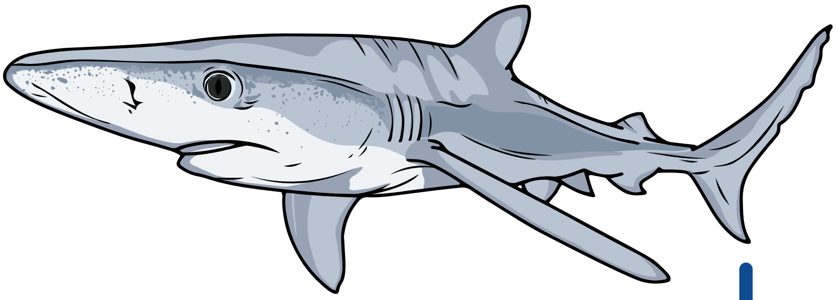

Blue Shark:
Economic valuation of the global market for blue shark products and interdependent policy analysis for sustainable management and trade

Final Report

November 2022

By POSEIDON
AQUATIC RESOURCE MANAGEMENT

in association with

China Ocean Institute 中国海洋研究所

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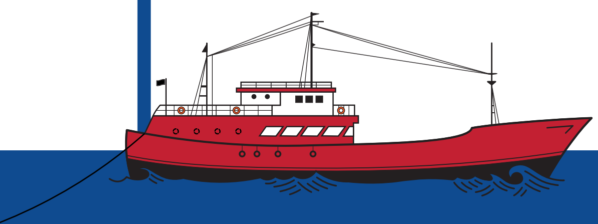

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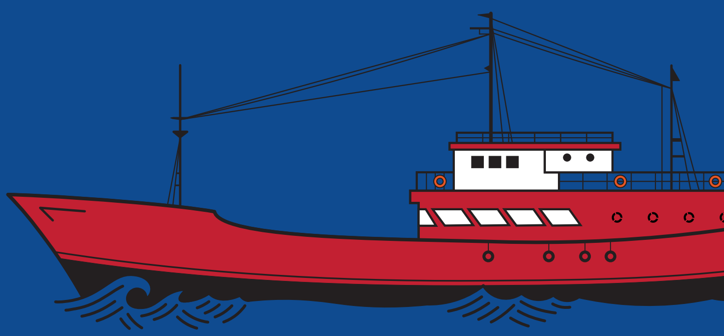

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Authors:

Rod Cappell, Poseidon

Gilles Hosch, Diatom Consulting

Tim Huntington, Poseidon

Pablo Pita, University of Santiago de Campostela (USC)

Sebastian Villasante, USC

Gill Ainsworth, USC

Tabitha Mallory, China Ocean Institute

Hao Chen, China Ocean Institute

Luke Perry, Poseidon

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EXECUTIVE SUMMARY

Shark catches and particularly trade data are often not reported to species level. There are also major discrepancies between reported catch and traded volumes of shark (Clarke, 2006). But where species are reported in catch and trade data, the dominance of blue shark (*Prionace glauca)* in both the meat and fin trade is evident. The grouping of numerous shark species under generic catch and trade reporting hides the commercial importance of species like blue shark.

This Poseidon report for Oceana involved a multi-disciplinary team of researchers to determine the global and regional significance of blue shark fisheries. It estimates the global blue shark catch, maps trade in the species, calculates economic values for blue shark and explores the policies and management measures in place.

The report finds that there is relatively limited direct management of these valuable resources and identifies where improvements should be made. Improvements are also needed regarding labelling blue shark products. These, along with other actions like tackling Illegal, Unreported and Unregulated (IUU) fishing by Distant Water Fleets and raising consumer awareness, would help to ensure blue shark resources are fished sustainably, and would benefit other, often endangered, shark species that are currently caught up in these fisheries and trade.

Blue Shark Catch

The estimated global catch (landed) of blue sharks in 2019 was **189,783 tonnes (t)** Live Weight Equivalent (LWE)**.** At an average of 27kg per shark (Coelho et al, 2017), this amounts to over 7 million blue shark landed in 2019. This estimated global figure for blue shark catch is obtained by reconciling data reported by flag States to both FAO (Fishstat J) and Regional Fisheries Management Organisations managing tuna & tuna-like species (t-RFMOs), using the highest of both reported figures. This estimate represents a conservative minimum with low uncertainty. Unreported catches and illegally harvested and landed or transhipped catches inevitably bypass reporting – leading to gaps of unknown size in global catch data for blue shark.

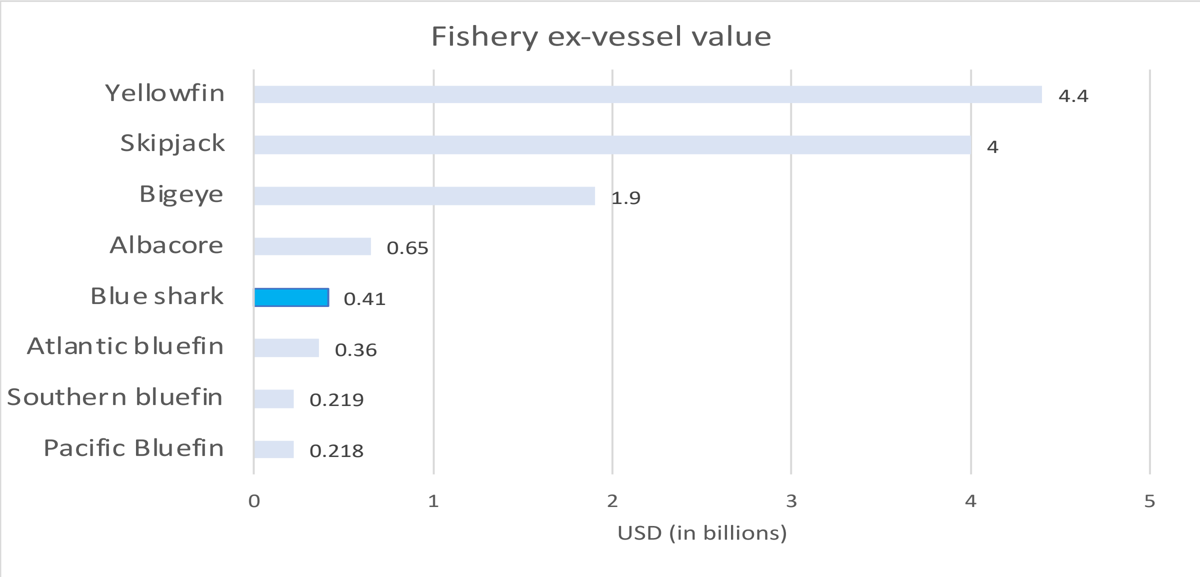
The Pacific Ocean accounted for 53% of the reported blue shark catch in 2019. The Atlantic and the Indian Oceans accounted for 34% and 13%, respectively. The Southwest Pacific sub-oceanic basin yields more catch of blue shark than the Atlantic and the Indian Oceans together.

Taiwan and Spain catch as much blue shark as all other flag States globally combined. The top five blue shark fishing nations (Taiwan and Spain, along with Japan, Indonesia and Portugal) account for close to 80% of global blue shark landings.

Most blue shark catch is targeted; it is misleading to merely consider blue shark as 'just bycatch' in tuna and swordfish longline fisheries. Large-scale commercial fleets harvest 90% of blue shark catches, the overwhelming majority of which are long-liners. Distant Water Fishing nations catch 74% of the global blue shark catch. Small-scale fisheries make a minor contribution to the global blue shark catch, except in the Indian Ocean.

The ex-vessel value of blue shark meat and fins in 2019 is estimated to be **$411 million.** The total value of blue shark meat is five times more than the value of the fins at this stage in the supply chain. This value exceeds the estimated 2018 ex-vessel values of each of the three bluefin tuna species (Figure A).

Figure A Global ex-vessel value of tuna species (2018), and minimum global ex-vessel value of blue shark (20182019) (source: Poseidon)



Although finning and dumping of carcasses has likely diminished with the rising value of shark meat globally, incentives to engage in finning remain, particularly where shark meat remains undervalued, or in fisheries where non-shark target catch (e.g. tuna and swordfish) is a lot more valuable than shark; where high-grading at sea makes financial sense at given times, and where reefers continue to accept illegal consignments of fins at sea.

The reconciled global catch estimate of 189,783 t is 9% higher than an estimate by Sea Around Us project, which also estimates that over 81,000 t of blue shark is discarded. Including these discards increases the estimated number of blue shark caught to over 10 million individuals. If we assume that those discards are illegally finned, then an additional quantity of blue shark fins would enter the market and the total ex-vessel value for meat and fins increases by 7% to $441 million.

Blue Shark Trade

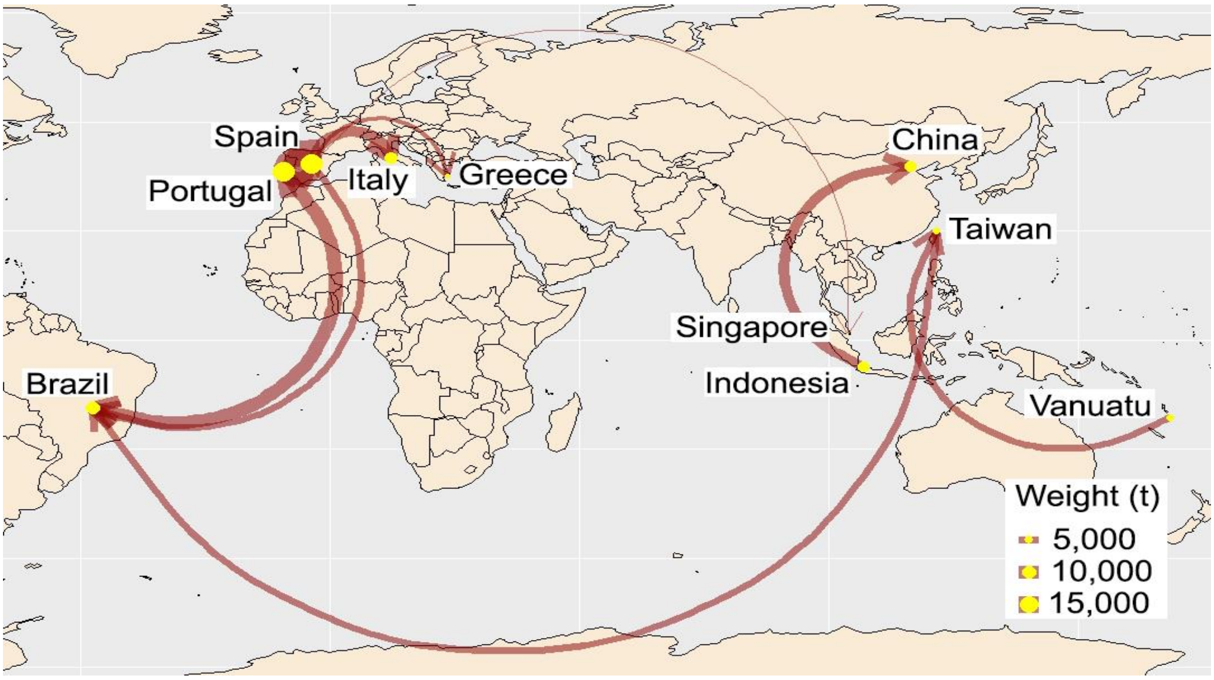
The last two decades has seen the global shark meat trade increase significantly, doubling in value since the early 2000s. At the same time, shark fin exports have been relatively stable. This change in the shark trade suggests an increase in full utilization of sharks and a potentially new threat to shark populations driven by demand for shark meat (Pincinato et al, 2022).

Shark Meat

The blue shark meat trade is more complex than the fin trade as there are more end-user markets. It involved 177 countries in the 2017-2019 period. In 2019, the volume exported equated to 67,326 t when converted to LWE, which is 35% of the global blue shark catch.

The ARTiS database shows that blue shark meat accounted for 36% of the global volume of shark traded in 2019 (Gephart, 2021). The data also shows relatively stable trade volumes for blue shark between 2012 and 2019, compared to other top traded shark species such as picked dogfish, shortfin mako and smoothound. Except for China, which gained prominence as an exporter and importer of blue shark meat, the main exporting (Spain, Portugal, Taiwan, and Indonesia) and importing countries (Brazil, Italy, Greece & Singapore) have remained stable over this period. The key bilateral trades are shown in Figure B.

Figure B Top 10 bilateral flows of blue shark meat 2017-2019 (source: ARTiS data)



When trade connections are analysed further, we find that China acts as a 'keystone,' connecting imports and exports to many other trading nations. Thailand, Taiwan and Vietnam were also other key trading countries in Asia, while Morocco, the USA and New Zealand, were key in Africa, America and Oceania, respectively.

Brazil is the top consumer nation of shark meat and blue shark specifically, but most consumers don't know they are eating shark meat. More than half of Brazilian consumers of "*cação*" (which commonly uses blue shark meat) say they have never eaten shark in their lives (Bornatowski *et al.* 2015). The role of Uruguay is key in this trade, acting as a regional hub; processing and trading landings by different international fleets into Brazil, which are classified as re-exports. This situation is underpinned by a weak regulatory framework that fails to identify products down to the species level throughout the supply chain.

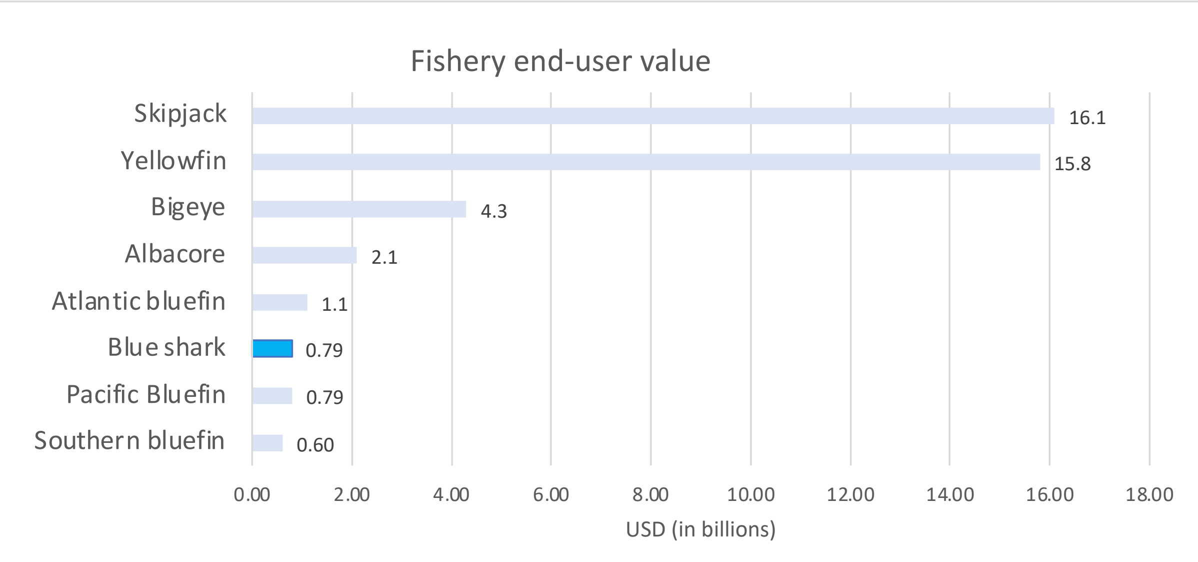
The lack of specific labelling in many shark meat supply chains means that consumers often do not know they are buying shark meat. This includes purchasers of pet food: researchers in Singapore and the US found shark in pet food products, with blue shark being the most common species identified. Generic terms like 'ocean fish' and 'white fish' are used on product labels, with no mention of shark meat (French & Wainwright, 2022, Cardeñosa, 2019).

Shark fins

Hong Kong remains the centre of the fin trade, but shark fin consumption in Hong Kong is declining and other Asian markets (Taiwan, China and Indonesia) are increasing their share of the trade. Cardeñosa et al (2022) found that blue shark accounted for 41% of shark fin in Hong Kong retail markets. If representative of the global fin trade, this equates to **16,180 t** (LWE) of blue shark fins. Our catch reconstruction for 2019 estimates that the potential wet weight of blue shark fins from reported catches on the global market is 11,387 t, and this total rises to **16,256 t** when fins are included from (illegal) finning of all estimated discards. Although based on several assumptions, the close alignment of the two totals does suggest that the amount of blue shark fin on the market cannot be supplied by the officially reported landings of blue shark alone. The generic product labelling of shark fin and poor traceability hides blue shark fin being supplied from illegal finning and the trading of endangered shark species.

The estimated **$786 million end-user value for blue shark meat and fins in 2019** exceeds the estimated 2018 end-user value of Southern bluefin tuna species and is very similar to Pacific bluefin (Figure C). It is notable that Southern bluefin tuna is the subject of a dedicated RFMO, while the fishery is of lower overall value than blue shark. This highlights the economic importance of blue shark fisheries and the comparatively minimal levels of science and management that blue shark fisheries are subject to compared to other fisheries. The end-user value rises to $846 million (a 7% increase) if including fins from the illegal finning of discards.

Figure C End-user value of tuna species (2018) and minimum end-user value of blue shark (2019) (source: Poseidon)



Blue shark status, conservation and management

The blue shark is a large oceanic pelagic shark that migrates following ocean currents and is wide-ranging throughout tropical and temperate waters. Recent genetic research by Nikolic *et al* (2020) suggests there are distinct genetic populations of blue shark, with two main genetic clusters for blue shark: (i) the northern Atlantic Ocean region, inc. the Mediterranean Sea and

(ii) the Indo-Pacific region, with the south-eastern Atlantic region possibly being an important area of mixture between these two regions. This has important implications for the management of blue shark stocks. Druon *et al.* (2022) identify distinct environmental preferences for different life stages of blue shark, which can inform spatio-temporal approaches to blue shark management.

The blue shark has the highest known population growth rates among pelagic sharks, which explains the species' comparative resilience to fishing pressure, but fishing effort is largely unmanaged and, in many regions, increasing. Blue shark is estimated to be declining in the Atlantic and Indian oceans and increasing in the Pacific. It is assessed as **Near Threatened (NT)**, nearly meeting Vulnerable (VU) (Rigby *et al*, 2019) at a global level and '**critically endangered' (CR) in the Mediterranean** (Sims *et al*. 2016).

Global policy for shark conservation has evolved considerably over the last 20 years, prompted by the International Plan of Action (IPOA) on Sharks; the increased listing of shark species in CITES and CMS Appendices; and monitoring shark species for the IUCN Red List.

There is no RFMO specifically dedicated to the conservation and management of sharks. Of the four t-RFMOs covered, only IOTC is constrained by its Convention to directly manage oceanic sharks. Management rules of the four t-RFMO provide for bans on shark finning, which directly benefits blue shark conservation. Many countries have also introduced measures to ban shark finning by their fleets and by their nationals, often extending these measures to trade rules. But overall, shark management plans remain fragmented and patchy, with numerous gaps as well as areas of overlapping (and conflicting) protection.

In 2019, ICCAT introduced blue shark-specific management measures in the form of TACs and quota limits for the north and south Atlantic blue shark populations. To date, these remain the only RFMO direct management measures specifically for blue shark. For RFMO management to be effective, it must be informed by robust member reporting. Heidrich et al (2022) concluded that '*there are substantial gaps in the taxonomic resolution of sharks and rays and 'other teleosts', and only about half of the reported global catches are georeferenced, despite existing mandatory requirements. Additionally, the estimation and reporting of discards in all tuna RFMOs remains incomplete*.' This inevitably limits the development and implementation of effective management for blue shark.

With shark meat rising substantially in value, we find that shark finning bans in general are losing traction in their ability to protect sharks, as sharks are increasingly targeted directly for their meat products as well as fins, requiring a holistic approach to the management of blue shark, as a globally shared and transboundary resource.

Recommendations

1. RFMOs should increase direct management of blue shark fisheries to properly manage fishing mortality relative to stock status.

2. RFMOs should improve monitoring, reporting and observer coverage on vessels targeting blue shark.

3. Support global and regional efforts to tackle IUU fishing by Distant Water Fleets as these will directly benefit blue shark fisheries. This includes implementation of the Port State Measures Agreement (PSMA) and governance capacity building in the regions associated with major blue shark fisheries (e.g. Southwest Pacific, Eastern Central Pacific, Southeast Atlantic).

4. Encourage the use of specific trade codes for the key traded shark species and improved inspection to ensure their correct use.

5. Prevent blue shark products from IUU fishing and endangered shark species being traded as blue shark by improving trade control through; a. development of Catch Documentation Schemes (CDS) in RFMOs; or b. listing blue shark as an Appendix II CITES species, which has a similar requirement to a CDS.

6. Support campaigns to improve seafood labelling and traceability requirements and raise consumer awareness in key consumer markets such as Brazil, Southern Europe and global pet food markets.

7. Encourage blue shark-targeted fisheries to under-go third-party certification as a driver for improved governance, e.g. to reduce the bycatch of juveniles and other shark species.

8. Promote sustainable, healthy shark fin alternatives to consumers in key Asian domestic markets & their expat communities overseas.

9. Spatial protection measures should be supported. To aid compliance, these should include mitigation for the impact of restrictions on the livelihoods of small-scale fishers.

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Acronyms used

AABPM	Asociación Armadores Buques de Pesca de Marín
AESG	Asociación Empresarial Espaderos Guardeses
ANAPA	Asociación Nacional de Armadores de Buques Palangreros de Altura
AOC	Area of competence (for RFMOs)
ARTiS	Aquatic Resource Trade in Species (database)
ASFIS	Aquatic Sciences Fisheries Information Service
BSH	Blue shark (FAO code)
CDT	Catch Documentation and Traceability
CDS	Catch Documentation Scheme
CMM	Conservation and Management Measures
CPCs	Contracting Party or Cooperating non-Contracting Party, Entity or Fishing Entity
CDS	Catch Documentation Scheme
CPUE	Catch per unit effort
CR	Critically Endangered (IUCN species status)
CWFN	Contiguous water fishing nation
DW	Dressed weight
DWF	Distant water fleet
DWFN	Distant water fishing nation
EEZ	Exclusive Economic Zone
EU	European Union
FAO	Food and Agriculture Organization of the UN
FL	Fork length
FW	Fresh weight
HS	Harmonised System (nomenclature for product codes)
IATTC	Inter-American Tropical Tuna Commission
ICCAT	International Commission for the Conservation of Atlantic Tunas
IFA	Inshore fishing area
IO	Indian Ocean
IOTC	Indian Ocean Tuna Commission
IPOA	International Plan of Action
IUCN	International Union for Conservation of Nature
IUU	Illegal, unreported and unregulated (fishing)
LWE	Live Weight Equivalent
NAFO	North Atlantic Fisheries Organisation
NEI	Not elsewhere identified
NPOA	National Plan of Action

NT	Near Threatened (IUCN species status)
ORPAGU	Organización Palangreros Guardeses
POP	Persistent Organic Pollutants
PSMA	Port State Measures Agreement
RA	Research Agenda
RFMO	Regional Fisheries Management Organization
RPOA	Regional Plan of Action
SFPA	Sustainable Fisheries Partnership Agreement
SIMP	Seafood Import Monitoring Program (US)
SKH	Sharks various *nei* (FAO code)
SKX	Sharks, rays, skates, etc. nei (FAO code)
SRFC	Sub-regional Fisheries Commission (West Africa) – also CSRP
t	tonnes (metric, i.e. 1,000kg)
TAC	Total allowable catch
TL	Total Length
ToR	Terms of reference
t-RFMO	Tuna Regional Fisheries Management Organisations
UN	United Nations
UBC	University of British Columbia
VU	Vulnerable (IUCN species status)
WCO	World Customs Organization
WCPFC	Western Central Pacific Fisheries Commission
WTO	World Trade Organization

1 Introduction

1.1 Background to the study

This report was prepared for Oceana by Poseidon Aquatic Resource Management Limited [Poseidon] following a request issued in November 2021. To answer the range of research questions posed, Poseidon brought together a multi-disciplinary team of researchers from University of Santiago de Compostela, China Oceans Institute and Diatom Consulting.

