hypostoma				

Trend

Have you ever target them?		
What do you think of the size of the fish?		
Increasing	Decreasing	Same
What about the catch amount?		
Increasing	Decreasing	Same

Ecological and Biological Information

From where they are mostly caught?	
Breeding season?	
How can you tell?	
How many times a year do they pup?	
How many pups do they give?	
Which size of these species are mostly caught?	
In which season do you mostly seen?	
How many did you catch the last season:	

Perception Study and Law

Do you think *Mobula* rays are important? Yes/No/I don't know	
Why	Why Not
What are reasons for increasing/decreasing number of *Mobula* rays?	
1. 2. 3. 4.	
What can be done to protect *Mobula*?	
What changes have you noticed about this species in all these years of your experience? What are the reasons for such differences:	
Have you noticed any species that is not available at present (but were abundant in the past)	
Do you think *Mobula* rays are an important part of the ecology?	
Yes, Why	No, Why Not

Benefits of *Mobula* rays	
After you catch *Mobula* rays, what do you do?	

Appendix II
Survey Questionnaire for Trader

Interviewer's Information

Name	
Location & (GPS)	
Date	

Respondent Information (personal)

Name	
Age	
Sex	
Present residence	
Duration in present residence	
Origin	
Position in boat	
When did you move	
Why did you move	
Education	
Occupation	
Secondary occupation	
Income from secondary occupation(monthly)	

Main Income

Salary		
Profit		
Are you the only person who incomes for your family?		
If not, what your other family members do as livelihood?		
Are you involved in any type community participation?		

General Trade Information

Do you buy *Mobula*?	
From where?	
Who are the main buyers of *Mobula*?	
How many buyers are there in CB?	
How many types of buyers?	
How much you buy a season?	
2000-05	
2005-10	
2010-15	
2015-2018	

Whole body or meat or other products?	

Price

Product	Buying Price per kg	Selling price/kg	L/E	Uses
Fresh Meat				
Dried Meat				
Skin/Tail				
Gill Plates				
Liver				

What is the cost of preservation (per kg)

Product	Salt drying	Drying without salt
Fresh Meat		
Dried Meat		
Skin		
Gill plates		
Liver		

Other Information

What is the processing of *Mobula* rays?	
What is the location of selling?	
Do the buyers keep track of *Mobula* they want? How:	
Which species do the buyers want the most:	
Which are the most valuable parts of *Mobula*?	
Which products are made from *Mobula*?	
What do the buyers do after buying *Mobula*?	
Is there any law about trading *Mobula*?	
What is it?	

Supply Chain Structure

What do they do after buying *Mobula* from fishermen?	
How do they transport them?	
What is the cost of transportation?	
What are the main locations:	
How do they preserve them?	
How long they can be preserved?	

Appendix III
Landing Site Datasheet

SL	General Features										Morphological Features			
	Photo ID	Common Name	Scientific Name	Trader /buyer	Target or by-catch	No. of catch	Fishing Gear	Sex (M/F)	Life stage	Pregnancy status (Y/N) +Pup no.	DW	DL	TL	W
1														
2														
3														
4														
5														
6														