1.2 Why blue shark?

Shark catch and particularly trade data is often not reported to species level. There are also major discrepancies between reported catch and traded volumes of shark (Clarke, 2006). For example, the amount of shark fin exported to Hong Kong (the global hub of the shark fin trade) from India (a major shark fishing nation) was found to be many times greater than estimates reported to the Food and Agriculture Organisation (FAO) based on landings data (Hausfather, 2004).

Where species are reported in catch and trade data, the dominance of blue shark for both meat and fins is evident. The Aquatic Resources Trade in Species (ARTiS) database shows that blue shark makes up around 36% of the total volume of the shark meat trade (Gephart, 2021). For the fin trade, a report showed that blue shark accounted for 49% on average of the fin trimmings in Hong Kong, and the species comprised 34-64% of the total fin trade in Hong Kong's retail markets (Fields *et al*., 2018).

Multiple reports detail the decline in shark abundance. As one of the more fecund shark species, blue shark is a relatively resilient elasmobranch species, but has been heavily fished for years and in certain regions is subject to increasing fishing pressure. Li et al (2020) note that blue shark in the Pacific Ocean is still at a healthy level but may decline soon. However, blue shark populations in the Atlantic and Indian Oceans are already found to be declining. The status of blue shark stocks is mostly informed by catch data, which can be inaccurate and are not a robust proxy for stock status and should be supplemented by survey to inform analytical assessments. Genetic research shows significant difference in blue shark populations between ocean regions and distinct regional variations (Nikolic et al, 2020), although genetic markers suggest that blue shark populations may be connected by gene flow at the global scale (Verissimo et al, 2017). This has implications for future blue shark fishery management, which should be expanded and improved for what is a highly valuable marine resource.

1.3 Objectives & approach

The objective of this research is to estimate a global value for blue shark fisheries, map catches and trade and review policy to inform the prioritization and targeting of future policy. Oceana posed a range of research questions across three inter-related research agendas (RA):

RA1: Valuation of global blue shark trade

Determine the volume of shark catch and map the volume traded, estimating ex-vessel (first sale) and end-user values for meat and fins.

RA2: Impact of fishing sector on shark abundance

What are the characteristics of the fishing sector (nationalities; gear types; large-scale v small-scale; high seas v domestic waters)

RA3: Review of policy and associated catch and bycatch measures for blue sharks

What shark assessment, conservation, management and trade measures are in place internationally, regionally and nationally.

The specific research questions under each RA and the databases and information sources the team used to inform those questions are presented in **Appendix B**. These information sources were supplemented by literature review, targeted consultation and media analysis.

1.4 Methodology

The work was carried out by the research team over four phases:

Phase 1: Inception and planning

An inception report was submitted to Oceana including an initial literature review and detailed work plan.

Phase 2: Data collection

This phase involved data collation from the sources listed in table 1 above; key informant interviews with shark researchers, regional NGO staff and industry identified by the team; and a continuation of the literature review. Data on catch was collated from FAO and Regional Fishery Management Organisations (RFMOs) managing tuna and tuna-like species. Trade data was collated from FAO, Comtrade and the Aquatic Resources Trade in Species (ARTiS) database. The latter was obtained through a materials transfer agreement with American University, the developers and owners of the database.

Phase 3: Data analysis

Catch data was analysed to identify and reconcile differences between reported catches under the FAO and RFMO reporting systems (see section 2.1 for further details on methods).

Trade data was analysed using graph theory to identify significant connections between trading nations (see section 3.1 for further details on methods).

Media analysis was conducted using the NexiUni database with multiple search terms related to blue shark in English, Chinese, Spanish and Portuguese. Findings from this analysis are used throughout this report.

Phase 4: Reporting and recommendations

As part of the inception phase, the research team and Oceana identified stakeholders, including shark researchers. These and additional experts identified during the project were consulted and were then invited to review draft findings as part of an online webinar to:

a. Ground-truth findings with researchers in the field;

b. Include any additional information proposed; and

c. Disseminate information to other researchers that may find it of interest.

Sixteen shark researchers and NGOs attended the online webinar on the 30th September, with the recording made available to those unable to attend live. The presentation of draft findings and subsequent debate with other researchers provided additional insight and enabled additional information to be included in this report.

2 Blue Shark Catch

2.1 Summary

- The 2019 minimum estimated global catch (landed) of blue shark, consisting of the wet weight of reported carcasses/meat and fins, was 189,783 t**.**
- This catch is estimated by reconciling data reported by flag States to FAO (Fishstat J) and/or t-RFMOs, always using the highest of both reported figures. This represents a conservative minimum with low uncertainty. No attempt is made to add in legally landed shark unreported by authorities to FAO or tRFMOs: such unreported landings are known to exist but cannot be estimated with confidence.
- The Pacific Ocean accounts for 53% of the reported blue shark catch in 2019. The Atlantic and the Indian Oceans account for 34% and 13%, respectively.
- Taiwan and Spain catch as much blue shark as all other flag States combined.
- Most blue shark caught is from targeted fisheries with large-scale commercial fleets harvesting 90% of blue shark catches, the overwhelming majority of which are longliners. Distant Water Fleets account for 74% of the global blue shark catch.
- Although finning and dumping of carcasses has likely diminished with the rising value of shark meat globally, incentives to engage in finning remain.
- The ex-vessel value for blue shark meat and fins in 2019 is estimated to be $411 million. This exceeds the ex-vessel values for each of the three bluefin tuna species. The total value of blue shark meat is five times more than the value of the fins.

2.2 Sources of blue shark catch data

Shark catch data, and blue shark data specifically, are collected and reported by coastal and flag States to various multilateral global entities that are tasked with fisheries data collection. These entities are primarily the FAO and the tuna Regional Fisheries Management Organizations (t-RFMOs), with the latter generally tasked with the collection of bycatch (or target catch) data for specific or all-shark species harvested in tuna fisheries.

FAO collects all marine capture harvest data from its members annually through a self-reporting mechanism, giving rise to the longest running and most complete set of all-catch data available globally. These data are segmented by year, by species, by flag and by oceanic origin and provide good overall resolution. However, not all States report data with the same accuracy (*e.g.* some developing countries often lack the capacity and the resources for satisfactory data collection) and not all fisheries receive the same attention (*e.g.* small-scale subsistence fisheries output in many States is underreported). Furthermore, the data reported to FAO are not disaggregated by gear type.

As Figure 1 illustrates, the Areas of Competence (AOCs) of tuna RFMOs overlap with the global distribution of blue shark, and these RFMOs require member States to report on shark catch, initially due to concerns over bycatch in fisheries for tuna/tuna-like species and more recently to better manage the direct targeting of sharks.

It is important to note that the t-RFMOs undertake catch reconstruction themselves to fill reporting gaps (using catch data from adjacent years or combining effort and CPUE data), which results in t-RFMOs reporting an adjusted nominal catch (*e.g.* the International Commission for the Conservation of Atlantic Tunas, ICCAT)[1].

Typically, sharks managed by general (non-tuna) RFMOs (*e.g.* North Atlantic Fisheries Organisation, NAFO) are limited to deep-sea shark species and none report oceanic shark catches.

Unreported catches, illegally harvested and illegally landed/transhipped data, etc. inevitably bypass this reporting – leading to gaps of unknown size in the data, which may affect different species to differing degrees. Major sources of underreported or non-reported shark catches include:

- Unreported catches in fisheries that may not be properly included in formal national reporting routines – and therefore not reported to FAO and/or RFMOs;
- Unreported catches from fisheries suffering from illegal, unreported and unregulated (IUU) fishing. Such operations may include illegal retention onboard, finning, dumping of finned carcasses, illegal/unreported transhipment of carcasses and/or dried fins, and finally laundering of such products into markets.

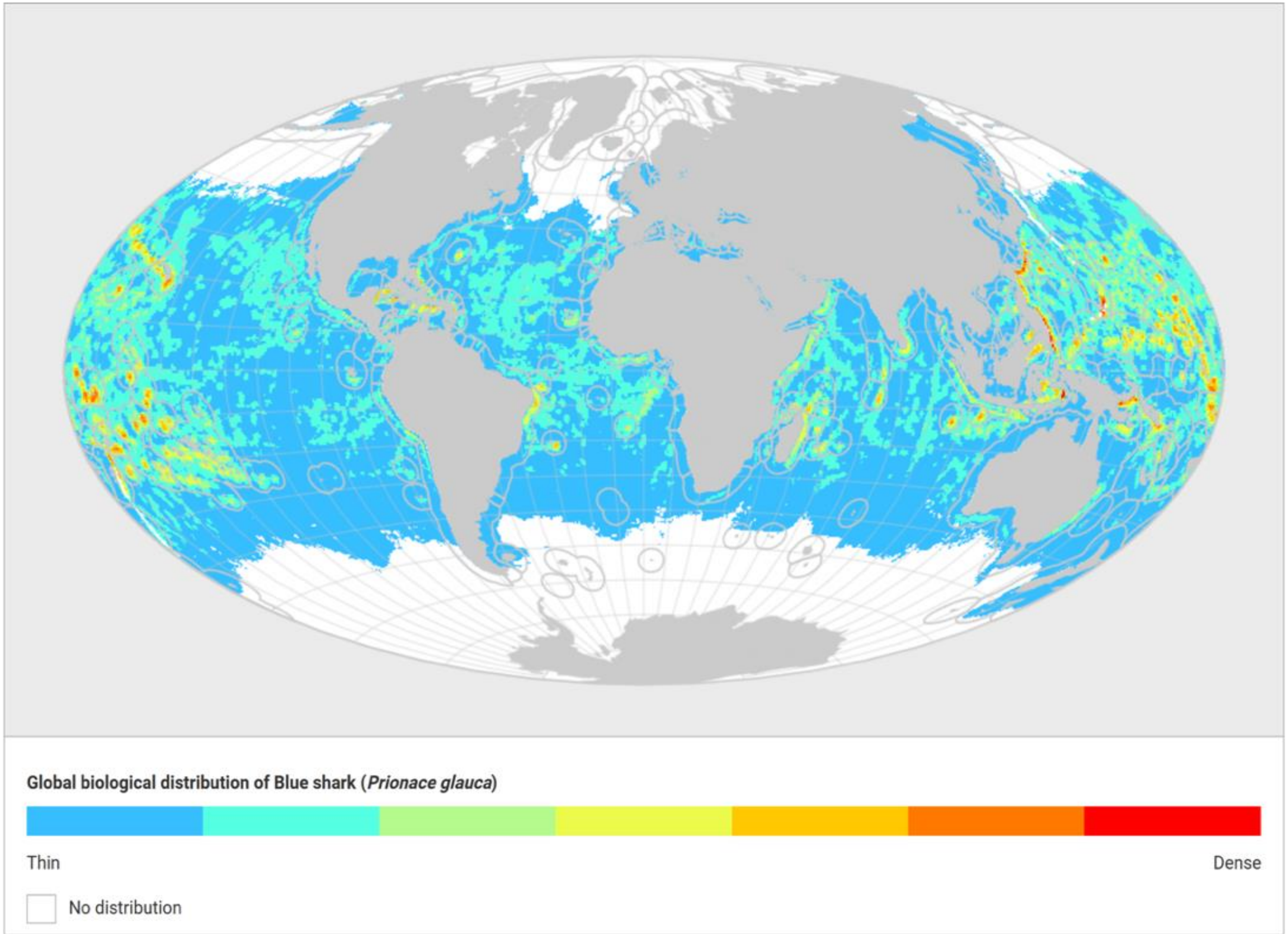
Though not insignificant, the first point is of more limited bearing for estimating global catch of blue shark fisheries, as nearly all non-commercial small-scale operations in inshore fisheries areas (IFA) – those that tend to be overlooked most in national statistics – occur in waters where the oceanic blue shark is generally entirely absent or not abundant, and not normally caught. However, small- and medium scale, and large-scale commercial shark fisheries are also known to suffer from under-reporting, varying by region, by country and in-between years, and which cannot easily be estimated in a global-scale study.

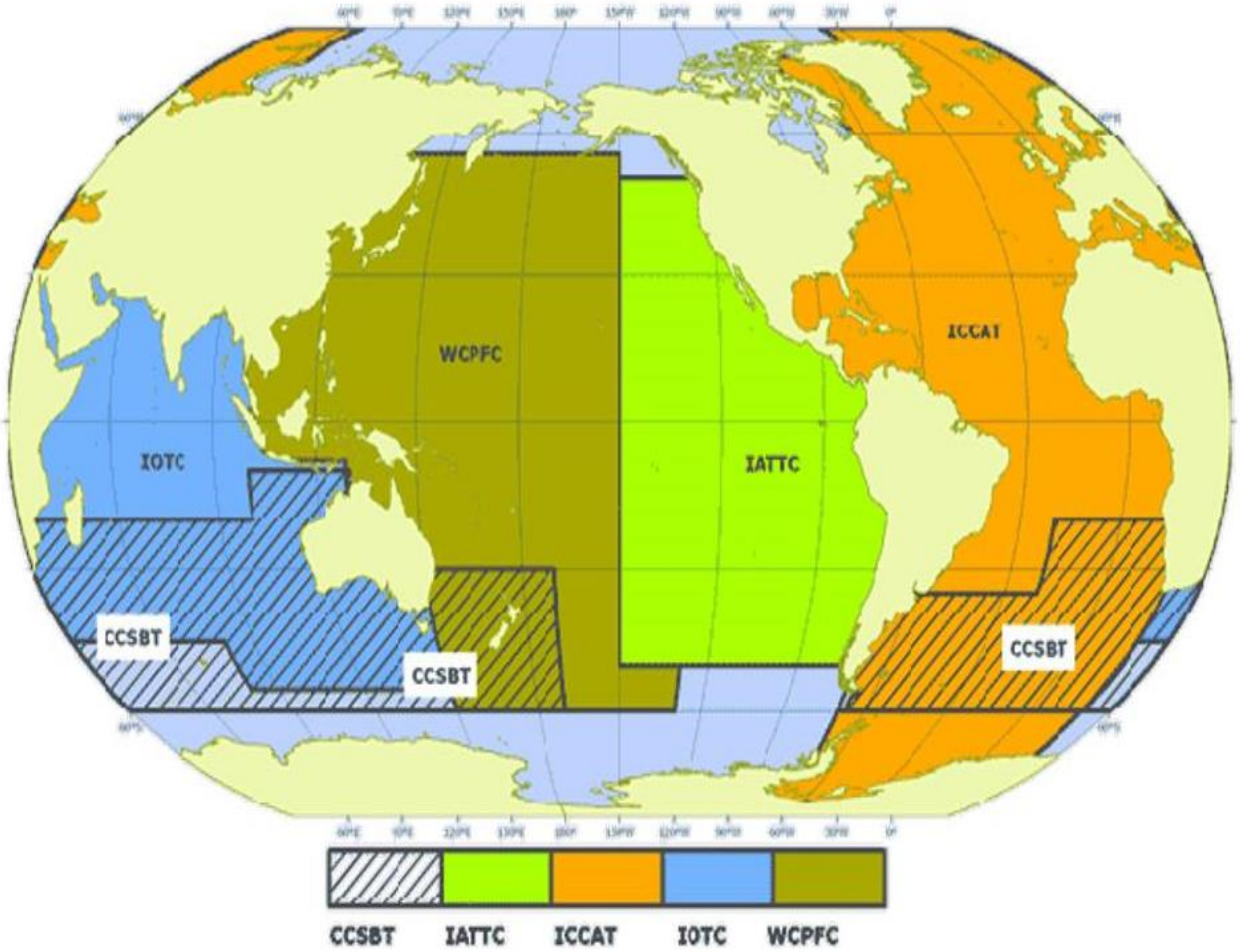
On the second point, it is known that IUU fishing is a major source of unreported catches/landings and creates more uncertainty in any estimate of global shark/blue shark catches. Therefore, the figures resulting of the blue shark catch reconstruction in this study are to be regarded as the minima for what is harvested, landed, reported and then put to market.

Detailed breakdowns from FAO and t-RFMO data sets are provided in **Appendix C**.

[1] ICCAT reconstruct BSH catches using effort and CPUE data. See: SCRS/2015/012 Collect. Vol. Sci. Pap. ICCAT, 72(4): 793-865 (2016). 2015 BLUE SHARK DATA PREPARATORY MEETING (https://www.iccat.int/Documents/CVSP/CV072_2016/n_4/CV072040793.pdf)

Figure 1 Blue shark global range (left) and tuna-RFMO Areas of Competence (right)





Source: UBC Sea Around Us project (left); FAO (right)

2.3 Methodology for determining blue shark catch

The global catch data sets used in this report span the years 2018 and 2019, both years predating the COVID-19 pandemic. The year 2019 was selected as the year on which the global valuation is based, as this is the latest available data prior to the pandemic impacting fleet operation and market dynamics from early 2020.[2]

The methodology to estimate global shark catches involved the following sequential steps:

1. FAO data for all-sharks and blue shark specifically were extracted using the FISHSTAT-J 2017-2019 datasets. All-shark and blue shark catches are presented by year, ocean basin and flag to provide a global picture of blue shark harvesting dynamics.
2. Tuna RFMO (t-RFMO) data for all-sharks and blue shark were downloaded from websites when available or provided by t-RFMO secretariats, allowing production of all-shark and blue shark catches by year, ocean basin, flag and gear. This provides a parallel global picture of blue shark harvesting dynamics in relation to t-RFMO areas of competence.
3. Analysis of FAO and RFMO data was then undertaken by flag to compare datasets, and to undertake data reconciliation as needed. For major flag States with large discrepancies, national authorities were contacted to gain an understanding of discrepancy origins. This resulted in a global dataset of blue shark catch where FAO and RFMO data are combined – providing a global minimum catch estimate based on the largest provided figure in the two multilateral data repositories, understood to resolve an important (yet unquantifiable) portion of the mis- and underreporting of catches. This estimate excludes discards.
4. To determine the potentially discarded portion of blue shark catches, of which fins remain susceptible to be retained and to enter markets illegally, the UBC's Sea Around Us dataset was used, raising/adjusting their latest (2018) blue shark discard estimate to a 2019 figure.[3]
5. Merging the third and fourth steps to derive an estimated global figure for blue shark catch. To accommodate uncertainty, two figures are provided as a minimum and a maximum estimate for total global blue shark catches. The minimum consists of the wet weight of reported carcasses/meat and fins (from step 3), while the maximum consists of the step 3 estimate, plus the wet weight of fins under a 100% illegal finning scenario of discards.

[2] See for instance: Döring, R., *et al*. (2021) Study on the main effects of the COVID-19 pandemic on the EU fishing and aquaculture sectors. EASME/EMFF/2018/011 Lot 1 Specific Contract No.4 and EASME/EMFF/2018/011 Lot 2 Specific Contract No.5. European Commission. 63 pp.

[3] This was decided upon when we found that our method of reconstructing blue shark catch in step 3 produced a very similar global catch estimate as the Sea Around Us reconstruction, which is regarded as one of the most granular, robust and authoritative such exercises currently in existence. The discard figure for 2019 was obtained by multiplying the 2018 Sea Around Us discard figure by (BSH 2019 catch [this study] / BSH catch 2018 [Sea Around Us project]).

2.4 Global contribution and distribution of blue shark fisheries

The estimated minimum global catch (landed and reported) of blue shark in 2019 was 189,783 tonnes (t), based on a reconciliation of data reported to FAO and t-RFMOs at the level of individual reporting countries. The estimated (wet round weight) discard volume is 81,156 t, of which an unknown portion may enter markets illegally as dried shark fin products resulting from illegal at-sea finning and dumping of carcasses.

In terms of contribution of all shark catches and blue shark catches to global fisheries output, and blue shark catch to all shark catch, several datasets were combined to run the analysis. In 2019, all-shark catch reported to FAO (431,908 t) was almost twice as large than that reported to RFMOs (258,555 t) – the former thus providing the go-to figure for that statistic. Global all-shark catch makes up around 0.5% of the total global marine catch reported to FAO. Blue shark makes up about 60% of all-shark catch reported to FAO, following subtraction of ray, skates and other non-shark cartilaginous fish.

Blue shark catch throughout this study is derived from the FAO/t-RFMO data reconciliation. Detailed calculations are shown in Appendix C. With regards to blue shark catch distribution between ocean basins (see Table 1 above), this results in the following findings:

- The **Pacific Ocean accounts for 53%** of the reported blue shark catch in 2019;
- The **Atlantic** and the **Indian** Oceans account for 34% and 13%, respectively;
- The sub-oceanic basin of the **Southwest Pacific** yields more blue shark catch than the Atlantic or the Indian Ocean in their totality.

Table 1 Distribution of blue shark catches between ocean basins, 2019 (sources: FAO, t-RFMOs, and FAO/t-RFMO reconciliation)

Blue shark catch - 2019			
Distribution by ocean basin	FAO data	t-RFMO data	Reconciled
Atlantic	**56,107**	**62,005**	**64,240**
Atlantic Southeast	14,634	20,681	20,205
Atlantic Southwest	13,877	14,022	13,827
Atlantic Northeast	7,848	16,027	12,174
Atlantic Eastern Central	14,989	0	11,052
Atlantic Northwest	3,576	10,917	5,742
Atlantic Western Central	1,124	254	1,135
Mediterranean	59	105	104
Indian	**24,732**	**25,001**	**25,313**
Eastern Indian Ocean	16,002	16,156	16,159
Western Indian Ocean	8,730	8,845	9,155
Pacific	**28,470**	**85,742**	**100,230**
Pacific Southwest	1,678	71,290	66,143
Pacific Eastern Central	7,836	14,452	20,789
Pacific Southeast	12,297	-	6,652
Pacific Western Central	6,648	-	6,645
Pacific Northwest	1	-	1
Pacific Northeast	10	-	-
Grand Total	**109,309**	**172,748**	**189,783**

Stark differences in distribution of catches can be seen between FAO and t-RFMO datasets within ocean basins (table 1) and between sub-oceanic basins also. While the reporting seems to be more balanced between FAO and t-RFMO data sources for the Indian Ocean, reporting for the Pacific Ocean presents large differences in the total figure for the ocean basin, and also between individual sub-oceanic basins – underlining reporting issues into either or both data repositories, and the need for the reconciliation undertaken.

The Pacific Ocean supplies 53% of the global blue shark harvest, closely mirroring the 54% of global tuna harvest from the Western Central Pacific Ocean.[4] Blue shark catch across the three ocean basins mirrors the distribution of global fisheries catch to a large degree, but with the Atlantic Ocean providing a somewhat higher relative yield. The latter may be due to either higher fishing pressure on blue sharks in the Atlantic or higher densities of blue shark occurrence, or both.

In t-RFMO associated fisheries, and using the 2018-2019 average, we find that in International Commission for the Conservation of Atlantic Tunas (ICCAT) and the Western Central Pacific Fisheries Commission (WCPFC) areas (87% and 89%, respectively), the fraction of reported blue shark is close to 9 in 10 sharks (by volume). Given the blue sharks' more modest body mass in comparison to other regularly harvested sharks,[5] it is probable that more than 9 in 10 sharks caught and landed in these two ocean areas by fleets reporting to t-RFMOs are blue sharks. In the Indian Ocean, blue shark only makes up one-third of the all-shark catch. In the Inter-American Tropical Tuna Commission (IATTC), the portion has fluctuated widely between 2018 and 2019 (indicative of shark data collection challenges), yielding an average of 49%. It is likely that the lower blue shark ratio in both the Indian and East Pacific Oceans owes to the higher proportion of small- and medium scale vessels making up the fleets targeting shark resources, operating overall closer to shore, and thus catching and reporting important volumes of non-oceanic sharks also. See **Appendix C**.

2.5 Blue shark catching nations

Table 2 overleaf lists the top 20 blue shark fishing nations following reconciliation of FAO and t-RFMO data for 2019. This list differs from the top 20 lists based on individual FAO and combined t-RFMO datasets (presented in **Appendix C**) and yields a substantially higher total catch in both instances (see table 1 above also), *i.e.* **189,783 t**.

Taiwan and Spain catch as much blue shark as all other flag States globally combined. The top five blue shark fishing nations comprise of two European and three Asian flag States, harvesting close to 80% of global blue shark resources.

Nine countries enter the top 20 ranking through their FAO reporting, and 11 countries based on RFMO reporting. Tellingly, the top 20 blue shark fishing nations in the reconciled dataset report 69% more blue shark catch than the total reported for all States in the FAO dataset alone.

[4] See: SPC-OFP, (2020), Estimates of Annual Catches in the WCPFC Statistical Area, *Western and Central Pacific Fisheries Commission Scientific Committee, Sixteenth Regular Session, Online Meeting*. wcpfc-sc16-2020/st-ip-1.

[5] The global average harvested blue shark weight is 27kg (equating to a fork length of 160cm), with a range of 10-56kg, using the Coelho et al. (2017) data, providing the longest timeseries of blue shark data studied to date (1966-2014).

Table 2 Top 20 blue shark catching nations, 2019 (source: FAO/t-RFMOs)

		Blue shark - 2019			
	Row Labels	Volume	Source	Cum. (%)	Cum. (vol.)
1	Taiwan	47,685	RFMO	25.1%	47,685
2	EU Spain	47,056	FAO	49.9%	94,741
3	Japan	27,834	RFMO	64.6%	122,576
4	Indonesia	14,920	RFMO	72.4%	137,496
5	EU Portugal	12,018	RFMO	78.8%	149,514
6	Ecuador	6,685	RFMO	82.3%	156,199
7	Mexico	4,774	FAO	84.8%	160,973
8	Vanuatu	3,894	FAO	86.9%	164,867
9	Brazil	3,784	RFMO	88.9%	168,651
10	China	3,399	FAO	90.7%	172,050
11	Peru	3,362	RFMO	92.4%	175,412
12	Fiji	2,137	FAO	93.6%	177,549
13	Morocco	1,524	RFMO	94.4%	179,073
14	Côte d'Ivoire	1,449	FAO	95.1%	180,522
15	Seychelles	1,115	FAO	95.7%	181,637
16	Panama	936	RFMO	96.2%	182,574
17	Sri Lanka	712	FAO	96.6%	183,285
18	France OT	619	RFMO	96.9%	183,904
19	Australia	536	RFMO	97.2%	184,440
20	Belize	534	FAO	97.5%	184,974
	-39 more countries-	4,809	mix	100.0%	**189,783**

2.6 Characteristics of blue shark fisheries

2.6.1 Fishing gears

Detail on fishing gear is only provided in the combined t-RFMO dataset (Table 3 overleaf), where 2018 and 2019 figures are presented to identify variation. This dataset is missing less than 10% of the global catch volume in the reconciled dataset and may therefore be regarded as a faithful rendering of the real-world situation of deployed gears harvesting blue shark.

While WCPFC only reports a single fishing gear (LL) harvesting blue shark, ICCAT reports six gears (BB, GN, HL, LL, OTH, PS).[6] This in part reflects the dominance of certain gears but also reveals likely data quality discrepancies between RFMOs. It is unlikely for blue sharks to not be harvested by any other gear but LL in the WCPFC's area. **With the exception of the Indian Ocean Tuna Commission (IOTC), surface longlines are the main gear used to harvest blue shark. Longlines account for nearly 90% of the total global blue shark harvest.** This provides an early indication that blue shark is mostly caught in large-scale commercial high seas, distant water fishing and/or deeper water fisheries in Exclusive Economic Zones (EEZs). This aligns with the oceanic pelagic range of blue sharks, and their overlap with tuna and swordfish stocks.

[6] BB: pole and line; GN: Gillnet; HL: Handline; LL: Longline; OTH: Other; PS: Purse seine

Table 3 Distribution of blue shark catch by t-RFMO and by fishing gear, 2018 & 2019

	2018		2019	
IATTC	**12,479**		**14,452**	
LL	12,393.9	*99%*	11,007.5	*76%*
OTH	84.8	*1%*	3,444.5	*24%*
RG	0.1	*0%*	0.2	*0%*
ICCAT	**68,331**		**62,005**	
BB	0.0	*0%*	5.1	*0%*
GN	703.5	*1%*	491.5	*1%*
HL	22.7	*0%*	18.4	*0%*
LL	66,577.7	*97%*	60,503.0	*98%*
OTH	41.4	*0%*	42.3	*0%*
PS	986.1	*1%*	944.4	*2%*
IOTC	**22,623**		**25,001**	
GN	1,781.5	*8%*	1,769.5	*7%*
HL	11,460.1	*51%*	13,190.2	*53%*
LL	9,381.7	*41%*	10,041.4	*40%*
PS	0.2	*0%*	0.1	*0%*
WCPFC	**60,610**		**71,290**	
LL	60,610.0	*100%*	71,290.2	*100%*
Grand Total	**164,044**		**172,748**	

Legend: BB=Pole&Line;GN=Gillnet; HL=Handline; LL=Longline; OTH=Other; PS=Purse Seine; RG=Recreational

Longlines and gillnets are the tuna gears that have the highest shark catch (or bycatch) ratios overall, while purse seines, whether setting on fish aggregating devices (FADs), free schools or on dolphins, have the lowest (Mura *et al*. 2021). While purse seining in the Atlantic tuna fisheries produced 70% of the total output, and longliners only 11% (2015-2019), the same longliners registered 97% and 98% of the total blue shark catch in 2018 and 2019, while purse seiners recorded only 1% and 2% respectively. This indicates that **most blue shark catch is targeted; while tuna and tuna-like species contribute to the total output, it is misleading to merely consider blue shark as 'just bycatch' in tuna and swordfish longline fisheries**.

The dominance of handlines in the Indian Ocean (53% in 2019) is indicative of important small- and medium-scale commercial segments targeting blue shark with simpler – yet effective – fishing gears. 99.8% of globally reported handline catches of blue shark originate from the Indian Ocean. It is also worth noting the significance of gillnets in the IOTC (7% in 2019), as is the 'other' gear category reported for the IATTC (24% in 2019).

2.6.2 Fleet types

It is challenging to break down blue shark catch into large- or small- and medium-scale fleet sources. First, there is not a universally applied and accepted definition of large-scale, medium-scale, small-scale and/or artisanal-scale fleets. Second, available blue shark catch data do not provide this level of detail, hence this must be inferred based on some guiding principles.

Based on blue shark fisheries research and given the distribution of the species is mainly beyond-the-continental-shelf in deep oceanic water, **artisanal small-scale fisheries of the**

(largely) non-commercial type – operating in the inshore fishing area (IFA)[7] – are considered to make a minor contribution to the global blue shark catch. This is exemplified by India, the second largest all-shark fishing nation according to FAO data, which shows negligible blue shark catches due to its very limited medium- and large-scale fleets that can operate beyond the continental shelf.[8] In other parts of the Indian Ocean, artisanal small-scale fleets can and do access deeper oceanic waters where blue shark would be caught.

Table 4 below reworks the gear data from Table 3 based on the assumption that longline, purse seine and pole & line vessels are large-scale vessels, often operating well beyond national EEZs and in the ABNJ, while all other gears are "small- and medium-scale commercial", many of which would often be expected to be national fleets operating within EEZs or slightly beyond.[9]

Table 4 Blue shark catch in 2019 by fleet type per RFMO area

	2018		2019	
Atlantic -ICCAT	**68,331.4**		**62,004.7**	
Artisanal small-scale	negligible	-	negligible	-
Small- & medium-scale commercial	767.6	1%	552.2	1%
Large-scale commercial	67,563.8	99%	61,452.5	99%
Indian - IOTC	**22,623.5**		**25,001.2**	
Artisanal small-scale	negligible	-	negligible	-
Small- & medium-scale commercial	13,241.6	59%	14,959.7	60%
Large-scale commercial	9,381.9	41%	10,041.5	40%
Pacific	**73,088.7**		**85,742.4**	
WCPFC	**60,610.0**		**71,290.2**	
Artisanal small-scale	negligible	-	negligible	-
Small- & medium-scale commercial	0	0%	0	0%
Large-scale commercial	60,610.0	100%	71,290.2	100%
IATTC	**12,478.7**		**14,452.2**	
Artisanal small-scale	negligible	-	negligible	-
Small- & medium-scale commercial	84.8	1%	3,444.7	24%
Large-scale commercial	12,393.9	99%	11,007.5	76%
Grand Total - small- & medium scale commercial	**14,094.0**	**9%**	**18,956.6**	**11%**
Grand Total - large scale commercial	**149,949.5**	**91%**	**153,791.7**	**89%**

While the small- and medium-scale commercial fleets produce the dominant proportion of the total blue shark catch in the Indian Ocean,[10] **globally, large-scale commercial fleets harvest 90% of blue shark catches, the overwhelming majority of which are longliners** (2018/2019 average). Globally, 10% are harvested by smaller and medium-scale commercial fleets that are more typically associated with national offshore EEZ fisheries. For example,

[7] Defined here as operating in waters less than 200m deep, and less than 50km from shore (whichever comes first), and within the EEZ. (Aligned with the Sea Around Us project definition for "IFA")

[8] Corroborated by Indian fisheries expert V. Elayaperumal.

[9] This is a necessary simplification, and it is noted that in some countries, smaller longline vessels do operate exclusively in the EEZ, and do not roam further, which would tend to bias the statistic in table 4 slightly towards the large-scale end of the spectrum, to the detriment of the small- and medium-scale segment.

[10] It is noted that a similar distribution between fleet types exists in Indian Ocean tuna fisheries, where small-scale fisheries harvest the majority of tuna and tuna-like resources. This is directly mirrored in the relative distribution of fishing gear types used to harvest blue shark also.

Taiwan's national data for 2019 report that 92.1% of blue shark landings originated from tuna longliners in "deep sea fisheries" (*i.e*. beyond the national EEZ); 7.7% originated from tuna longliners operating in "offshore fisheries" (i.e. deeper EEZ); and less than 0.2% originated from small-scale "coastal fisheries" using gill nets, largely mirroring the global results obtained in this study.

2.6.3 Contiguous and Distant Water Fleets

When considering global fishing interests, a useful distinction is between distant water fishing nations (DWFNs) that operate in many oceanic basins and sub-basins worldwide, and contiguous water fishing nations (CWFNs),[11] the latter defined here as fleets fishing either within their EEZ, and/or the oceanic sub-basin(s) that are immediately contiguous with their EEZ. From an RFMO perspective, these are invariably Coastal States.[12]

CWFNs have a bigger long-term stake in the sustainable management outcome of a species such as blue shark than DWFNs, as these Coastal States are co-custodians of a transboundary and straddling resource, and thus have a direct national social and economic stake in its sustained existence. On the other hand, the DWFN are normally foreign entrants that can operate opportunistically, having more flexibility to move on to other fishing opportunities once catches start to dwindle.

Table 5 Distribution of BSH catch in 2019 between Distant Water & Contiguous Fleets

Reconciled blue shark catch - 2019			
	CWFN	DWFN	CWFN / total catch
Atlantic	8,292.26	55,948.13	13%
Indian	15,857	9,457	63%
Pacific	24,593	75,636	25%
Grand Total	**48,742**	**141,041**	**26%**

In the reconciled list of 59 flag States catching blue shark in 2019 (see table C.9 in **Appendix C**), the list of true DWFNs is limited to the following ten States: Belize, China, France, Japan, Korea (Rep.), Portugal, Seychelles, Spain, Taiwan, and the UK.[13] The Spanish longline fleet, for instance, that operates in the Atlantic, Indian and Pacific Oceans [targeting blue shark] lands its catches in many different countries, including, *inter alia*, in Brazil, Cape Verde, Chile, Ecuador, French Polynesia, Mauritius, Namibia, Panama, Peru, Seychelles, and South Africa.[14]

Table 5 above provides a break-down of blue shark catches by ocean basin, segregating them into CWFN and DWFN catches. **The DWFN catch accounts for 74% of the global blue shark catch. The highest portion of DWFN catch occurs in the Atlantic Ocean (87%)**, followed by the Pacific Ocean (75%). The Indian Ocean, already distinctive based on the very different fishing gear mix, is the only ocean where CWFNs dominate the blue shark catch,

[11] There is no relation to the concept of "contiguous zone" as defined in article 33 of UNCLOS. The word "contiguous" has been chosen as an antonym of maritime tenor to the term "distant".
[12] UNCLOS Art.33 defines 'contiguous' as up to 24 miles from baseline, but here we use a broader definition to include the whole EEZ and the sea basin within which they are located.
[13] For former colonial powers, like France and the UK, the overseas territories are disregarded as a factor of contiguousness.
[14] See for instance: La Voz de Galicia, Sunday 19 April 2020

harvesting close to two thirds of the total (63%). The dynamics of political engagement between these ocean basins may well differ as a result.

2.7 Under-reporting, misreporting, finning, discarding, and IUU fishing

Here we provide an estimate of how much blue shark may enter the global economy, bypassing blue shark data collection and reporting frameworks currently in place. Under- and misreporting may occur in *bona fide* reporting imperfections (*e.g*. reporting blue shark under a "sharks nei" heading), as well as from illegal activities. Illegal activities associated with blue shark may include finning and dumping of carcasses, and the illegal landing or transhipment of fins, and their eventual sale into consumer end-markets.

2.7.1 'Shark NEI' groupings

A number of NEI ("not elsewhere indicated") or other multi-species groupings exist across all datasets (FAO and t-RFMO), under which more blue shark could potentially be reported in a generic and unquantified manner. These groups include the following:

- Sharks *nei* Aquatic Sciences Fisheries Information Service (ASFIS) FAO reporting category)
- Requiem sharks *nei* (ASFIS – FAO reporting category)
- Sharks, rays, skates, etc. *nei* (ASFIS – FAO reporting category)
- AG38 - Blue shark, shortfin mako, oceanic whitetip shark (IOTC reporting category)

In the absence of a specific and globally representative study, we cannot estimate what portion of additional blue shark catch is 'hidden' in the generic groups of reported catches to determine whether that portion is significant. However, given the distinctive appearance of blue shark and the relative ease with which fishers around the world identify blue shark, which differs physically from other requiem sharks, as well as related mackerel, thresher and hammerhead shark, it appears reasonable to assume that blue shark are easier to be reported at the species level.

IOTC catch reporting using SKH (Sharks various *nei*) and AG38 (Blue shark, shortfin mako, oceanic whitetip shark) groupings is higher than other t-RFMOs, even though the IOTC nominal catch dataset is reconstructed and adjusted in the same manner as the nominal catch datasets in other t-RFMOs are. In 2015 IOTC's Working Party on Ecosystems and Bycatch concluded that IOTC's nominal blue shark catch data were *highly uncertain*, and *likely severe underestimates*.[15] A reconstruction of blue shark catches done partly on a ratio-based approach, extracting further blue shark catch from generic reporting groups, and adding it to the nominally reported catch, found that blue shark catch may have been in the order of 50–60,000 t at the end of the time period covered (2015) (Martin *et al*. 2017). This is much higher than the IOTC-posted nominal Indian Ocean catch for 2019 of 25,001 t (table 1). However, the ratio-based approach has not been adopted by IOTC to further adjust the nominal blue shark catch. If it had, blue shark would make up a higher proportion of the overall shark catch in the IO (some 75-80%) – bringing it more in line with other ocean basins – and it is likely that the total reconciled annual blue shark catch estimated in this study would surpass 200,000 t.

[15] IOTC, 2015. Report of the 11th Session of the IOTC Working Party on Ecosystems and Bycatch. Olhão, Portugal, 7-11 September 2015.

In summary, a portion of blue shark catch certainly does exist within generic shark *nei* groups and is likely to be important for the Indian Ocean, but in the absence of a comprehensive study of the ratios of blue shark in these generic groups the amount cannot be determined robustly. In reconstructing catch levels, we therefore do not allocate a proportion of 'shark *nei*' to the total blue shark catch, which is presented as an estimated minimum catch.[16]

2.7.2 Unreported and misreported catches and landings

The RFMO and national regulatory frameworks on shark harvesting (including protected species, discarding rules, catch limits, finning rules and trade bans in certain products) have developed substantially over the past 15 years. Shark catchers and traders are required to apply new and more stringent rules to their shark harvesting and supply chain operations. This would naturally work towards capturing better and more complete harvest data.

Reporting discrepancies of national BSH catch data

As seen in earlier sections, large reporting discrepancies exist between FAO FishstatJ and the combined t-RFMO statistics on blue shark catches despite both organizations mandated to seek the totality of blue shark catches. **A minority of coastal States (28%) reports data to both FAO and t-RFMOs which are consistent.** FAO data should provide for higher volumes as FAO members are supposed to report all commercial, artisanal, subsistence and recreational retained catch to FAO annually, from their EEZ and Areas Beyond National Jurisdiction (ABNJ). But despite some coastal States not being members of t-RFMOs, the RFMO data provides the higher total.

Several factors contribute to the weaknesses in the FAO dataset. In practice, many countries have difficulties collecting catches for subsistence, recreational and some segments of their smaller-scale fisheries, leading to under-reporting. Discrepancies between FAO and RFMO data may pertain to different contact persons and teams within national administrations dealing with either organization(s), different reporting deadlines, or aggregation of species into larger groups (*e.g.* SKH, SKX)[17] when reported to FAO.[18] With regards to the latter, our analysis found that for the top three blue shark catching nations with big discrepancies in blue shark catch between RFMO and FAO datasets, with severe underreporting to FAO,[19] the reason was not the reporting of blue shark to FAO under generic groupings, since the sum of the generic shark groupings reported to FAO were invariably largely insufficient to account for all of the blue shark not reported to FAO.

Overall, this leads to the conclusion that **no reliable global dataset on reported blue shark catch exists. Any attempt to raise a better figure of global blue shark catch beyond the portions of unreported catches that the comparative analysis between FAO and RFMO data in this study provides as a reconciled global total must focus on estimating and adding in a systematic manner the unreported fractions owing to IUU fishing-related**

[16] This approach is consistent with the Sea Around Us project , which also does not re-allocate nei shark catch in their reconstruction of blue shark catches.

[17] SKX: Sharks, rays, skates, etc. nei ; SKH (Sharks various *nei*)

[18] Personal communication, FAO

[19] Taiwan, Japan and Ecuador

non-reporting (including finning, flouting of quota allocations, etc.), and under-reporting relating to weak country data collection systems.

Finning and discarding of carcasses at sea

Shark finning continues, despite the almost total global ban on the practice. The fin trade is lucrative, and fins can be concealed relatively easily, particularly when dried. The varying performance and results of national enforcement agencies is also documented, including by (or via) observer agencies (Schwenzfeier *et al*. 2022) and the regular media reports on continuing strong demand for shark fins,[20] mean it is sensible to expect that networks of criminal operators remain in place, seeking to monetize strong demand in markets where the legal supply of these products may prove challenging.[21]

Given the concealed and mostly criminal nature of finning, it is very difficult to provide an estimate. **Different authors have employed varying methodologies to estimate fishing mortality related to finning, which has yielded multiplication factors of between 2.5 and 4 of the shark catch reported to FAO** (Worm *et al.* 2013, Clarke *et al*. 2006). Beyond the very wide difference in estimates of unreported catch relating to the practice, **one of the challenges today is that both these studies were based on the 2000 FAO dataset, a time at which most national and regional finning bans had not yet been enacted.** The key question that arises is: To what extent have the regulatory frameworks that have sprung up since, and accompanying enforcement efforts, contributed to reducing shark finning?

An additional confounding factor is that the demand for – and therefore value of – shark meat has grown significantly with major shark meat markets like Brazil, differing completely from the key shark fin markets in Hong Kong and Asia (see Section 3 on trade). **This creates a financial incentive to land the whole shark, falling into line with regulatory requirements to land shark with fins attached.** These developments are expected to significantly weaken the incentive for finning and discarding of carcasses at sea.[22]

Blue shark discard practices were historically reported in Spanish longline fleets since the eighties and earlier decades of the 20th century. However, the blue shark (bodies and fins) have gradually been retained onboard fully and landed by this fleet starting in the mid-nineties when freezing systems were largely introduced. This change in fishing practices is also related to price increases of this species and its products in international markets. The practice of 'finning' in surface longline fleets (understood as the removal of the fins and discarding the

[20] See: https://www.theguardian.com/environment/2020/jul/06/shark-finning-why-the-oceans-most-barbaric-practice-continues-to-boom

[21] A May 2020 press release of the Hong Kong Customs and Excise Department informs of the historic seizure of an illegal 26 t consignment of dried shark fins inbound from Ecuador, with an estimated market value of about $8.6million, sliced from the carcasses of an estimated 38,500 sharks. (See: https://www.customs.gov.hk/en/publication_press/press/index_id_2906.html)

[22] Momballa (2020) notes with regards to the Congo: "Directed artisanal shark fishing […] has been an important fishery […] since the early 1980s, driven by extensive demand from East and Southeast Asia for fins. It is also driven by local demand for processed shark meat, *which reduces any incentive for the wasteful practice of on-board shark finning*." (emphasis by the authors of this report). Diop & Dossa (2011) inform that shark meat was not previously valued in some West African countries, such as Mauritania, where up to 1978 sharks were released/discarded whole. The explosion of shark fin prices in SE Asia after 1980 (rising by 3000% over the next decade) drove the development of targeted shark fisheries, in which finning became a ubiquitous phenomenon, owing to the weaker shark meat market across the SRFC region at the time. However, in Ghana significant amounts of landed shark meat are traded across the region, where it now commands high prices.

rest of the body) is not typical of surface EU fleets anymore, due mainly to the above-mentioned economic drivers and legal constraints. The Spanish fleet as a whole normally makes full use of the blue shark (bodies and their fins) for human consumption (Espino et al, 2010), and the drive to ensure full usage/landing was ultimately completed through the 2003 EU regulation[23] establishing a finning ban for vessels flying an EU flag.

However, **in regions where shark meat remains undervalued, or in fisheries where non-shark target catch (most of which tuna and swordfish) is a lot more valuable than shark, where high-grading at sea makes financial sense at given times, and where reefers continue to accept illegal consignments of fins at sea, incentives to engage in finning remain.**

It is not just shark fins driving illegal shark harvesting and trading practices. Seafood fraud is another, possibly underestimated avenue, through which large amounts of sharks, including blue shark, are traded globally under labels suggesting to consumers that they are looking at a different species (WWF, 2019).

Sea Around Us project catch reconstructions

The University of British Columbia's Sea Around Us project is world-renowned for its catch reconstructions, which seek to quantify the elements that contribute to under-reporting in official data. This work includes estimates for discarded catch, aiming to provide an estimate of total fishing mortality by species, which differs from the aim of this research, aiming to provide a best estimate of landed volume entering the value chain.

In 2018 – the latest year on record for blue shark – the Sea Around Us project reports a global total catch figure of 244,784 t. The landings proportion of this is around 60% more than the FAO FISHSTATJ statistic of 104,694 t for the same year (Table 6).

Table 6 Estimated discards and landings of blue shark (2018) in tonnes (source: UBC)

UBC/Sea-around-us blue shark reconstruction - 2018						
	Artisanal	Industrial	Recreational	Subsistence	%-age	Grand Total
Discards	2,916.6	74,516.1	0.3		32%	77,433.0
Landings	12,147.9	120,934.7	34,266.5	2.6	68%	167,351.7
Grand Total	**15,064.6**	**195,450.7**	**34,266.8**	**2.6**		**244,784.7**

When we apply the UBC estimate to the year 2019, using this FAO/UBC landings ratio, we get a figure of 174,675.8 t of landed blue shark.[24] **Our reconciled global estimate for blue shark landings for the same year is 189,783 t, which is 9% higher than the inferred UBC estimate**. This relatively similar result to the Sea Around Us project (with an established methodology widely used in fisheries management and research) gives further assurance of the catch estimate derived from this research. The resulting reconciled/ reconstructed volume for global blue shark landings is a robust figure that provides an established minimum volume of whole blue shark (*i.e*. meat and fins) that has been caught and landed, and that has entered the supply chain in 2019.

[23] See: Council Regulation (EC) No 1185/2003 on the removal of fins of sharks on board vessels. (updated in 2013)

[24] Note that the 2019 equivalent figure for discards would be 81,156 t.

Apart from the unknown additional volume relating to unreported catch that transcends the catch reconstruction and reconciliation presented in this study, and discussed above, one of the elements that remains open to conjecture is the figure UBC provides for discards, and to what degree these discards will have been illegally finned and illegally put to market. Given the ongoing reports of illegal shark fin consignments entering Hong Kong (see above), and illegal fins getting detected elsewhere,[25] it is clear that the market drivers for illegal finning and underreporting remain firmly in place.

Theoretically, additional shark fins could enter the market from the 81,156 t of discarded blue shark that is estimated by the Sea Around Us project. On the basis of a 6/94 fins-to-carcass weight ratio (as explained in **Appendix E**), if finning always occurs when discarding, this equates to a further 4,869 t of fins (wet weight) going to market. This is explored in the valuation section, which compares the reported trade volumes for fins with our estimated minimum catch and these additional fins assumed from the illegal finning of discards.

Temple *et al*. (2022) discuss the complexities of estimating IUU fishing volumes and underline the need for developing a species/fisheries-specific modelling approach that takes into account all pertinent factors that would allow for robust estimates to be produced. We are not aware of any recent global blue shark IUU estimates in the literature, preventing further reasonable estimations of unreported global landings (meat and/or fins) beyond those we have applied.

2.8 Total minimum catch estimate

Table 7 below provides the reconciled global minimum tonnage of blue shark caught and landed and the two major products (meat and fins) in Live Weight Equivalent (LWE) in 2019. **The total minimum catch estimate figures come with very low uncertainty, given their conservative derivation in this study.** The total LWE tonnage for blue shark fins is also presented, including an assumed illegal finning of all estimated discards. While such assumption is clearly unreasonable – not all operators act illegally, nor do all operators act legally – it serves the purpose to derive a potential maximum economic value within our minimum global blue shark catch estimate, accounting for potential additional illegal finning.

Table 7 Total estimated volume of blue shark catch (LWE), 2019 (source: FAO, t-RFMO, UBC)

Data source / item	Volume (t)	Considerations / Notes
FAO/RFMO reconciled total global landed catch	189,783	This should be considered a minimum, owing to stated limitations in estimating IUU
Meat weight of total global landed catch	178,396	Based on a 6/94 fin-to-carcass ratio and the above total catch figure
Fin weight (wet) of total global landed catch	11,387	
Discards	81,156	Adjusted from 2018 UBC Sea Around Us blue shark discard estimate
Fin weight (wet) in discards	4,869	Based on a 6/94 fin-to-carcass ratio and the above discard figure

[25] See for instance: https://www.justice.gov/opa/pr/owner-japanese-fishing-vessel-charged-unlawful-trafficking-shark-fins https://www.justice.gov/opa/pr/owner-japanese-fishing-vessel-charged-unlawful-trafficking-shark-fins

Total meat (wet)	178,396	Minimum
Total fins (wet)	11,387	Derived from legitimately landed whole sharks, and zero illegal finning of discards
	16,256	Based on legitimately landed whole sharks + illegal finning of all estimated discards

Given that unreported catch beyond our reconciliation effort remains unaccounted for, but certainly exists, this approach is likely to bring us closer to a real-world figure, bearing in mind that unaccounted shark fins in circulation will derive either from unreported fishing of the illegal operations type, or unreported fishing of the lacking-government-monitoring-capacity type.

2.9 Global ex-vessel value of blue shark

This section produces a financial value for global blue shark fisheries at the first point of sale from the vessel. We do not estimate 'non-market values' in terms of blue shark's contribution to marine ecosystems and the services they provide or the existence value of the species (*e.g.* as a contributor to shark tourism or people's willingness to pay for the existence of the species). A separate exercise would be required to explore these non-market values.

Table 8 provides an economic valuation of the first-hand sales value of blue shark, based on the reconstructed catch figures presented in section 2 of this report. For the purposes of the valuation calculations, a blue shark fin to round weight ratio of 6% is applied as this is an average that is reported across multiple studies[26]. The methodology used and breakdowns per RFMO are provided in **Appendix F**.

The total ex-vessel value of blue shark in 2019 is estimated to be $410.5 million based on the estimated minimum total catch of blue shark (Table 8). **The results reveal that blue shark meat overall is about five times more valuable than the legal fins.**

If we assume the illegal finning of the discards estimated by the Sea Around Us, a further 4,869 t wet weight of fins may enter the market. This results in a global fin supply of 16,256 t is very close to the 16,180 t total volume of fins estimated from trade figures in the following chapter (see section 3.5). While this may be coincidental, it supports our assertion that $411 million should be considered a minimum global ex-vessel value.

The paucity of evidence for illegal activities makes it difficult to determine the accuracy of the assumption that 100% of discards are finned, but the trade data suggests that adding in the value of these additional fins, increasing the global ex-vessel value to $441 million, may result in a closer approximation of global ex-vessel value.

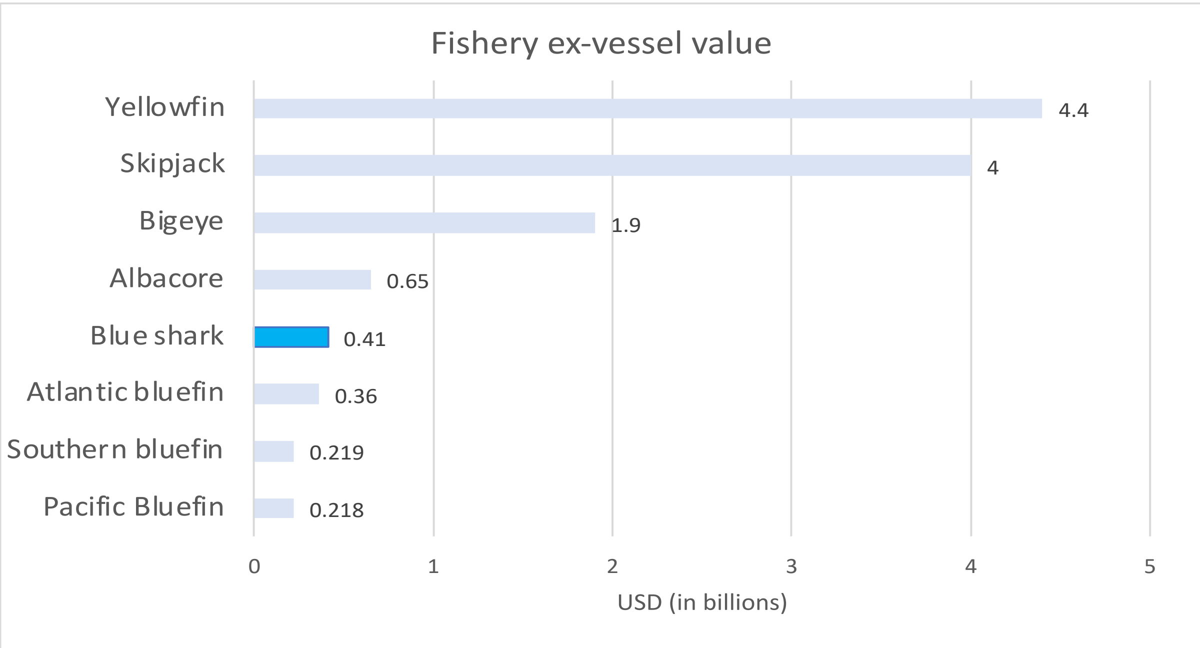
[26] This is consistent with WWF's recent methodological work on blue shark conversion factors: https://sharks.panda.org/images/PDF/Tools/WWF_Sharkulator_Methodology_2020.pdf

Table 8 Estimated ex-vessel value of the global blue shark catch, 2019 (US$)

Item	Volume LWE (tonnes)	Price per kilo (av.)	LWE conversion	Total*	Notes
Total meat	178,396	$1.90	94%	$ 339,827,562	Based on a 6/94 fin-to-carcass ratio
Total fins	11,387 (legal)	$6.21	6%	$ 70,745,929	Based on a 6/94 fin-to-carcass ratio
	16,256 (legal + illegal)		6%	$ 100,949,760	
Total				$ 410,573,492	Assumes zero illegal finning of discards
				$ 440,777,322	Including assumed illegal finning of all discards

By way of comparison, our conservative estimate for **the 2019 total ex-vessel value for blue shark meat and fins exceeds the estimated 2018 ex-vessel values of each of the three bluefin tuna species**, as estimated in 'Netting Billions' (Figure 2). This highlights the global economic importance of blue shark fisheries and the minimal levels of science and governance the species is currently subject to.

Figure 2 Global ex-vessel value of tuna species (2018), and minimum global ex-vessel value of blue shark (2019) (source: Poseidon)



3 Blue Shark Trade

3.1 Summary

- Over the last two decades, the global shark meat trade has increased significantly, doubling in value since the early 2000s to nearly $300 million dollars in 2016 [based on FAO trade data].
- At the same time, shark fin exports have been relatively stable at an average of nominally $160 million per year. This change in the shark market may suggest an increase in full utilization of sharks and a potentially new threat to shark populations driven by demand for shark meat (Pincinato et al, 2022).
- Brazil is the top consumer nation of shark meat and blue shark specifically, but most consumers don't know they are eating shark meat.
- Hong Kong remains the centre of the fin trade, and blue shark accounts for nearly half of this trade. Even though consumption in Hong Kong is declining, markets in mainland China and other Asian countries maintain demand for shark fin despite reduced prices.
- When imports into these markets are converted to live weight, it is evident that the total volume of blue shark fin significantly exceeds the volumes possible even from our higher catch estimate. This supports the anecdotal evidence that illegal finning continues.
- The generic product labelling of shark fin and poor traceability masks supplies of blue shark fins from illegal finning and the trading of endangered shark species.
- We estimate that the global end-user value for blue shark meat and fins is $786 million, which is more valuable than some tuna resources that are subject to far more rigorous management.

3.2 Trade data on blue shark

We have identified four global databases providing trade data on blue shark:

1) UN Comtrade (https://comtrade.un.org);

2) EU Eurostat (https://ec.europa.eu/eurostat);

3) FAO Global Fish Trade (https://www.fao.org/fishery/statistics-query/en/trade_partners); and

4) Aquatic Resource Trade in Species (ARTiS) database.

The extent to which species, particularly in relation to shark fin products, are reported is limited. The 6-digit Harmonised System (HS) nomenclature of the World Customs Organisation (WCO) only distinguishes between sharks and shark fins. It does not distinguish species (Table 9).

Table 9 Trade codes for shark meat and fin products (source: Okes & Sant, 2019)

HS CODE	MEAT	HS CODE	FINS*
30265	Dogfish & other sharks, fresh/chilled (excluding fillets, other fish meat of 0304, livers & roes)	30292	Fish; fresh or chilled, shark fins
30281	Fish; fresh or chilled, dogfish & other sharks, (excl. fillets, livers, roes, & other fish meat of 0304)	30392	Fish; frozen, shark fins
30375	Dogfish & other sharks, frozen (excl. fillets, other fish meat of 0304, livers & roes)	30571	Fish; edible offal, shark fins
30381	Fish; frozen, dogfish & other sharks (excl. fillets, livers, roes, and other fish meat of 0304)	160418	Fish preparations; shark fins, prepared or preserved, whole or in pieces (but not minced)
30447	Fish fillets; fresh or chilled, dogfish and other sharks		
30456	Fish meat; excluding fillets, whether or not minced; fresh or chilled, dogfish & other sharks		
30488	Fish fillets; frozen, dogfish, other sharks, rays and skates (Rajidae)		
30496	Fish meat, excluding fillets, whether or not minced; frozen, dogfish and other sharks		

*Fin specific codes available only from 2012.

The combined nomenclature of the EU was updated in 2018[27] and entered into force in 2019, which enables reporting to distinguish blue sharks at the species level (Frozen blue shark "Prionace glauca" 03038140). At the EU level, this gives us – potentially – at best three years (2019, 2020, 2021) of data where blue shark meat is distinguished and only for trade involving EU entities. All other official trade records still aggregate blue shark under a more general heading (e.g. frozen fillets of sharks (excl. dogfish 03042969) and shark fins are still not disaggregated to species level (frozen shark fins 03039200; smoked, dried, salted or in brine shark fins 030571).

American University researcher, Dr. Jessica Gephart, has developed the Aquatic Resource Trade in Species (ARTiS) database. ARTiS applies a mass-balance methodology to determine species-specific trade flows based on species production detailed in the FAO production database. Dr. Gephart provided the team with a data run for blue shark showing the estimated volume of imports and exports between countries for 2017-2019. Again this only includes blue shark meat as including fins creates the risk of double-accounting. For the shark fin trade, FAO and Comtrade data are used.

3.3 Blue shark's contribution to the meat trade

The blue shark meat trade is more complex than the fin trade as there are more end-user markets. It involved 177 countries in the 2017-2019 period. In 2019 the volume exported equated to 67,326 t when converted to LWE. This is 35% of the global blue shark catch estimated here, 189,783 t.

[27] COMMISSION IMPLEMENTING REGULATION (EU) 2018/1602 of 11 October 2018 amending Annex I to Council Regulation (EEC) No 2658/87 on the tariff and statistical nomenclature and on the Common Customs Tariff

The ARTiS database shows that blue shark meat accounted for 36% of the global volume of shark traded in 2019 (Gephart, 2021). The data also shows relatively stable trade volumes for blue shark between 2012 and 2019, compared to other top traded species such as picked dogfish, shortfin mako and smoothound.

With the main exception of China, which gained weight as an exporter and importer of blue shark meat, the main exporting and importing countries have remained stable over this period. The key bilateral trades are shown in Figure 3 and Figure 4.

Further analysis of the ARTiS trade data using graph theory finds that China has the most significant trades with other countries, acting as a ‘keystone’ connecting imports and exports to many other trading nations. Spain, followed by Portugal in Europe, were relevant in terms of the overall importance of the global blue shark commercial flow, but China was by far the most important trading country. Thailand, Taiwan and Vietnam were also other key trading countries in Asia, while Morocco, the USA and New Zealand were key in Africa, America and Oceania, respectively.

Figure 3 Top 10 bilateral commercial flows of blue shark meat 2017-2019 (source: ARTiS data)

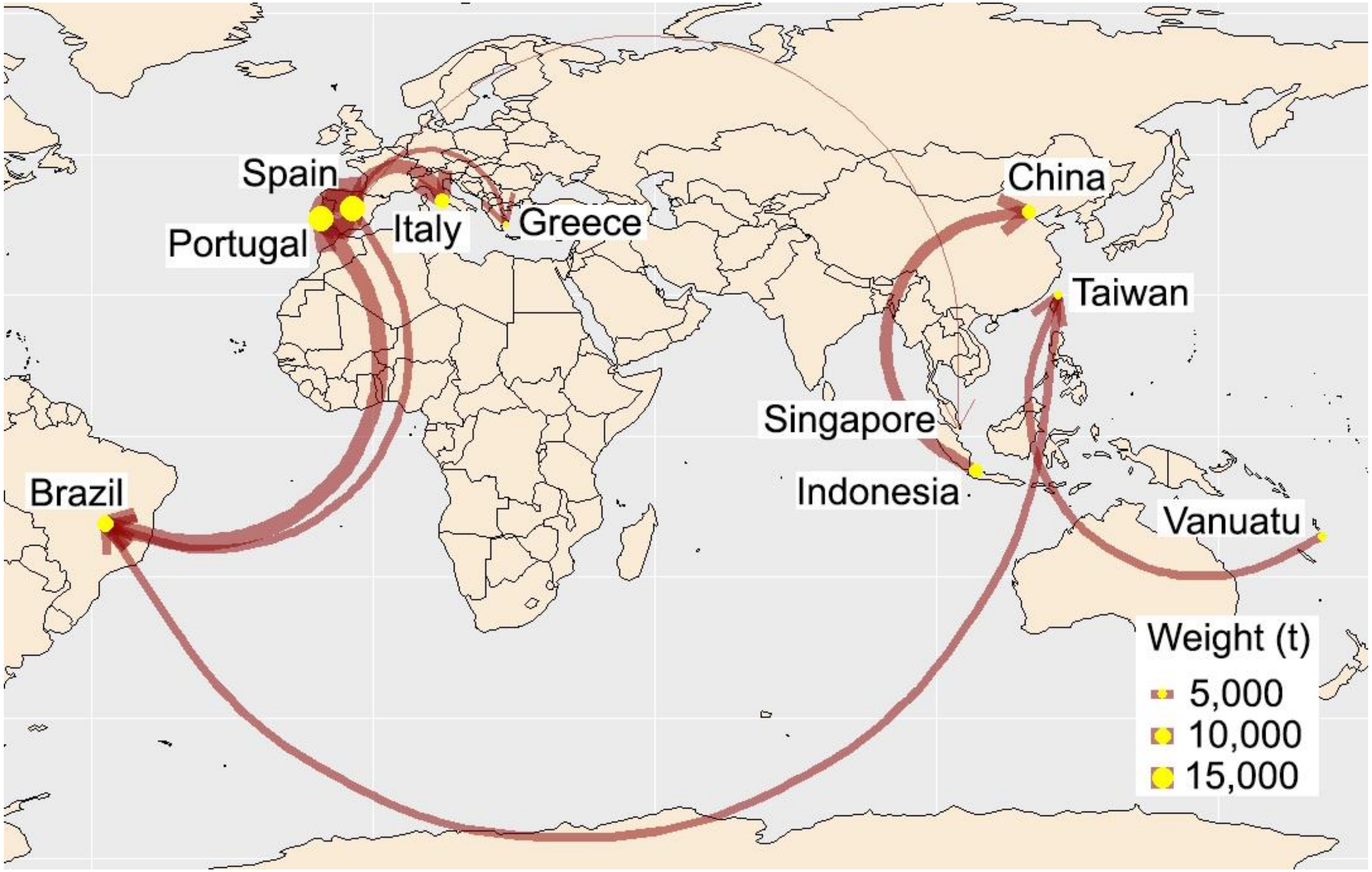
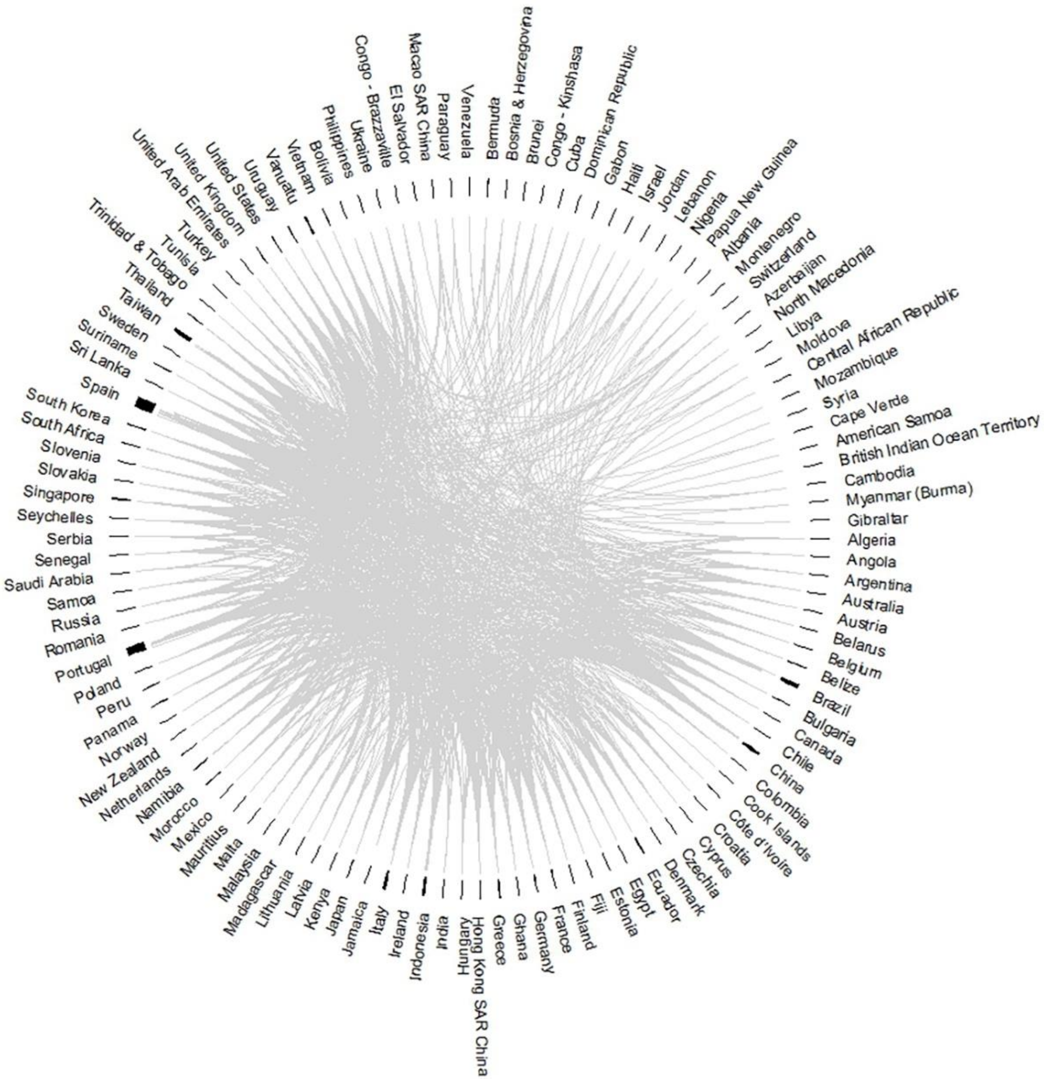


Figure 4 Bilateral trade flows of blue shark meat 2017-2019 (source: ARTiS)



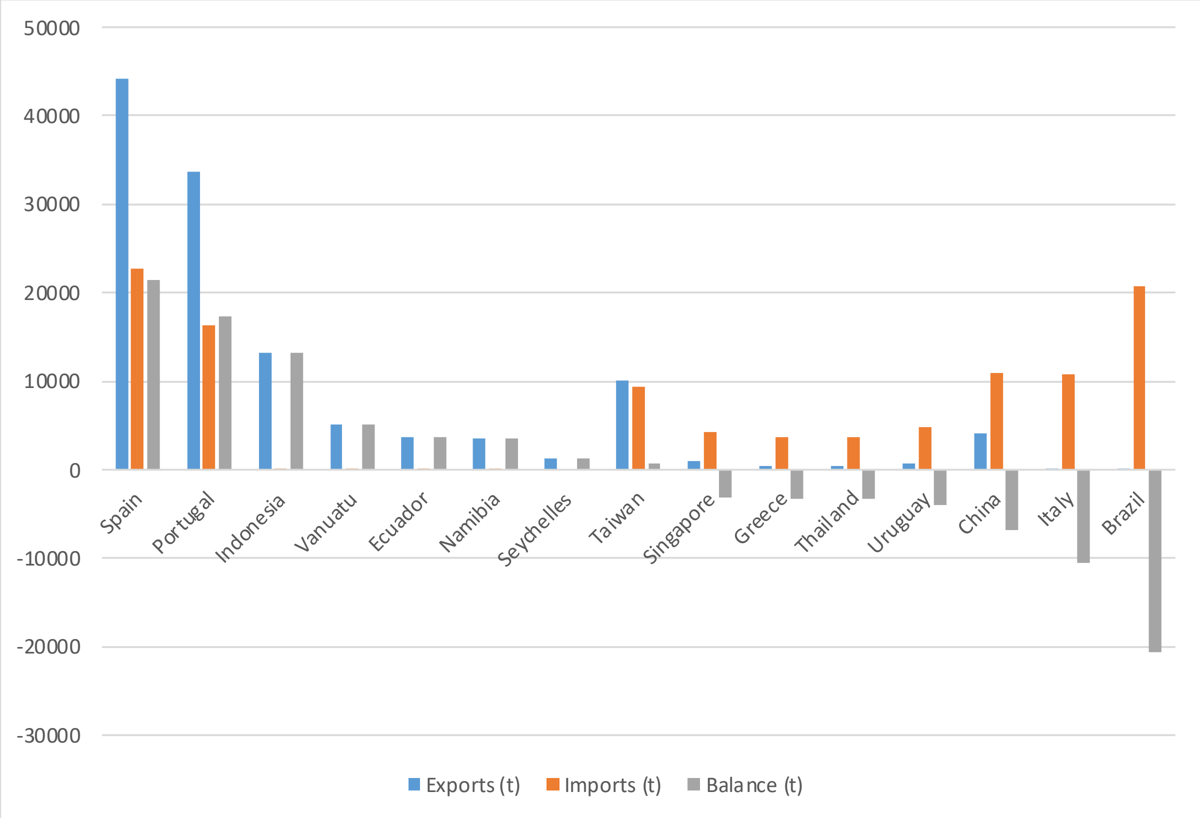
The thickness of the lines is relative to the importance of commercial transactions between countries, within a range between 0.10 t and 6824.75 t. Minor flows have been excluded for visualization purposes.

Table 10 Top 10 blue shark meat bilateral trade flows 2017-2019 (source: ARTiS data)

Exporter	Importer	Product weight (tonnes)
Portugal	Spain	19,221
Spain	Portugal	13,980
Portugal	Brazil	9,812
Spain	Italy	8,519
Indonesia	China	7,287
Taiwan	Brazil	4,790
Vanuatu	Taiwan	4,775
Spain	Brazil	4,618
Spain	Greece	3,387
Spain	Singapore	2,544

Spain and Portugal are key countries in the global trade of blue shark meat, both in terms of exports and imports, although they were net exporters (Figure 5). Indonesia and Taiwan in Asia, Vanuatu in Oceania, Ecuador in America and Namibia in Africa are also significant exporters of blue shark meat, showing positive trade balances. By contrast, Brazil, and to a lesser extent Italy and China, showed the largest negative trade balance among the top importing countries. According to recent reports, Brazil has become the main destination for finless shark carcasses; the country's annual consumption is about 45,000 t.[28]

Figure 5 Blue shark meat trade balance for top trading nations 2017-2019 (source: ARTiS data)



In relation to the main commercial flows of shark meat, trade flows between Spain and Portugal are especially relevant between 2017 and 2019. Exports from Portugal to Brazil and from Spain to Italy were also very important for the overall trade. The trade goes beyond historic and cultural trade links. Other relevant commercial trades outside Europe were between Indonesia and China, between Taiwan and Brazil, and between Vanuatu and Taiwan (Table 10). For 2019, 77% of frozen shark exports from Taiwan were to Brazil, mainland China and Uruguay. Brazil's imports accounted for 52% of Taiwanese frozen shark exports, which were more than twice the amount of China's and Uruguay's imports.

[28] https://brazilian.report/environment/2022/06/24/shark-meat-problem/

3.4 Key markets and products

We conducted 11 interviews with key informants in Brazil (2 interviews), Ecuador (1), Portugal (1) and Spain (7), including with members of the Spanish longline association ORPAGU (Organización Palangreros Guardeses). The experts were selected for their recognized knowledge of different aspects of blue shark fisheries in key countries. During the interviews, performed with the aid of a semi-structured questionnaire, we also obtained information on ex-vessel prices of blue shark meat and fins, along with other information.

Shark fisheries experts in key trade countries agreed that the commercial importance of the blue shark has increased over time, to the point that blue shark landings of some longliners in Brazil, or Spain, are higher than the landings of the previous main target species, i.e., swordfish, and other large pelagic bony fish. The demand for blue shark meat has increased over time, especially in Brazil (Barreto et al., 2016) and Eastern European countries. Further detail on this global trade is provided in **Appendix D**.

Fresh and frozen sharks are landed in many ports in the key fishing countries. In some cases, like in Europe, fishing regulators require vessels to land the fins attached to the body. One of the interviewed experts complained that this prevents quick and effective on-board processing, lowering the quality of the meat and resulting in the species having a reputation for bad smell among fishers: “who catches it does not eat it". However, other experts indicated that the main reason why the quality of the processing is deficient in some cases is its low price in the market. Consumer demand is driven by low prices, about 2-3 USD·kg^{-1} in Spanish fish markets and supermarkets, making blue shark one of the cheapest fishery products available. The low price for shark meat implies that the profit margin along the value chain is moderate, reducing market incentives to improve the management of fisheries and trade in the species, despite the high value of these fisheries globally.

Landing intact means that for European fishing nations, the meat is processed on land at facilities in key countries like Spain or Portugal, rather than on board, into fillets and small portions with or without skin and offered for sale in local and international markets as fresh, frozen or salted meat, while fins are dried and exported to Hong Kong mainly.

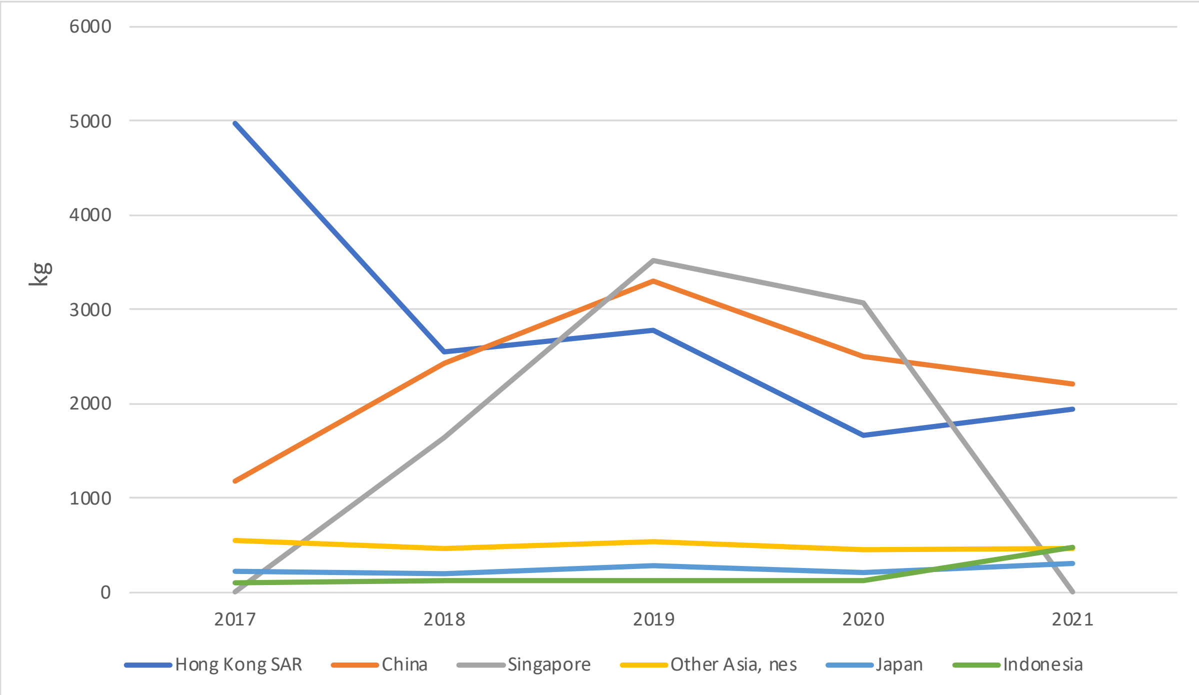
European industry operators highlighted that blue shark fisheries are subject to different national and international regulations, but overall, they recognised that blue shark is fully exploited over its whole distribution range. In fact, the species is listed by the International Union for Conservation of Nature (IUCN) as Near Threatened globally but as Critically Endangered in the Mediterranean (Rigby et al., 2019; Sims et al., 2016).

Following the listing of mako sharks in the CITES convention, some operators expect the future listing of blue shark. Although impacting producers and marketers due to the increase in commercial administrative obstacles, a listing in CITES will improve the information available on trade and on catches. This would help to address the concerns of European operators around systematic underreporting of catches by some Asian fleets, along with other undesired practices like finning and illegal transhipments. One representative of a Spanish fishing company explained that: “Spanish longliners are surrounded by Asian vessels in the international fishing grounds and this is not reflected in the fishing statistics”.

3.5 Blue shark's contribution to the shark fin trade

A key flaw in the blue shark trade data is the lack of fin codes by species in any available database. The following section relies on general shark fin trade data and recent research using DNA profiling to determine the contribution of blue shark to the shark fin trade.

Figure 6 Trend in total shark fin imports 2017-2021 (source: Comtrade)



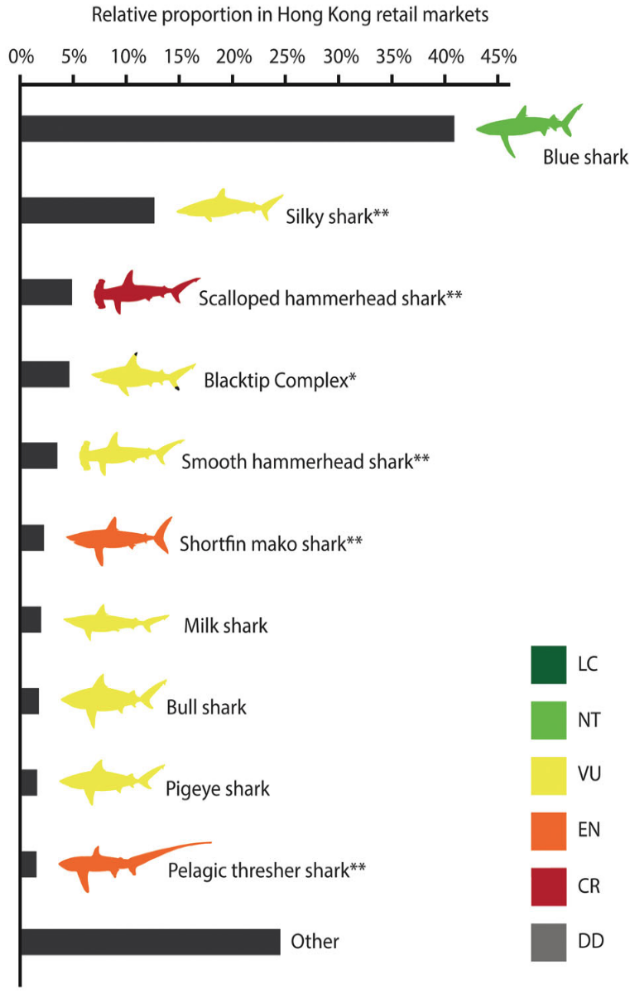
For the three shark fin product categories (dried, frozen and fresh), the overall amount has fluctuated around 10,000 t, but Hong Kong's share of that total shows a declining trend, with China and Singapore increasing their share of total imports (noting the Covid-related market impacts seen in 2020/21) (Figure 6). EU member states supply 28% of shark-fin imports by HK, Singapore and Taiwan, rising to 45% in 2020. Import data indicates that Spain supplies nearly 100 times more than 2nd place Portugal (Shea et al., 2022a).

South America has also become a major supplier of shark fins to the Asian market. According to Abrams World Trade Wiki data from the last eight years, Spain, Peru and Ecuador accounted for 19%, 15% and 5% of the shark fin market, respectively. An investigation published on the Bitácora Ambiental website[29] shows that between Ecuador and Peru, illegal shark fishing is "laundered" and then sent to Asia. Although shark fishing is prohibited in Ecuador, except in cases of incidental fishing, the value of shark fin exports declared by the country for 2020, according to the Bitácora Ambiental report, was USD 1.2 million with a weight of 30 tons, according to data from the National Customs Service of Ecuador (SENAE). The descriptions of the exports correspond to blue shark fins, dried fins of rabon, mico and bittershark; dried anal pelvic fins of blue shark. All these exports are destined for Peru and left through Huaquillas.

[29] https://en.bitacoraec.com/post/it-is-not-illegal-but-between-ecuador-and-peru-millions-of-shark-fins-are-launder

Fields et al (2016) estimated that blue shark accounted for around 49% (range 34 to 64%) of the Hong Kong fin trade. In a more recent study, Cardeñosa et al (2022) found that blue shark made up 41% of fin trimmings taken at retail markets in Hong Kong (Figure 7). While imports are decreasing, Hong Kong remains a global hub of the fin trade and, in terms of species composition, we assume that the Hong Kong market is representative of the global market for fins.

Figure 7 Relative contribution of top 10 species to shark fin trimmings in Hong Kong markets (source: Cardeñosa et al, 2022)*



*Species are color-coded by their IUCN Red List status. Blue Shark is *near threatened* (NT).

According to Comtrade data, the total amount of all-shark fin imported by Asian countries in 2019 was:

- 3,138 t of dried fins (i.e. edible offal; shark fins, code 30571); and
- 8,075 t of frozen fins (Fish; frozen; shark fins, code 30392);

(with less than 40 t of fresh shark fin traded, code 30292)

Using the ratio of 10:1 for processing wet (or frozen) fins into dried shark fin (Cornish and Pun, 2020), this yields a global dried fin trade total of 3,946 t. This may represent an over-estimation as some imported frozen fin may then be exported as dried fin and so is already be included in the dried fin total. But this potential overestimate is not very large as frozen fins only make up 20% of the total fin imports.

If blue shark accounts for 41% of the global fin trade total, this equates to 1,618 t of dried blue shark fin. As dried fin is around 10% of the wet weight, this amounts to **16,180 t** of blue shark fins in wet weight equivalent. The catch reconstruction for 2019 estimates that the potential wet weight of blue shark fins from legitimate catches on the global market is 11,387 t. This total rises to **16,256 t** if all estimated discards are subject to (illegal) finning.

The above calculations are subject to several caveats, yet the close alignment of the two totals does indicate that the amount of blue shark fin on the market cannot be supplied by the officially reported and our reconciled catch of blue shark alone. As noted above, the portion that is currently attributed entirely to (illegal) finning of the discarded portion in this study will break down into an unreported portion of otherwise legitimate catches, plus illegal finning of discards in the real world.

The close alignment between the estimated trade volume for fins (this chapter) and the *legal + illegal* catch estimate volume for fins (previous chapter) suggests that the methodology for estimating the global catch is indeed robust and conservative, and that it continues to embody a likely underestimate. The latter also owes to the fact that a (likely) substantial portion of blue shark fins harvested by the dominant flag State (Taiwan) will be landed and consumed domestically, will not enter world trade, and will thus not appear in world trade data.[30]

3.6 Species substitution and mislabelling

Food fraud[31] is very prevalent in the global seafood trade given the very wide variety of species often traded in processed forms. It may occur for different reasons, including:

a) to harvest, retain, land and monetize prohibited or otherwise protected/ restricted species;

b) to substitute lower-priced species with higher-priced species, to increase profits; and

c) incorrect identification (i.e. *bona fide* error).

These types of food fraud include the critically endangered Mediterranean blue shark sold as swordfish in Italy and Greece, with open-air markets and smaller seafood shops providing the main avenues for these types of seafood fraud (mislabelling and species substitution) to flourish (*e.g*. Meloni *et al*. 2015). The same findings apply in Chile, where blue shark is sold as swordfish in open-air markets and small retailers (Duffloq *et al.* 2022).

Delpiani *et al*. (2020), studying mislabelling and species substitution of bony and cartilaginous fish, report that in the most important seafood market of Argentina (Buenos Aires province), the total detected substitution rate was 21.34%, with most replacements involving cartilaginous, rather than bony fish – most of which were sharks. This underlines the vulnerability of sharks to not be properly accounted for along the supply chain, undermining

[30] Taiwan is also one of the top three consumer nations of shark fins, alongside Hong Kong and Singapore. (See: Shea *et al.* 2022a)

[31] Food fraud is defined as an intentional adulteration to mask product conditions, or hide requirements that it does not meet, such as nutritional characteristics and price (Spink & Moyer, 2011).

the use of trade and consumption data to estimate or corroborate landings and fishing mortality.

In Brazil, the largest shark meat market, the popular dish of "*cação*" (composed in part of blue shark meat) takes place in a bubble of tested and verified consumer ignorance regarding the type of source food being consumed, with more than half of "*cação*" consumers thinking to never have eaten shark in their lives (Bornatowski *et al.* 2015). Another study, focusing on South Brazil, found that blue shark was being mislabelled in fish markets as "salmon", "sand tiger shark" and "croaker" – the general rate of seafood fraud in markets measured at 30% (Staffen *et al.* 2017). This state of affairs is underpinned by a weak regulatory framework that fails to identify products down to the species level throughout the supply chain, with Staffen *et al*. reporting that "*in Brazil there is no control that requires the identification of Shark species by commercial establishments, and it is usually sold only with the generic term of cação*". This mirrors the consumer-facing shark fin trade in Hong Kong, reported to generally not indicate the shark species on sale, with the price of fins being commanded by species-independent physical and organoleptic properties of the fins.

The role of Uruguay is key in this trade, acting as a regional hub, processing and directing the trade of this species from landings by different international fleets into Brazil, and so being classified as re-exports (MGAP-DINARA, 2019). The lack of incentives for trading companies to correctly report the codes used, and the amounts moved, added to the lack of control by the Brazilian authorities over this regional trade, which includes a large amount of transportation by road from Uruguay (according to information provided by the experts consulted), which could explain the large difference between the official values as reported in the ARTiS database and the estimates obtained by Pincinato et al. (2022).

The lack of specific labelling in many shark meat supply chains means that consumers often do not know they are buying shark meat. This includes purchasers of pet food: researchers in Singapore and the US found shark in pet food products, with blue shark being the most common species identified. Generic terms like 'ocean fish' and 'white fish' are used on product labels, with no mention of shark meat (French & Wainwright, 2022, Cardeñosa, 2019).

Shark products are also mis-labelled in terms of what the product is. Products that are traded as 'yuchun' in Chinese markets translate as 'shark lips', but appear to be a specific type of dried shark fin product, usually part of the caudal fin (Shea pers. comm.) A 2021 report that used DNA barcoding to investigate the shark species composition of 'shark lips' in the Chinese market reveals that blue shark accounts for 65.5% of such products.[32] This is a substantially higher proportion than blue shark in the general shark fin market, indicating that blue shark is a particular preference for shark lip products.

[32] Zhang, X., Armani, A., Wen, J., Giusti, A., Zhao, J., & Li, X. (2021). DNA barcoding for the identification of shark lips (鱼唇): A nationwide survey for analyzing a never investigated product in the Chinese market. Food Control, 126, 108075.

3.7 Consumption trends

3.7.1 Shark meat

Meat consumption has increased markedly in recent years. One of the top consumer and import markets is Brazil (see **Box 1**), with the key suppliers being Spain, Portugal, Uruguay and Taiwan (Druon et al., 2022). Almeron-Souza et al (2018) found blue shark was the most abundant shark species in samples in Southern Brazilian fish markets, traded as “cação,” “caçonete” or “filé anjo.”

For several years, shark meat in Bahia [Brazil] was considered low-quality meat (peixe de terceira) or muamba (characterizing a product of dubious origin) and therefore, displayed rather limited commercial value. Corroborating this, several fishers reported receiving these fish as gifts from boat owners in the past. Therefore, sharks were usually consumed only by fishers and their families and by the local population, comprising an important food source.

However, these fish have been gradually upgraded to the status of high-quality fish (peixe de primeira), leading to dramatic changes in shark meat catches and consumption by local Bahia fishers. Regionally, immature sharks are preferred because they have the most tender and tasty meat, according to the interviewees. These preference motifs concur with those reported by Musick (2005), who, in a worldwide study on the different ways of using these fish, points out that small sharks are preferred for meat consumption because they generally display lower urea and mercury concentrations in relation to larger individuals (Barbosa-Filho et al, 2019).

Europe includes several countries in which blue shark consumption is well established, including Spain as the top meat consumer, but Austria, Czechia, Germany, Hungary, Italy and Romania, also received significant blue shark meat trade flows (see **Appendix D**). As evidenced in Italy (Storelli et al., 2022), consumers in most of these countries probably do not know that they are consuming blue shark.

Consumption of blue shark in Spain is higher in the South and in the Mediterranean coast, where the typical dish (*adobo*) that traditionally used dogfish is currently made with blue shark, causing some confusion in consumers. In general, consumers have little knowledge about cooking this species as it is mostly consumed in bars and restaurants. Spanish hotels and institutional catering are the main markets for blue shark meat, using it as a cheap substitute for the marinated dogfish dish, 'Cazon en Adobo'.

Blue shark is also the main shark species sold for meat in Japan, Taiwan and Uruguay (Okes & Sant, 2019). In Japan, blue shark is an ingredient in “hanpen” – a fluffy white fishcake.[33] Even a shark's heart, known as the star of moka (salmon shark), can be enjoyed as sashimi.[34]

In addition to increasing concerns over the sustainability of shark meat in some markets, particularly the US and Europe, there are also health concerns over the consumption of shark meat. This is due to the concentration of arsenic and heavy metals by apex predators such as sharks; these materials can reach dangerous levels as they concentrate up the food chain.

[33] https://www.seafoodsource.com/news/environment-sustainability/japans-first-blue-shark-and-swordfish-fip-launched

[34] https://matcha-jp.com/en/10271

A recent study of Persistent Organic Pollutants (POPs) in Atlantic blue shark samples found that 'from a consumption perspective, concentrations found in muscle (the most commonly consumed part) were below the EU maximum allowed levels in foodstuffs. But for the liver, about 58% and 78% of samples exceeded European levels for intake, which may be of importance when considering consumption of oil-related products (Munoz-Arnanz *et al*, 2022).

3.7.2 Shark Fin

Shark fin is a traditional luxury ingredient for shark fin soup that became synonymous with Chinese celebratory meals at weddings. The dish was known to be "fit for an Emperor" and when served, it was considered to reflect a family's wealth and affluence. However, a more international outlook and awareness of environmental issues has led to more consumers questioning the inclusion of shark fin soup on banquet menus. There is decreasing demand in high-value markets because of policy changes by the Chinese government and international hotel & restaurant chains taking shark fin soup off the menu, but the trade is still widespread and valuable (Shea pers. comm.).

Ho & Shea (2021) report changing tastes for Hong Kong consumers: the percentage of survey respondents who said they consumed shark fin soup in the last 12 months fell from 72.9% in 2009/10 to 33.1% in 2019/20. 54% of respondents have reportedly decreased consumption since 2014/15, and a further 15.2% have stopped consumption entirely, mostly for environmental reasons. These changing consumption patterns have resulted in a drop in prices in Hong Kong retail markets, but demand from the growing numbers of middle-class consumers in mainland China and from Chinese ex-pat communities overseas means that overall demand remains high. There is also niche, traditional consumption of the fins in Japanese cuisine, e.g. shark fin steaks, where fresh whole fin is processed by removing the skin, meat and bones from fins, leaving only the cartilage which is then dried and fried.[35]

The great majority of traded shark fin is used in shark fin soup to provide texture, with other ingredients providing the soup's flavour. When seeking alternatives for banquet menus, some hotels switched to offering bird nest soup, which has its own sustainability concerns[36]. However, there are mushroom and plant-based alternatives (e.g. mung bean, agar-agar or glass noodles) to replicate the texture of shark fin soup. Following a ban on the sale of shark fin, US consumers are accepting of these cheaper alternatives[37].

In addition to sustainability and cost, health concerns have emerged around the use of shark fin. While traditionally its consumption was considered to have health benefits, studies have identified high levels of BMMA, a neurotoxin linked to degenerative brain diseases such as Alzheimers[38] along with dangerous levels of arsenic and mercury (Barcia *et al*, 2020).

[35] https://matcha-jp.com/en/10271

[36] https://www.audubon.org/news/birds-nest-soup-more-popular-ever-thanks-swiftlet-house-farms

[37] https://www.nytimes.com/2015/08/30/nyregion/customers-embrace-shark-fin-substitutes.html

[38] https://www.sciencedaily.com/releases/2012/02/120223182516.htm#:~:text=A%20new%20study%20by%20University,Lou%20Gehrig%20Disease%20(ALS).

Box 1: Brazil's shark meat market

Brazil is the largest single consumer market and importer of shark meat, estimated to amount to 45,000t/yr[1]. The share of imports in Brazilian shark meat consumption has increased from less than 10% in late 1990s to 50% in 2017. Most imported sharks are blue sharks, and come from Uruguay, Taiwan and Spain. Taiwan and Spain (EU) implemented restrictions on finning in 2011 and 2013, respectively, but in Uruguay finning has not been restricted, and since the 2000s a considerable share of this fishing has been in international waters of the South Atlantic.

The increase in shark meat consumption is part of a general trend in Brazil in which seafood consumption has increased due to population increase, changes in diet preferences, access, convenience and availability. In particular, imports and aquaculture have provided most of the seafood available, given the limited domestic supply.

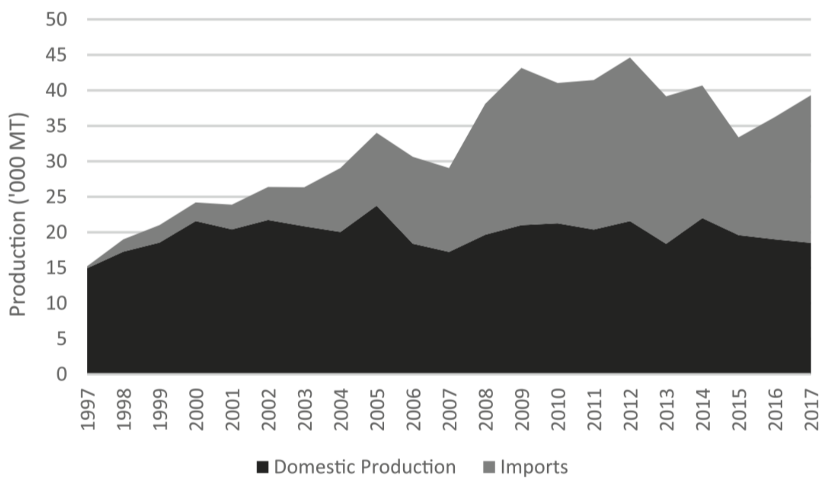


Figure 8 Brazil's domestic production and imports of shark 1997-2017 (source: Pincinato et al., 2022)

Imported sharks are mostly marketed as generic "sharks" instead of a specific species. Blue sharks may benefit from selling under a generic name as it is one of the main imported shark species, but is not considered the best for consumption due to its soft and strong flavoured meat.

The lack of species-specific labeling may also raise safety concerns, in particular for shark meat. In general, small shark species have lower concentrations of toxins, making them healthier options for consumption of shark meat. This may be one of the reasons why dogfish, mako and tope sharks are preferred for meat, while fin products typically come from larger sharks, such as hammerhead, oceanic whitetip and blue sharks. Recently, relatively larger sharks (e.g., blue shark), are widely marketed for their meat, and in many cases without the systematic testing for concentration of toxins (e.g., heavy metal) as is the case in Brazil. This highlights a void that certification and traceability programs may help to address by enabling consumers to make more informed decisions with respect to consumption of shark meat, and, thus, put some pressure on the value chain to adopt sustainable practices.

Source: Pincinato et al, 2022

(1) https://brazilian.report/environment/2022/06/24/shark-meat-problem/

3.8 Global End-user Value of Blue Shark

This section produces a financial 'end-user' value for the global blue shark trade, generally based on the retail prices for shark meat and fin products.

We do not estimate 'non-market values' in terms of blue shark's contribution to marine ecosystems and the services they provide or the existence value of the species (e.g. as a contributor to shark tourism or people's willingness to pay for the existence of the species). A separate exercise would be required to explore these non-market values.

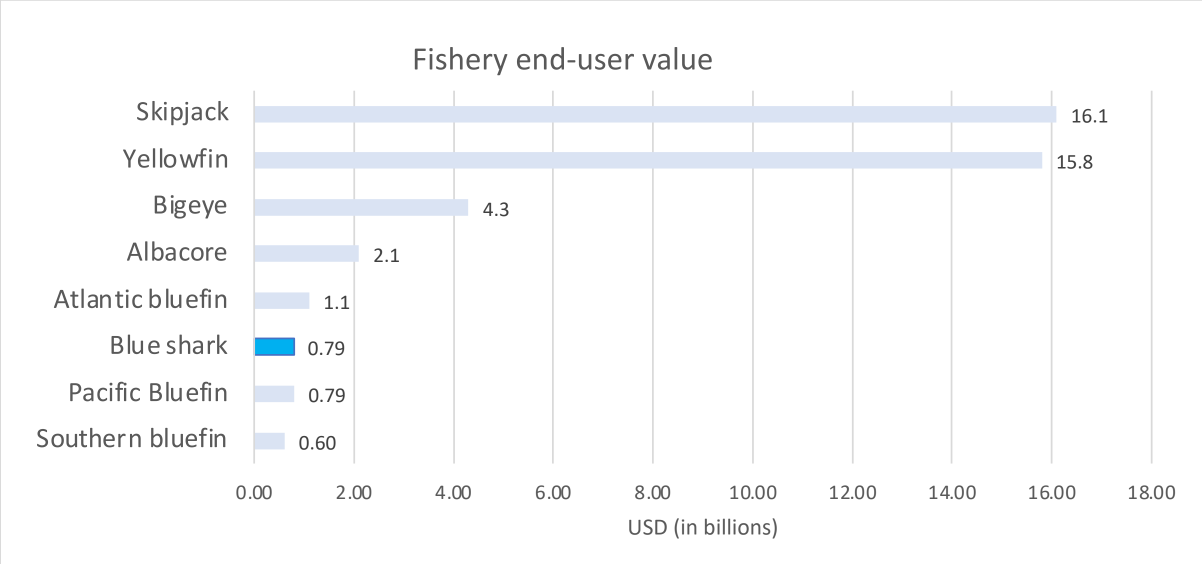
The total end-user value of blue shark in 2019 is estimated to be $786 million based on the proposed minimum total catch of blue shark presented in this report (Table 11). If the value of additional fins from potential illegal finning activities is factored in, this value rises to $846 million. This is nearly double (+91%) the estimated ex-vessel price.

Table 11 Estimated end-user value of the global blue shark catch, 2019 (US$)

Item	Volume product (tonnes)	Price per kilo (av.)	Total	Notes
Total meat	113,870	$ 5.66	$ 644,500,051	Assumes 60% usable meat ratio, currently often lower.
Total fins	1,139	$ 124.00	$ 141,198,745	Assumes 6/94 fin ratio and end-use is of dried fins at 10% of wet weight.
	1,626		$ 201,578,892	
Total			$ 785,698,796	Assumes zero illegal finning of discards
			$ 846,078,943	Including assumed illegal finning of all discards

By way of comparison, the estimated total for blue shark of $786 million exceeds the estimated 2018 end value of Southern bluefin tuna species and is very similar to Pacific bluefin (Figure 9). It is notable that Southern bluefin tuna has an entire RFMO dedicated to it alone as the species of competence, while the fishery is of lower overall value than blue shark. This further highlights the economic importance of blue shark fisheries and the comparatively minimal levels of science and management that blue shark fisheries are subject to compared to other fisheries.

Figure 9 End-user value of tuna species and blue shark (source: Poseidon)*



*tuna value estimate for 2018 (Poseidon, 2020), shark data 2019.

4 Blue shark status, conservation and management

4.1 Summary

- The blue shark's reproductive biology explains the species' comparative resilience to fishing pressure, but effort is largely unmanaged and, in many regions, increasing. Blue shark is estimated to be declining in the Atlantic and Indian oceans and increasing in the Pacific.
- Recent genetic research suggests there are distinct genetic populations of blue shark, with two main clusters: (i) the northern Atlantic Ocean region, inc. the Mediterranean Sea and (ii) the Indo-Pacific region, with the south-eastern Atlantic region possibly being an important area of mixture between these two regions.
- The global policy environment for shark conservation has evolved considerably over the last 20 years, prompted by the International Plan of Action (IPOA) on Sharks; through the increased listing of shark species in both CITES and CMS Appendices; and the sustained monitoring of shark species for the IUCN Red List.
- There is no RFMO specifically dedicated to the conservation and management of sharks. Of the four t-RFMOs covered, only the IOTC is constrained by its Convention to directly manage oceanic sharks.
- Management rules of the four t-RFMO provide for bans on shark finning, which directly benefits blue shark conservation. Many countries have also introduced measures to ban shark finning by their fleets and by their nationals, often extending these measures to trade rules. But overall, shark management plans remain fragmented and patchy, with numerous gaps as well as areas of overlapping (and conflicting) protection.
- With shark meat rising substantially in value, we find that shark finning bans in general are losing traction in their ability to protect sharks, as sharks are increasingly targeted directly for their meat products as well as fins, requiring a holistic approach to the management of sharks, as a globally shared, transboundary and straddling resource.

4.2 Biology, distribution and status

The blue shark (*Prionace glauca*) is a large (up to 380 cm total length (TL)) oceanic pelagic shark that is wide-ranging throughout tropical and temperate waters from the surface down to 1,000 m deep (Rigby *et al*, 2019). Blue sharks inhabit cool ocean waters around the globe as far south as southern Chile and as far north as Norway. They migrate following ocean currents to seek water ranging in temperature from 7 to 25° C. In temperate regions, they may be found offshore, but in tropical waters, they must swim deeper to seek a comfortable temperature. Blue sharks are carnivorous predators that feed mainly on squid, other cephalopods and fish. They are known to eat other sharks, cetaceans (whales and porpoises) and seabirds (Stevens, 2009).

The species has the highest known population growth rates among pelagic sharks - blue sharks are viviparous and are noted for large litters of 25 to over 100 pups. The gestation period is between nine and 12 months. Females mature at five to six years of age and males at four to five. The pups are an important food source for other predators, but sharks that survive to maturity may live 20 years. **The blue shark's reproductive biology explains the species' relative resilience to fishing pressure, when compared to other less fecund shark species.** Recent research suggests that elasmobranchs in general, and blue sharks in particular, are also physiologically resilient to catch-and-release stress, implying that survival rates under such circumstances, including in recreational fisheries, may be somewhat higher than earlier assumed (Ciprian *et al.*, 2022; Shea *et al*. 2022b; Panayiotou *et al.*, 2020).

A recent paper by Druon *et al.* (2022) identifies distinct environmental preferences for different life stages of blue shark. The species tends to shift from mesotrophic and temperate surface waters during juvenile stages to more oligotrophic and warm surface waters as adults. However, low productivity limits all classes of blue shark habitat in the tropical western North Atlantic, and both low productivity and warm temperatures limit habitat in most of the equatorial Indian Ocean (except for the adult males) and tropical eastern Pacific. This information could be useful to spatio-temporal approaches to conservation and management of blue sharks.

There are no data available on the absolute global population size of the blue shark. Until recently genetic studies suggested one global population, with weak or no differentiation within and between ocean basins (Ovenden *et al.* 2009, King *et al*. 2015, Leone *et al*. 2017, Verissimo *et al*. 2017, Bailleul *et al.* 2018). However a more recent study (Nikolic *et al,* 2020) used more specific genome scan analysis and **detected significant differences that distinguished genetic clusters from the northern (Mediterranean and North Atlantic) vs. southern (south-eastern Atlantic, Indian Ocean and southwestern Pacific) oceanic regions**. There were also lower, but still distinct differences between locations from distinct regions within the Atlantic Ocean (northern vs. north-eastern vs. south-eastern Atlantic). This has significant implications for the management of blue shark stocks.

Across regions, blue shark was estimated to be **declining in the North and South Atlantic and Indian Oceans** and **increasing in the North and South Pacific**. In general, whilst no blue shark stocks are considered to be overfished or (with the possible exception of the Mediterranean and the Indian Ocean) subject to overfishing, there is considerable uncertainty about this. Stock assessment details per ocean basin are provided in **Appendix F**.

Due to uncertainty in some of the regional estimated trends; inferred declines in the Mediterranean Sea; the high levels of exploitation and the extensive trade in meat and fins, IUCN estimate a global population reduction of 20–29% over three generation lengths (30–31.5 years). Therefore, **blue shark is assessed as Near Threatened (NT)**, nearly meeting Vulnerable (VU) (Rigby *et al*, 2019) at a global level and '**critically endangered' (CR) in the Mediterranean** (Sims *et al*. 2016).

It is noted that new techniques are being brought in to support decision-making in quantifying status risk for fish and seabirds (Winker *et al*, 2020).

4.3 Blue shark conservation and management policy

The global policy environment covering shark conservation has considerably evolved over the last 20 years, prompted by the IPOA-Sharks, but also through the increased listing of sharks in both CITES and CMS Appendices, and the sustained monitoring of shark species at the level of the IUCN Red List.

Global policy instruments covering a diverse array of initiatives targeting shark protection are detailed in **Appendix H**. These instruments have progressed significantly and have translated into the gradual adoption of improved shark conservation and management policy, not only at the level of nation States, but also at the level of regional mechanisms through which nations collaborate.

These are positive policy developments, but for clear improvements in shark management and conservation to emerge, this global-level suite of instruments must be translated at regional and national levels and then proposed actions to be effectively implemented. The following section explores the extent to which this has occurred.

4.4 RFMO shark conservation & management frameworks

There is no RFMO specifically dedicated to the conservation and management of sharks. Four tuna-RFMOs cover the natural distribution range of blue shark (Figure 1). These are ICCAT (Atlantic), IOTC (Indian), WCPFC (Western Pacific) and IATTC (Eastern Pacific). Over the last two decades, all four t-RFMOs have gradually adopted a succession of shark protection and conservation measures. Table 12 provides a summary of current shark fishing rules across the four t-RFMOs. **Appendix I** provides more detail on t-RFMO shark management measures.

Of the four tuna-RFMOs covered, **IATTC and WCPFC have tuna-associated and/or dependent species included in their mandates (invariably mentioning oceanic sharks).**

ICCAT amended its Convention in 2019 (Article IV) to include oceanic sharks and rays to become able to directly manage such species. Following stock assessments in both the north and south Atlantic in 2015, **in 2016 ICCAT first recommended management measures for the conservation of Atlantic blue shark.**

In 2019, **ICCAT Conservation Management Measures (CMMs) 19-07 and 19-08 introduced management measures in the form of TACs and quota limits for the north and south Atlantic blue shark populations, respectively**. These were followed in 2021 by CMM 21-09 on the conservation of Atlantic shortfin mako, also providing detailed conservation measures for this species but stopping short of introducing catch limits. The 2019 blue shark CMMs were amended in 2021 by CMMs 21-10 and 21-11, respectively, re-iterating the same TAC and quota allocations based on updated scientific advice.

The two blue shark CMMs differ in that the one for the north Atlantic (CMM 21-10) sets both a TAC (39,102 t) and quotas for three major blue shark-catching actors (the EU, Japan and Morocco), requiring all other flag States to ensure that they remain within their historic catch limits. CMM 21-11 merely sets an overall TAC (28,923 t) for the south Atlantic, without allocating specific quotas.

IOTC is thus the only t-RFMO that remains constrained by its Convention regarding its potential to directly manage oceanic sharks, like blue shark.[39]

For RFMO management to be effective, it must be informed by robust member reporting. Heidrich et al (2022) concluded that '*there are substantial gaps in the taxonomic resolution of sharks and rays and 'other teleosts', and only about half of the reported global catches are georeferenced, despite existing mandatory requirements. Additionally, the estimation and reporting of discards in all tuna RFMOs remains incomplete*.' This inevitably limits the development and implementation of effective management.

Finning rules apply across all four t-RFMOs, banning the practice of shark finning, which directly benefits blue sharks. The rule is expressed in the same way – with minor differences in wording – making it easy to apply standardized enforcement globally (for instance, by port State inspections). Wherever shark fins arrive detached from their carcasses and/or in the absence of carcasses in the indicated ratio, illegal harvesting of shark fins has occurred and should lead to immediate sanctioning.

[39] The IOTC Agreement lays out the species falling under the mandate of the Commission in its Annex B, which lists 16 species of tuna and tuna-like (billfish) species and explicitly excludes any other potentially associated or ecologically related species, such as sharks, rays or marine mammals.

Table 12 Regulations and Conservation Management Measures by tuna RFMOs relating to shark (source: t-RFMOs)

Measure	IATTC	ICCAT	IOTC	WCPFC
Specific to blue shark		Initial measure committing to assess the effectiveness of management if catches exceeded the average from 2011-2015. CMM 16-12 Allocated annual TAC of 39,102 t for North Atlantic blue shark is established CMM 19-07 Unallocated annual Total Allowable Catch (TAC) of 28,923 t for South Atlantic blue shark is established CMM 19-08. The 2019 blue shark CMMs were amended in 2021 by CMMs 21-10 and 21-11, respectively, re-iterating the same TAC and quota allocations based on updated scientific advice.		
Data reporting	Report data for shark catches, gear type, landings and trade in line with procedures – where possible CMM C-05-03	Tasks I & II apply to shark catches – including blue shark CMM 04-10; CMM 07-06	Record and report blue shark catch in line with CMMs 15/01 and 15/02 CMM 18/02	Key shark species to be fully covered in daily catch and effort reporting – including blue shark CMM 2013-05; CMM 2019-04
	Enhanced data reporting oceanic whitetip via observers CMM C-11-10	Enhanced data reporting for all no-retention sharks via observers CMM 04-10	Reporting obligations cover shark species (target & bycatch) CMM 18/07	Annual catch levels in albacore fishery south of 20° S to cover sharks CMM 2015-02
	Submit catch data for silky & hammerhead sharks in line with procedures CMM C-16-05; 21-06	Ensure enhanced shortfin mako catch reporting CMM 14-06	LL & GN vessels: Mandatory blue shark catch reporting	Specific shark data reporting tables for compliance monitoring CMM 2019-06

Measure	IATTC	ICCAT	IOTC	WCPFC
	LL vessels: 5% scientific observer coverage Report interactions with sharks – incl. blue shark specifically CMM C-19-08		Other gears: Mandatory generic reporting of sharks CMM 15/01	
Gear setting and avoidance rules	PS vessels; Whale sharks; Prohibition to set in their presence CMM C-19-06	Reduce catching Porbeagle & north Atl. shortfin mako CMM 07-06	PS vessels; Whale sharks; Prohibition to set in their presence CMM 13/05	PS vessels; Whale sharks; Prohibition to set in their presence CMM 2019-04
Gear specifications	LL vessels; Shark lines prohibited; CMM C-16-05		Non-entangling FAD design to protect sharks CMM 19/02	LL vessels; Shark lines prohibited <u>or</u> not use wire trace as branch lines or leaders CMM 2019-04
	LL vessels: No steel leaders for vessels transgressing 20% silky shark rule CMM C-21-06		Artificial light prohibition on DFADs to avoid shark bycatch CMM 16/07	Non-entangling FAD design to protect sharks CMM 2021-01
Zero retention rules	Non retention of oceanic whitetip CMM C-11-10	Non retention of bigeye thresher CMM 09-07	Non retention of thresher sharks CMM 12/09	Non retention of whale shark, silky shark and oceanic whitetip CMM 2019-04
	Non retention of whale shark CMM C-19-06	Non retention of oceanic whitetip CMM 10-07	Non retention of oceanic whitetip CMM 13/06	
	PS vessels: Non retention of silky sharks CMM C-21-06	Non retention of hammerhead sharks except *S. tiburo* CMM 10-08		

Measure	IATTC	ICCAT	IOTC	WCPFC
	LL vessels: Retention of silky sharks limited to 20% of total catch volume CMM C-21-06	Non retention of silky sharks CMM 11-08 No retention of shortfin mako unless dead (2022 & 2023) CMM 21-09		
Live release rules	PS vessels: Release all sharks CPCs to do research CMM C-04-05; CMM C-16-05 Live release of oceanic whitetip, whale shark CMM C-11-10; C-19-06	Live release of bigeye threshers, oceanic whitetip, hammerheads, silky sharks, porbeagle sharks, shortfin makos CMM 09-07; 10-07; 10-08; 11-08; 15-06; 21-09	Whale sharks; Oceanic whitetip; Threshers Live release required CMM 13/05; CMM 13/06	Unwanted sharks to be released alive – including those under zero retention rule CMM 2019-04
Finning rules	Fully utilize retained shark catches Fins not more than 5% to 1st point of landing Fins obtained illegally may not be landed/traded CMM C-05-03	Retention aboard of all shark parts to 1st point of landing Fins not more than 5% to 1st point of landing Fins obtained in contravention cannot be landed CMM 04-10	Retention aboard of all shark parts to 1st point of landing Fresh: finning prohibited (partial slicing ok) Frozen: 5% fin/ carcass ratio Fins obtained illegally not to be sold CPCs to undertake shark research CMM 17/05	Fully utilize retained shark catches Finning is prohibited Fins to be naturally attached or kept attached by wire or kept in same bag as carcass CMM 2019-04
Other rules			Transhipment rules apply fully to sharks in the same manner as tuna CMM 22/02	CPCs to develop and share shark mgt plans CMM 2019-04

Legend: orange cells: measures explicitly excluding blue shark; green cells: measures covering blue shark also; blue cells: measures covering blue shark specifically.

4.5 National shark conservation and management rules

National conservation and management regulations for shark fisheries can have significant impacts, especially when they are implemented by major harvesting States and where international regulation may be ineffective or absent. National regulations may be applied to national waters and markets, as well as national operators fishing in the ABNJ.

Focusing on the top five blue shark fishing nations (Taiwan, Spain, Japan, Indonesia and Portugal), accounting for nearly 80% of global blue shark catch in 2019, this sub-section highlights the most relevant national initiatives currently adopted and in force. Relevant rules from other countries are referenced to further illustrate best practices and challenges faced by developing countries.

Regarding the performance of EU members reporting under the 2003/2013 EU regulation banning shark finning, this study finds that compliance with EU-internal reporting requirements differs between States, and that Spain emerges as the most pro-active and responsible State player.

The EU Catch Documentation Scheme (CDS) and US Seafood Import Monitoring Program (SIMP) - two key trade-related measures to which shark imports are subjected – remain paper-based and easy to fraud, and it is unclear how far these programs have managed to contribute to shark protection.

Japan, Taiwan and Indonesia account for an estimated 48% of global blue shark catches. Japan and Taiwan have introduced national shark finning bans, while Indonesia has banned the exportation of threatened shark species.

Finally, developing countries with important shark fisheries (*e.g*. Ghana, Congo) – and regardless of their membership of various bodies (CITES, CMS, etc.) – often struggle to collect and report detailed and complete catch data for many species, including shark, which cannot then inform effective, sustainable management efforts of their shark fisheries – and cannot confidently be accounted for – notably in studies of the type contained in this document.

See **Appendix J** for further details.

4.6 Effectiveness

Despite the plethora of regional and national management measures, there have been very few reviews of their effectiveness. Techera & Klein (2011) and Shiffman & Hammerschlag (2016) suggest that management is relatively effective in some countries, but **overall management plans remain fragmented and patchy, with numerous gaps as well as areas of overlapping (and conflicting) protection**.

Shiffman & Hammerschlag (2016) conducted a review of shark conservation and management policies and measures. The main results are summarized in Table 13.

Table 13: Pros and cons of shark conservation and management policies and measures

Approach	Pros	Cons
Target-based shark fisheries	Can allow sustainable fishing of sharks based on their stock characteristics.	Only really work for small, short-lived sharks with capable management systems.
Catch limits / gear restrictions.	Allows science-based restrictions and adaptive management, and thus favoured by RFMOs.	Can lead to high-grading of smaller or less valuable animals. Gear restrictions are disliked by fisheries targeting BSK.
Finning bans: fin to carcass ratios	Discourages finning and discard of the carcasses. Can be port-monitored.	Do not restrict fishing pressure or total catch.
Species-specific catch & trade restrictions	Can provide strong legal protection. Can allow species-specific actions.	Possible post-release mortality. Some restrictions provide few specifics and are non-binding. May not alleviate other stressors e.g. bycatch mortality.
NPOAs for sharks	Provide a robust, simple framework that can be easily replicated.	Still not undertaken by many countries. Often not enforced and rarely reviewed / updated.
Fin use / sale bans	Easy to enforce. Attracts a high level of public engagement. May generate a social stigma against consumption of fins.	Don't prevent sharks being killed and sold if the fins are not sold.
No take zones	Can protect smaller fish, as well as migration pathways. Provide habitat benefits as well.	Boundaries often political, rather than biologically based. Poor enforcement can degree effectiveness.
Shark sanctuaries	Can protect key life-history phases of vulnerable sharks. Relatively easy to enforce.	Poor design e.g. from lack of stakeholder input. Do not necessarily restrict other types of fishing, which may result in over-exploitation of sharks' natural prey, or even accidental shark mortality due to bycatch.

Source: Shiffman and Hammerschlag (2016)

5 Conclusions & Recommendations

This study shows that blue shark is a highly valuable marine resource that needs to be better managed from a conservation perspective, but also for the livelihoods of the many fishers and traders that depend on blue shark fisheries. Improved management of the catch and trade in blue shark will also support the conservation of the many other threatened shark species that form part of the global shark meat and fin trade.

There are no data available on the absolute global population size of the blue shark. Genetic results **suggest one global population, with weak or no differentiation within and between ocean basins.**

Across the regions, blue shark was estimated to be **increasing in the North and South Pacific, but declining in the North Atlantic, South Atlantic and Indian Oceans and critically endangered in the Mediterranean**. With stock and fishing effort uncertainties, it is not known what a sustainable level of fishing is.

Due to uncertainty in some of the regional estimated trends; the high levels of exploitation, the extensive trade in meat and fins and estimated global population reduction, IUCN considers the blue shark as **Near Threatened (NT),** nearly meeting Vulnerable (VU) (Rigby *et al*, 2019).

Based on data reported to FAO and tuna RFMOs by fishing nations, a minimum of **189,783 t of blue shark was caught and landed in 2019**. The total ex-vessel value of this global blue shark catch is estimated to be $411 million in 2019. By way of comparison, this estimated ex-vessel value for blue shark exceeds the 2018 ex-vessel values estimated for the three bluefin tuna species individually (Figure 2).[40] It is notable that southern bluefin tuna has a full RFMO dedicated to it as a single species of competence – while the fishery is of substantially lower overall value.

If it is assumed that illegal finning of all blue shark discards occurs, the value of these additional fins **increases the ex-vessel value to $441 million**.

The ex-vessel value of the global blue shark fishery highlights its economic importance to fishers and seafood traders around the world. Yet blue shark stocks are subject to relatively minimal levels of science and governance compared to other highly valuable fishery resources such as the bluefin tuna species.

5.1 Blue Shark Fisheries

The Pacific accounts for nearly 53% of reported blue shark catches, with 2/3 of this caught in the Southwest Pacific (more than the Atlantic, 33%, and Indian Ocean, 13% individually).

Taiwan and Spain catch as much blue shark as all other flag States globally, combined. The top 5 blue shark fishing nations comprise of two European (Spain and Portugal) and three Asian (Taiwan, Japan and Indonesia) flag States, harvesting close to 80% of reported global blue shark catches.

[40] Note: this also remains the case when further illegal finning of discards is factored out.

Other than in the IOTC, where handline is the main fishing gear, longline is the main gear used in all other areas, and this gear accounts for nearly 90% of the total global blue shark harvest.

Large-scale fleets harvest 90% of blue shark catches. Blue shark fisheries in the Indian Ocean are an exception, as small-scale coastal fisheries account for a significant proportion of the blue shark catch.

Distant Water Fleets (DWF) account for 74% of reported blue shark catch globally, with this rising to 87% in the Pacific. Again, the Indian Ocean is an exception, where contiguous fleets fishing in their own EEZ or adjacent offshore waters harvest around 2/3 of the total.

Much of the blue shark catch is from targeted fisheries, which are mostly offshore fisheries and generally within an RFMOs Area of Competence; it should not be considered merely as bycatch in swordfish and tuna fisheries. However, to date, ICCAT is the only RFMO that has introduced direct blue shark management with total allowable catches now being set.

Recommendation: RFMOs should increase direct management of blue shark fisheries to properly manage fishing mortality relative to stock status.

Blue shark's global distribution throughout temperate and tropical oceans means that it is impacted by global fisheries problems of overfishing and IUU fishing. Industry operators that directly targeted blue shark claim to comply with anti-finning and reporting requirements but express concern over a lack of enforcement enabling DWF to continue illegal finning and transhipment.

Recommendation: Support global and regional efforts to tackle IUU fishing by Distant Water Fleets as these will directly benefit blue shark fisheries.

5.2 Blue shark trade

Blue shark is a major component of the international trade in meat and fins. The value of the shark meat trade has doubled over the last 20 years, while the value of the shark fin trade has declined in real terms, mainly due to reduced prices. This major change in the shark trade results from increased global demand for sources of cheap seafood and increased utilization of sharks with finning bans requiring bodies to be landed intact or specified fin/carcass ratios. This change in demand brings a new and different threat to blue shark populations.

The relatively low price for shark meat implies that the profit margin along the value chain is moderate, which reduces the incentive for the market to improve the management of blue shark fisheries and trade, despite the overall high value of these fisheries globally.

International trade information on blue shark has very significant gaps. Asia's significant role in the global trade of blue shark meat is revealed by the network analysis using graph theory of the ARTiS database. However, Europe has an important role in the demand for blue shark meat products: Spain, Portugal and Italy, but also Eastern European countries. Other sources of information on global trade, such as COMTRADE, lack specific product codes for the different species traded.

Recommendation: Encourage the use of specific trade codes for the key traded shark species and improved inspection to ensure their correct use.

The catch reconstruction for 2019 estimates that the wet weight of blue shark fins from legal catches on the global market amounts to 11,387 t. This total rises to **16,256 t** if all estimated discards are subject to (illegal) finning. Shark fins are traded using a generic trade code and so it is not possible to determine blue shark fin volumes directly from fin trade data. Cardeñosa et al. (2022) found that blue shark accounts for 41% in Hong Kong markets. Assuming these markets are representative of the global market, the total blue shark fin traded in 2019 (16,180 t) closely aligns with the higher total, which indicates that **the amount of blue shark fin on the market cannot be supplied by the officially reported and our reconciled catches of blue shark**.

The total end-user value of blue shark in 2019 is estimated to be $786 million based on the estimated minimum total catch of blue shark. **When the potential value of fins from illegal finning is factored in, the blue shark end-user value increases to $846 million.**[41] This estimated end-user value is nearly double (+91%) the estimated ex-vessel price for blue shark. It is close to the estimated 2018 end-user value of Atlantic bluefin and exceeds the value of both Southern bluefin and Pacific bluefin tuna (Figure 9).

It is notable that Southern bluefin tuna has an entire RFMO dedicated to it, even though the fishery is of lower overall value than blue shark. This highlights the economic importance of blue shark fisheries and the comparatively minimal levels of science and governance the stocks are currently subject to.

There is anecdotal evidence that illegal finning continues as well as recent reports of attempts to trade fins illegally. The shark fin trade not only masks illegal trading activity in relation to protected species, but also illegal fishing of blue shark, the most traded species.

There is still a lack of traceability across supply chains, with many catch documentation and traceability (CDT) systems still lacking species-level reporting and recording for shark species and shark-derived products, facilitating trade in IUU caught shark.

Additional trade codes to species level for shark fin can take time to adopt (as the specific code for frozen blue shark meat shows) and would be complex to introduce and inspect. Increasing supply chain transparency and traceability through improved catch documentation (as is required with a CITES Appendix II listing) will help to close trade loopholes. A CITES Appendix II listing would also incentivize improvement assessment and the direct management of blue shark as species cannot be traded without proof that fishing does not threaten their survival.

Recommendation: To prevent blue shark products from IUU fishing and endangered shark species being traded as blue shark, support better trade control through a. the development of Catch Documentation Schemes in RFMOs; or b. listing blue shark as an Appendix II CITES species, which has a similar requirement to a CDS.

[41] Note that our trade analysis corroborates the likely existence of these fins in the world market (!)

5.3 Consumers

As blue shark meat is not distinguished in major consumer markets, such as the South American shark meat market or global petfood markets, it cannot be effectively traced, and many consumers do not know what they are purchasing or eating.

Recommendation: Support campaigns to improve seafood labelling and traceability requirements and raise consumer awareness in key consumer markets such as Brazil, Southern Europe and global petfood markets.

Long-term consumer campaigns against shark fin on ethical grounds have had an impact. Recent health concerns about shark fin may create an even stronger disincentive. Fin prices have declined along with demand in high-value markets. But sufficient demand remains in Asian domestic markets and their expat communities overseas for there to be a strong financial incentive to retain and trade fins.

Recommendation: Promote sustainable, healthy shark fin alternatives to consumers in key markets (South American & European markets for meat and Asian markets for fins).

5.4 Blue Shark Conservation and Policy

Until the millennium, there was very little management of shark fisheries and associated trade. Expanding catches of sharks and growing global concern for shark populations led to FAO's International Plan of Action (IPOA) for the Conservation and Management of Sharks. This has led to regional and national plans of action. These are positive policy developments, but clear improvements in shark management and conservation require that the global-level suite of instruments not only be translated at regional and national levels, but that proposed actions are effectively implemented.

The Port State Measures Agreement (PSMA) will continue to improve in-port inspections and the identification of repeat offenders, but there are still large gaps in the global port surveillance network (Hosch et al, 2019). Many countries require more trained officers for fisheries monitoring and control, and there is often a need for institutional strengthening.

Recommendation: Support implementation of the PSMA and governance capacity building in the regions associated with major blue shark fisheries (e.g. Southwest Pacific, Eastern Central Pacific, Southeast Atlantic).

Most RFMOs and national authorities do not consider blue shark to be a high-priority species for protection, as it is not viewed as particularly vulnerable to fishing pressure at a population level, despite stocks being considered as 'decreasing'. Gilman *et al* (2022) state that the five tuna RFMOs use a very small subset of elasmobranch bycatch mitigation methods for pelagic longline fisheries. The nature of shark reproductive biology, even relatively more fecund species like blue shark, suggests that earlier interventions are needed as delays may result in sharper rates of decline once a certain population threshold is breached.

Determining target and limit reference points through stock assessments would allow stock-specific management. Except for the recent ICCAT output rules, no blue shark directed management measures or international trade regulations exist that apply throughout their range. Blue shark populations are likely to continue to decline until direct and enforceable measures are introduced to ensure sustainable exploitation.

For fisheries where blue shark catch is particularly high (e.g. swordfish and tuna longline fisheries), gear-specific mechanisms have the potential for targeted, low-cost bycatch reduction. Hook sizes and moving away from steel traces and other mechanisms have been introduced in some fisheries, but could be applied much more widely.

Operators in fisheries targeting blue shark, such as the Spanish longline fleet, express concern that their compliance with regulations and efforts to trade legitimately are being undermined by DWF vessels that continue the practice of shark finning and transhipment at sea. Tackling IUU fishing will make a major contribution to the more effective management of blue shark.

Despite improvements in the RFMO reporting of sharks in general, there are still high levels of non-species level reporting of sharks (around 10% of RFMO sharks are reported as 'SKH Sharks various nei') and also a likely high level of misreporting, although this is less likely to apply to the distinctive blue shark. There are also uncertainties in the catch and effort data from all RFMOs associated with blue shark.

Recommendation: Encourage RFMOs to improve monitoring, reporting and observer coverage on vessels targeting blue shark.

Recommendation: Blue shark-targeted fisheries should be encouraged to under-go third-party certification as a driver for improved governance, e.g. in reducing the bycatch of juveniles and other shark species.

Spatial protection such as the ban of fishing for sharks in the Maldives shows that relatively straightforward approaches like this can have a positive impact on local and regional shark populations (Gilman *et al*, 2022), but such measures can also adversely impact local fisher livelihoods.

Recommendation: Spatial protection measures should be supported. To aid compliance, these should include mitigation for impacts of restrictions on the livelihoods of small-scale fishers.

Appendix A: References

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Appendix B: Research questions & information sources

Table B.1 Research questions and information sources

Research agenda	Data & information sources
RA1: Valuation of global blue shark trade • **What is the volume of blue shark landings by origins (ocean basin and key catch locations), by management entity (RFMOs or country jurisdiction), and fishing flag?** • **How does this data compare to other highly-traded shark species?**	FAO Fishstat RFMO data National catch data from top fishing nations
• **What is the global breadth of blue shark trade (mapping the volume and value of shark products through import, export, and re-export locations)?** • **What is the estimated value (for key products – meat, fins, and other) of blue sharks globally and by country/region?**	UN Comtrade FAO trade data ARTiS data set. National trade data from top trading nations
• **What are the dock/first sale ex-vessel values of blue sharks?** • **What are the consumed end values of the product types?** • **How have the different product sectors of the market changed over time in volume, value, origin and destination, and what have been the main drivers of those changes?**	Catch data Consumer data in main end markets. Adaptation of approach adopted for tuna in Netting Billions
• **Where do gaps in data, identified by comparing trade and catch data, point to potential suspicious activity, including corruption, fraud, and laundering of IUU products?**	Analysis of catch & trade data, i.d. conversion factors and yields per species/product type.
RA2: Impact of fishing sector on shark abundance • **What are the characteristics of the blue shark fishing sector (i.e., industrial vs small scale fisheries, domestic vs distant-water fishing (DWF)?** • **What is the percentage of large-scale to small-scale fishing in the blue shark industry?** • **What is the percentage of DWF in the blue shark industry?**	RFMO fleet & catch data specific to shark, but also related to associated fisheries with shark bycatch (e.g. tuna & swordfish) Supplemented by key informant interviews incl. scientists, industry and RFMO fishery managers.

• **How would you characterize each of these sectors' role and contribution to the shark meat and shark fin commodity chains within the blue shark trade network?** • **What are the gear types used in the various sectors?** • **What are the target species for the gear types?** • **Where does the fishing occur, and under whose jurisdiction?** • **What percentage of catch originates from the high seas (and distant water fishing) vs. domestic waters?** • **Which are the most important fleets harvesting blue shark?** • **What are the most prominent flag States harvesting blue shark?** • **What are the key companies catching blue sharks?** • **How has the share of blue shark catch (as bycatch) evolved, relative to putative target species (e.g. swordfish and tuna), changed over time for key fleets?**	
RA3: Review of policy and associated catch and bycatch measures for blue sharks • **Survey past and existing conservation measures for blue shark catch management (whether targeted or as bycatch), product trade, and habitat protection.** • **Identify the blue shark-relevant fisheries management, species/seafood trade, and habitat protection measures at the national, regional, and international level including:** • **Shark finning bans/regulations ▪ Catch management measures (input or output controls) ▪ Bycatch measures ▪ Import/export measures, such as prescribed by CITES, EU's IUU Fishing Regulations, and US Seafood Import Monitoring Program ▪ Shark sanctuaries and protected areas management** • **Review scientific recommendations from blue catch stock assessments and bycatch working groups to the relevant RFMOs, whether they were**	Review of **international treaties, regulations** and agreements related to sharks: CMS Sharks MoU CITES PSMA **Regional agreements**: USMCA and CPTPP Review & update of 2019 work done by HSI.org on RFMO, regional and national **policy & measures** (in key fishery areas and for top fishing nations) policy and shark management measures. National Plans of Action (NPOA) status.

adopted and how long it took for implementation to occur.

- **Are there contradicting measures that may increase vulnerability for sharks (e.g., food consumption measures that promote blue shark catch)?**

Appendix C: Additional catch data tables & figures

C.1 FAO catch data

FAO FISHSTATJ data[42] for 2018 and 2019 were compiled into a single Excel spreadsheet. The data for all marine catches, all shark catches and blue shark catch in particular were then analysed to obtain an allocation of catches by reporting year, by (flag and coastal) States and by ocean basin. The ground-level analysis allowed to establish the fraction of sharks, rays and skates as a group (Chondrichthyans) within the overall group of marine fish harvests, and the fraction of blue shark within the groups of sharks, and within the wider group of sharks, rays and skates.

Table C.1 regroups key figures for the years 2018 and 2019 regarding distribution of global marine fish catch amongst full ocean basins.

Table C.1 Distribution of total marine catch between ocean basins 2018-2019, tonnes (source: FAO)

	Total marine catch	
By full ocean basin	**Sum of [2018]**	**Sum of [2019]**
Atlantic	22,151,228	20,496,958
Pacific	49,995,760	47,342,107
Indian	12,323,091	12,363,995
Mediterranean & Black Sea	1,298,697	1,390,004
Antarctic and Arctic seas nei	11,955	2,438
Total	**85,780,731**	**81,595,502**

In the above table, the dominance of the Pacific Ocean emerges, providing in excess of 50% of global marine wild harvest catches reported to FAO.

Table C.2 regroups all reported shark groups (as individual species and/or as groupings of species across taxonomic levels of aggregation) by full ocean basin.[43]

Table C.2 Distribution of all shark catch between ocean basins 2018-2019, tonnes (source: FAO)

	ALL sharks	
By full ocean basin	**Sum of [2018]**	**Sum of [2019]**
Atlantic	157,219	150,559
Pacific	143,529	142,145
Indian	120,845	129,542
Mediterranean & Black Sea	10,403	9,662
Total	**431,995**	**431,908**

The first element arising from the comparison above is that the relative contribution of shark catch between ocean basins differs from that of total marine catch, and that the domination of

[42] See: https://www.fao.org/fishery/en/statistics/software/fishstatj

[43] Note that this dataset contains the "Sharks, rays, skates, etc. nei" group, which our analysis indicates may contain a 50/50 distribution between shark and non-shark elasmobranch species.

the Pacific Ocean is not verified for sharks. The three major ocean basins (Atlantic, Indian and Pacific) yield very similar overall shark catches in the FAO dataset. All-shark catch makes up but ±0.5 percent of global marine fish catch.

Table C.3 regroups all blue shark catches by ocean basin, both as nominal catch, and also as a portion of all-shark catches within the same ocean basin.

Table C.3 Distribution of blue shark catch between ocean basins 2018-2019, tonnes (source: FAO)

	Blue shark catch (mt)		Blue shark (% of all sharks)	
By full ocean basin	Sum of [2018]	Sum of [2019]	% BSH [2018]	% BSH [2019]
Atlantic	61,481	56,048	39.1%	37.2%
Pacific	21,263	28,470	14.8%	20.0%
Indian	21,902	24,732	18.1%	19.1%
Mediterranean & Black Sea	48	59	0.5%	0.6%
Totals / average	**104,694**	**109,309**	**24.24%**	**25.31%**

The total global blue shark catch reported to the FAO in 2018 and 2019 is 104,694 and 109,309 t, respectively. Overall, and with close agreement between both years, blue shark makes up about 25% of all sharks (individual species and broader taxonomic groupings) that are reported to FAO, implying that – based on this dataset – 1 in 4 sharks caught globally is a blue shark. If the generic group "Sharks, rays, skates, etc. nei" – which contains an estimated 50% of non-shark elasmobranchs, and which is part of the all shark catch is halved in order to remove the estimated portion of rays, skates and sawfish,[44] then **the estimated portion of blue sharks against all sharks becomes 1 in 3, establishing the importance and dominance of blue shark as an individual shark species within the FAO FISHSTATJ dataset.**

It also emerges from the above FAO dataset figures that the Atlantic Ocean is both the ocean basin with the highest nominal reported catches – making up more than 50% of globally reported blue shark catch in both years – and that blue shark reported from the Atlantic as a portion of all shark catches is about double that reported in the Pacific and Indian oceans. This stands in stark contrast to blue shark catches reported to RFMOs, and these discrepancies appear to find at least part of their origins in the way that individual members report blue shark and other shark catches to FAO on one side, and to RFMOs on the other. The Mediterranean yields an insignificant amount of blue shark harvests, both in nominal and in relative terms.

[44] This would bring the yearly all-shark catch total down to 327,520 (2018) and 327,262 (2019) t, and the estimated blue shark portion for both years would be 32.0% and 33.4% respectively.

Table C.4 Top 20 all shark and blue shark catching nations by volume, 2019, tonnes (source: FAO)

	All-sharks - 2019				Blue shark - 2019			
	Flag State	Volume	Cum. %	Cum. vol.	Flag State	Volume	Cum. %	Cum. vol.
1	Spain	54,781.1	12.7%	54,781	Spain	47,056.0	43.0%	47,056
2	India	43,738.0	22.8%	98,519	Indonesia	14,920.0	56.7%	61,976
3	Taiwan	37,785.0	31.6%	136,304	Portugal	11,974.0	67.7%	73,950
4	Mexico	31,784.0	38.9%	168,088	Taiwan	4,910.0	72.1%	78,860
5	Indonesia	24,575.0	44.6%	192,663	Mexico	4,774.0	76.5%	83,634
6	Japan	17,682.0	48.7%	210,345	Vanuatu	3,894.0	80.1%	87,528
7	Brazil	14,323.0	52.0%	224,668	Brazil	3,784.0	83.5%	91,312
8	Portugal	13,511.0	55.1%	238,179	China	3,399.0	86.6%	94,711
9	Nigeria	13,338.7	58.2%	251,518	Peru	3,025.6	89.4%	97,737
10	New Zealand	12,567.0	61.1%	264,085	Ecuador	2,581.9	91.8%	100,319
11	Mauritania	10,323.0	63.5%	274,408	Fiji	2,137.0	93.7%	102,456
12	USA	9,972.0	65.8%	284,380	Côte d'Ivoire	1,449.0	95.1%	103,905
13	Tanzania, UR	8,508.0	67.8%	292,888	Seychelles	1,115.0	96.1%	105,020
14	Peru	7,953.5	69.7%	300,841	Sri Lanka	711.8	96.7%	105,731
15	Mozambique	7,825.0	71.5%	308,666	Belize	534.0	97.2%	106,265
16	France	7,721.7	73.3%	316,388	Ghana	414.0	97.6%	106,679
17	Costa Rica	6,690.0	74.8%	323,078	Palau	401.7	98.0%	107,081
18	Yemen	6,647.0	76.3%	329,725	Suriname	383.0	98.3%	107,464
19	Ecuador	6,031.0	77.7%	335,756	United Kingdom	375.0	98.7%	107,839
20	Malaysia	5,791.6	79.1%	341,548	Korea, Rep.	313.2	98.9%	108,152
	-111 more States-	90,360.5	100.0%	**431,908**	*-19 more States-*	1,156.4	100.0%	**109,309**

Table C.4 regroups all shark catches (all elasmobranch species and taxonomic groupings being, or including sharks) on one hand, and blue shark on the other, reported by the top 20 coastal/flag States to FAO, both as nominal catch, and also as cumulative nominal and relative portions reported to FAO. The all-shark figures are inclusive of blue shark catch also.

131 FAO members reported shark catches to FAO in 2019. The top 20 shark fishing nations accounted for 79.1% of the global shark catch, with the three countries Spain, India and Taiwan accounting for almost one third of global shark catches reported to FAO.

Only 39 countries reported blue shark catch to FAO in 2019, implying that just under 30% of countries reporting shark catch to FAO were also reporting blue shark catches. The top 20 countries – *i.e*. just over half of all countries reporting blue shark catch – accounted for 98.9% of total reported global blue shark catch, with the top 3 countries, Spain, Indonesia and Portugal accounting for well over two thirds of globally reported catch.

The list of top 20 blue shark reporting FAO members contains 12 countries not listed as a top 20 all-shark catching nation. Conspicuously absent from the top 20 blue shark listing are India, Japan and Nigeria, all three reporting zero blue shark catches to FAO, and thus being entirely absent from the pool of 39 nations reporting any blue shark catch at all.

C.2 RFMO catch data

Catch data from four t-RFMOs (ICCAT, IOTC, WCPFC & IATTC) for 2018 and 2019 were compiled into a single Excel spreadsheet where all gear and flag codes were harmonized so as to allow for holistic cross-RFMO data analysis of reported shark data.

Note that the areas of competence (AOC) of the four tuna RFMOs (ICCAT, IOTC, WCPFC & IATTC) cover the full global range of blue shark, as shown in Figure 1 of Chapter 2. Since all four t-RFMOs have binding rules in place, mandating the detailed reporting of shark catches, this implies all of the catches from their members should be captured and provide a globally accurate picture.

Reporting gaps in this dataset would be expected to originate from flag States like Argentina, the Republic of Congo or Myanmar, which are not members of the t-RFMO administering the AOC they are bordering in a coastal State capacity (ICCAT and IOTC respectively, in these examples) – especially for catches originating from within their respective EEZs.[45]

Table C.5 Distribution of catch reported to tuna RFMOs by ocean basin and species, 2018-2019, tonnes (source: t-RFMOs)

Ocean basin	2018		2019	
Atlantic (ICCAT)	**854,669**		**801,415**	
BILLFISH	32,682	4%	34,041	4%
OTHERS	21,694	3%	20,620	3%
RAYS	42	0%	29	0%
SEERFISH	31,894	4%	31,147	4%
SHARKS	75,985	9%	73,439	9%
TUNAS	692,372	81%	642,138	80%
Indian (IOTC)	**2,146,443**		**2,076,944**	
BILLFISH	95,015	4%	92,834	4%
OTHERS	168,823	8%	136,806	7%
RAYS	2,091	0%	1,997	0%
SEERFISH	199,089	9%	210,420	10%
SHARKS	62,228	3%	82,907	4%
TUNAS	1,619,197	75%	1,551,980	75%
Pacific (IATTC&WCPFC)	**3,716,727**		**3,966,555**	
BILLFISH	74,329	2%	73,448	2%
OTHERS	24,110	1%	19,177	0%
RAYS	132	0%	17	0%
SHARKS	106,014	3%	102,217	3%
TUNAS	3,512,142	94%	3,771,696	95%
Grand Total	**6,717,838**		**6,844,914**	

[45] In these examples, and for the reporting year 2019, Argentina reports 4,800 t all-shark catches to FAO, and none to ICCAT (and of which zero blue shark), Myanmar reports no sharks to neither FAO nor IOTC, and the Congo reports 534 t to FAO and none to ICCAT (and of which zero blue shark). In combination with the analysis in the following sections, this shows that t-RFMO non-membership does occult important volumes of harvested shark resources, and has the potential to occult substantial blue shark harvests also – depending on the country.

Table C.5 regroups key figures for the years 2018 and 2019 regarding distribution of monitored and reported catch of several marine fish groups across four t-RFMOs. The relative contribution of a species group within an ocean basin is indicated in the column following the nominal total catch figures.

The data allow us to compare the reported overall catches by ocean basin for species falling under the direct or indirect[46] competence of t-RFMOs with the figures of catch data reported to FAO – for the same ocean basins. To do this, IATTC and WCPFC data were pooled to report data for the Pacific Ocean. In these data, it also appears that the Pacific Ocean provides the major fraction of global catches covered by these RFMOs, with the following distribution (based on the 2018/2019 average): Pacific Ocean (57%), Indian Ocean (31%) and Atlantic Ocean (12%). This differs somewhat from the global marine catch reported to FAO (Table C.1 – this Appendix), where the Atlantic Ocean yields more catch overall than the Indian ocean, but with the Pacific Ocean also the dominant one by far.

With regards to all-shark catch, the situation also differs substantially from the FAO dataset results (Table C.2), with the Pacific yielding the highest all-shark catch by ocean basin (±104,000 t), and the Atlantic and Indian oceans yielding a comparable lower volume (±73,000 t) – based on 2018/2019 averages.

However, **the relative volume of all-shark catch in the Atlantic (9.0%) is more than twice the contribution of that in the Indian ocean (3.4%) and more than three times the contribution of that in the Pacific Ocean (2.7%), singling out the Atlantic Ocean basin as the one where sharks play the most important role as target and bycatch species in relative terms**.

Table C.6 shows the nominal and relative (to all-shark) contribution of blue shark catch at the level of the four tuna RFMOs.

Table C.6 Distribution of total reported shark and blue shark catch (tonnes) by tuna RFMOs 2018-2019 (source: t-RFMOs)

t-RFMO / SHARKS / BSH / BSH gear	2018		2019	
IATTC				
SHARKS	**37,920.3**		**22,426.6**	
BSH	12,478.7	33%	14,452.2	64%
ICCAT				
SHARKS	**75,985.2**		**73,439.3**	
BSH	68,331.4	90%	62,004.7	84%
IOTC				
SHARKS	**62,228.0**		**82,906.8**	
BSH	22,623.5	36%	25,001.2	30%
WCPFC				
SHARKS	**68,093.2**		**79,790.0**	
BSH	60,610.0	89%	71,290.2	89%
Grand Total (all-sharks)	**244,226.73**		**258,562.67**	
Grand Total (BSH)	**164,043.56**		**172,748.30**	

46 "Indirect" refers to catches of bycatch species, such as blue shark, which have to be reported to all four t-RFMO under binding CMMs covering shark target and/or bycatch reporting rules.

The first element of note is that the total annual blue shark catch reported to the four t-RFMOs (2018/2019 average: 168,396 t) is 57.4% higher than blue shark catch reported to FAO for the same years (2018/2019 average: 107,002 t). This points to several substantial challenges afflicting the FAO dataset, including – potentially: the non-reporting of blue shark data, the under-reporting of blue shark data and/or blue shark harvest data aggregation into higher generic taxonomic groups when reporting to FAO.

Table C.7 Top 20 all shark and blue shark catching nations in 2019, tonnes (source: t-RFMOs)

		All-sharks - 2019				Blue shark - 2019		
	Flag State	Volume	Cum. %	Cum. Vol.	Flag State	Volume	Cum. %	Cum. Vol.
1	Taiwan	52,209.6	20%	52,210	Taiwan	47,685.3	28%	47,685
2	EU Spain	43,725.5	37%	95,935	EU Spain	40,697.2	51%	88,382
3	Japan	31,131.6	49%	127,067	Japan	27,834.3	67%	116,217
4	Indonesia	20,992.5	57%	148,059	Indonesia	14,920.1	76%	131,137
5	India	15,248.0	63%	163,307	EU Portugal	12,017.8	83%	143,155
6	EU Portugal	12,665.4	68%	175,973	Ecuador	6,685.0	87%	149,840
7	Ecuador	8,232.1	71%	184,205	Brazil	3,784.3	89%	153,624
8	Yemen	6,647.0	74%	190,852	Peru	3,362.0	91%	156,986
9	Tanzania	6,459.9	76%	197,312	China	2,510.8	92%	159,497
10	Madagascar	5,640.1	78%	202,952	Vanuatu	2,134.3	94%	161,631
11	Namibia	5,456.6	81%	208,408	Morocco	1,524.3	94%	163,155
12	Peru	5,318.7	83%	213,727	Côte d'Ivoire	1,202.4	95%	164,358
13	Brazil	4,524.5	84%	218,251	Panama	936.4	96%	165,294
14	Mozambique	3,755.8	86%	222,007	Seychelles	768.7	96%	166,063
15	Iran Islamic Rep.	3,525.4	87%	225,533	Sri Lanka	711.8	97%	166,775
16	Costa Rica	3,041.0	88%	228,574	Other	629.3	97%	167,404
17	China	2,941.4	90%	231,515	Australia	536.0	97%	167,940
18	Oman	2,627.9	91%	234,143	Belize	533.6	98%	168,474
19	Vanuatu	2,346.0	91%	236,489	Ghana	414.1	98%	168,888
20	Morocco	2,065.4	92%	238,554	FSM	400.8	98%	169,288
	-69 more States-	20,001.2	100%	**258,555**	*-38 more States-*	3,459.9	100%	**172,748**

The second point of note is the fraction of blue shark reported from these various RFMOs. We did not amalgamate into oceanic basins here, as the differences between west and east Pacific are of importance. It arises that in the AOCs of ICCAT (Atlantic) and the WCPFC (Western central Pacific), the fraction of reported blue shark is close to 9 in 10 sharks (by volume) – 87% and 89%, respectively. Given the blue sharks' more modest body mass in comparison to other regularly harvested sharks,[47] it may be safely asserted that more than 9 in 10 sharks caught in these two ocean areas are blue sharks indeed. In the Indian Ocean, on the other hand, blue shark only makes up one third of the all-shark catch,[48] and in IATTC, the

[47] The global average harvested blue shark weight is 27kg (equating to a fork length of 160cm), with a range of 10-56kg, using the Coelho et al. (2017) data, providing the longest timeseries of blue shark data studied to date (1966-2014).

[48] A 2017 blue shark catch reconstruction exercise has been undertaken by the IOTC Secretariat and the Working Party on Ecosystems and Bycatch on 2015 data, resulting in the near doubling of blue shark catch estimated to be harvested and landed (Martin *et al*. 2017). However, these results have not been adopted and posted as further adjusted nominal blue shark catch. Had they been adopted and maintained in the following years, blue shark would

relative number has fluctuated widely between 2018 and 2019, indicating potential data collection and quality challenges both at IOTC and IATTC.

Table C.7 provides the combined top 20 list of both all-shark catching nations, and of blue shark catching nations by volume for 2019. It also provides the cumulative portion and the cumulative volume of the annual catch.

Table C.7 shows that the top four flag States harvest just over three quarters of the world's blue shark resources, these being Taiwan, Spain, Japan and Indonesia (in descending order). The same four countries, in the same order, harvested more than half (57%) of the global all-shark catch in 2019. The top 20 blue shark catching nations[49] harvest 98% of the global harvest.

11 out of 20 (or 55%) of the top 20 blue shark fishing nations are also in the group of the top 20 all-shark fishing nations. However, reflecting trends in the FAO dataset, some of the top 20 all-shark catching nations do not report any (or hardly any) blue shark catches at all. This is the case, *inter alia*, for India[50], Yemen, Tanzania and Mozambique. This is an indication of the fact that **there are fundamentally different shark fisheries in the world; in some fisheries, blue shark provides the major portion of the catch, and in others, blue shark is entirely sub-dominant or absent.**

C.3 Reconciling RFMO and FAO catch data for blue shark

Comparing FAO FishstatJ and RFMO datasets on all-shark and blue shark harvests reveals very significant differences between datasets. Not only are the nominal values of individual countries often orders of magnitude off the mark between datasets, but sometimes there may be zero catch reported to one institution, while thousands of tonnes are reported to the other. Also, the "behaviour" of given datasets tends to be more consistent on one side, and a lot more inconsistent/incoherent on the other – leading to the conjecture that reporting of blue shark catches to one of the institutions (i.e. to FAO) is overall weak and unsuitable as a single basis to work from.

C.3.1 Key sources and types of discrepancies between FAO and RFMO datasets

Nominal catch - global

Table C.8 lists the global nominal catch (in tonnes) for all-shark and blue shark catch for both years 2018 and 2019 from both (the combined) t-RFMO and the FAO sources. The data reveal that overall shark reporting to FAO (all-sharks) is almost twice the volume reported to t-RFMOs, while blue shark reporting results in the opposite dynamic, where blue shark reported to t-RFMOs is more than 50% higher than to FAO. The likely reason behind the first element is that many shark fisheries worldwide do not fall under the remit of mandatory reporting to RFMOs, while blue shark – as a ubiquitous bycatch species in tuna fisheries – does.

make up a more important portion of the overall shark catch in the IO (some 75-80%) – aligning it more with other ocean basins – and it is likely that the total reconciled and reconstructed annual blue shark catch estimated in this study would have surpassed 200,000 t.

[49] The top 20 list also includes one entry for all reported harvests not attributed to a flag State, grouped under "Other"

[50] Papers reporting on the diversity of the shark catch in India fail to mention BSH at all.

Table C.8 Comparison of total reported all shark and blue shark catch (source: FAO and t-RFMOs)

	2018	2019
FAO		
All-shark	431,995	431,908
Blue shark	104,694	109,309
t-RFMOs		
All-shark	244,227	258,563
Blue shark	164,044	172,748

Of the 59 countries reporting blue shark in 2019 to either FAO and/or t-RFMOs, only 6 countries (10%) report the exact same figure to both destinations. This implies that inconsistent blue shark catch reporting to FAO on one hand, and t-RFMOs on the other is the rule, rather than the exception, underlining the difficulties in working with the existing official datasets, and the need for an approach that pays attention to detail.

Nominal catch – individual country discrepancies between datasets

Table C.9 presents the same nominal blue shark catch data for 2019 side-by-side from both FAO and RFMO sources for all reporting States (reporting to either or both institutions), indicating the discrepancy when subtracting the (combined) t-RFMO-reported value from the FAO value. The subtraction is done from FAO data, as the FAO dataset is supposed to contain all of a State's marine catches, while the RFMO data are only based on reporting that is mandatory for cooperating and/or member parties (CPCs) of the four t-RFMOs – and would naturally be expected to yield smaller volumes. Overall, this shows a discrepancy of 63,440 t, consisting of 80,478 t missing in reporting to FAO while reported to t-RFMOs, versus 17,035 t reported to FAO and missing in reporting to t-RFMOs.

While some of the most important blue shark fishing nations (Taiwan, Japan and Ecuador – in the top 6 based on RFMO data ranking) report zero - or but a fraction - of their blue shark catches to FAO, they report substantial fractions of the total global catch to t-RFMOs. At the opposite end of the spectrum, similarly important blue shark fishing nations (Spain, Mexico and Fiji – in the top 11 based on FAO data ranking) report zero, an infinitesimal, or a large fraction of their blue shark catch to t-RFMOs – but invariably more to FAO.

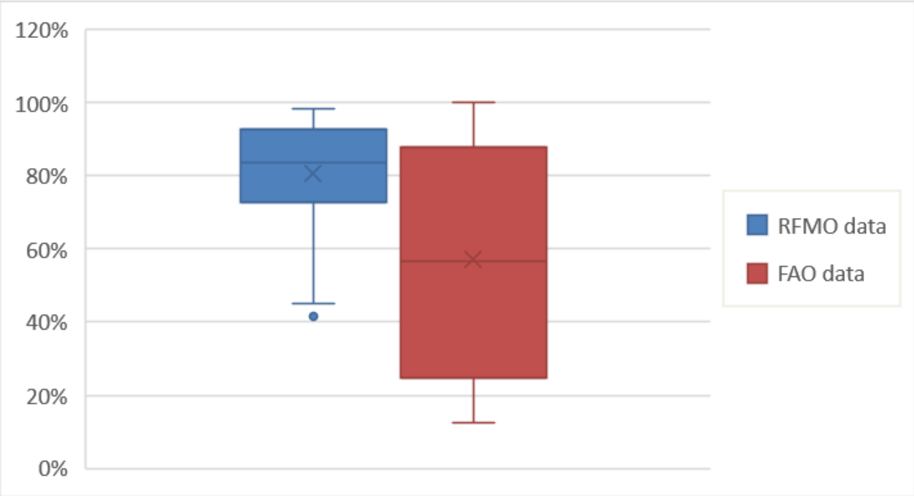
The first question is whether blue shark catches, duly reported under t-RFMO frameworks, may have been reported to FAO in aggregated form within generic taxonomic groups. An analysis of the top three under-reporters to FAO (Taiwan, Japan and Ecuador) reveals that in all three cases, the total volume of national blue shark catches reported to t-RFMOs is larger than the total volume of all-shark catches reported to FAO (128%, 130% and 119% respectively). Hence, blue shark catches reported to t-RFMOs are simply not reported to FAO by these countries – beyond the fractions that may have been declared.

This leads to the conclusion that the reporting mechanism for blue shark, displayed by a country, must inform and guide the selection of the data to be used to reconstruct the global catch, on the basis of opting to use the higher of either supplied figures.

Blue shark as a portion of all-shark catch

To gain a better understanding of the quality, consistency and behaviour of the data reported to t-RFMOs on one hand, and the FAO on the other, it is useful to compare the portion of blue shark catch in the all-shark harvest of the top 20 blue shark catch fishing nations in both datasets. Figure C.1 provides the results of that analysis.

Figure C.1 Blue shark as a proportion of all shark catch in top 20 fishing nations (source: FAO and t-RFMOs)



Legend: x: mean; Horizontal line: median; Box: upper and lower quartiles; Whiskers: variability outside upper and lower quartiles; Horizontal whisker line: upper/lower data value; Point: outlier (Ghana; 42%)

It can be seen in Figure C.1 above that the portion of blue shark in the top 20 blue shark fishing nations by t-RFMO ranking is very high, with a mean of 80.7%, and that the data are clustered into the >73% range. On the basis of the FAO top 20 ranking, the spread in data ranges from just over 10% to 100%, giving a mean of 57.2% - significantly less than that reported to RFMOs. The spread and variability in this dataset conveys the idea that the data are not the object of consistent, complete and faithful reporting, suggesting that the t-RFMO dataset on blue shark is the one of overall higher quality, consistency and reliability.

Table C.9 Total reported blue shark catch by countries in combined datasets, 2019 (source: FAO and t-RFMOs)

		Blue shark catch - 2019			
	Row Labels	FAO 2019	RFMO 2019	diff. (nominal)	diff. (relative)
1	Taiwan	4,910.0	47,685.3	- 42,775.3	-871%
2	Japan	-	27,834.3	- 27,834.3	
3	Ecuador	2,581.9	6,685.0	- 4,103.1	-159%
4	Morocco		1,524.3	- 1,524.3	
5	Panama	242.0	936.4	- 694.4	-287%
6	Other	-	629.3	- 629.3	
7	France OT	-	618.6	- 618.6	
8	Australia	-	536.0	- 536.0	
9	Federated States Of Micronesia	3.0	400.8	- 397.8	-13259%
10	Peru	3,025.6	3,362.0	- 336.5	-11%
11	Marshall Islands	-	189.3	- 189.3	
12	Solomon Islands	-	129.3	- 129.3	
13	Costa Rica	-	107.0	- 107.0	
14	New Zealand	103.0	206.0	- 103.0	-100%
15	South Africa	266.9	368.6	- 101.7	-38%
16	Kenya	-	88.0	- 88.0	
17	Venezuela	0	55.127922	- 55.1	
18	EU Portugal	11,974.0	12,017.8	- 43.8	0%
19	Western Samoa	40.0	82.91	- 42.9	-107%
20	Papua New Guinea		37.3	- 37.3	
21	USA	10.0	46.9	- 36.9	-369%
22	Chile	38.0	72.0	- 34.0	-89%
23	Comoros	-	23.4	- 23.4	
24	Korea Rep	313.2	323.2	- 10.0	-3%
25	Tuvalu	-	5.3	- 5.3	
26	Tonga	-	4.8	- 4.8	
27	Kiribati	-	3.9	- 3.9	
28	Algeria	-	3.5	- 3.5	
29	Barbados	-	2.2	- 2.2	
30	Mauritius	-	1.3	- 1.3	
31	EU France	81.0	82.3	- 1.3	-2%
32	Russian Federation		0.4	- 0.4	
33	Brazil	3,784.0	3,784.3	- 0.3	0%
34	Indonesia	14,920.0	14,920.1	- 0.1	0%
35	Equitorial Guinea		0.1	- 0.1	
36	EU UK	375.0	375.1	- 0.1	0%
37	Madagascar	25.0	25.1	- 0.1	0%
38	Ghana	414.0	414.1	- 0.1	0%
39	Senegal	39.5	39.5	- 0.0	0%
40	Trinidad and Tobago	0.3	0.3	- 0.0	0%
41	Libya	6.0	6.0	-	0%
42	Sri Lanka	711.8	711.8	0.0	0%
43	EU Italy	33.0	33.0	0.0	0%
44	EU Malta	1.6	1.6	0.0	3%
45	Canada	4.0	3.9	0.1	2%
46	Belize	534.0	533.6	0.4	0%
47	Liberia	13.0	9.6	3.4	27%
48	Colombia	9.0		9.0	100%
49	Tanzania, United Rep. of	10.0		10.0	100%
50	Cook Islands	231.0	108.0	123.0	53%
51	Palau	401.7	228.7	173.0	43%
52	Côte d'Ivoire	1,449.0	1,202.4	246.6	17%
53	Seychelles	1,115.0	768.7	346.3	31%
54	Suriname	383.0		383.0	100%
55	China	3,399.0	2,510.8	888.2	26%
56	Vanuatu	3,894.0	2,134.3	1,759.7	45%
57	Fiji	2,137.0	177.9	1,959.1	92%
58	Mexico	4,774.0	-	4,774.0	100%
59	EU Spain	47,056.0	40,697.2	6,358.8	14%
	TOTALS	**109,308.5**	**172,748.3**	**- 63,439.8**	

Appendix D: Analysis of the global blue shark trade using graph theory

Graph theory (Harary, 1969) applied to the study of connections (edges) between elements (nodes) in the global blue shark trade network was used to identify hidden properties in the relationships of nodes (trading countries) and edges (traded value in USD) by using the ARTIS database and the exports FAO database. Emerging properties in the global blue shark trade were revealed by using Degree, Betweenness and PageRank as network centrality dimensions.

Centrality dimensions and the global blue shark trade network

Degree of a node (countries) is the number of relations (edges) that arrive or leave that node. In weighted networks, node Degree, also known as **Strength**, is the sum of weights of links connected to the node. It indicates if a trading country is involved in important trades with other countries. Traders with high Strength can be acting as keystones since they are connected by imports and exports to many neighbouring traders. In Figure D.1, we show that although Spain, followed by Portugal in Europe were relevant in terms of the overall importance of the global blue shark commercial flow, China was by far the most important trading country. Thailand, Taiwan, and Vietnam were also other key countries in Asia, while Morocco, the USA and New Zealand, were key in Africa, America and Oceania, respectively (Fig. D.1).

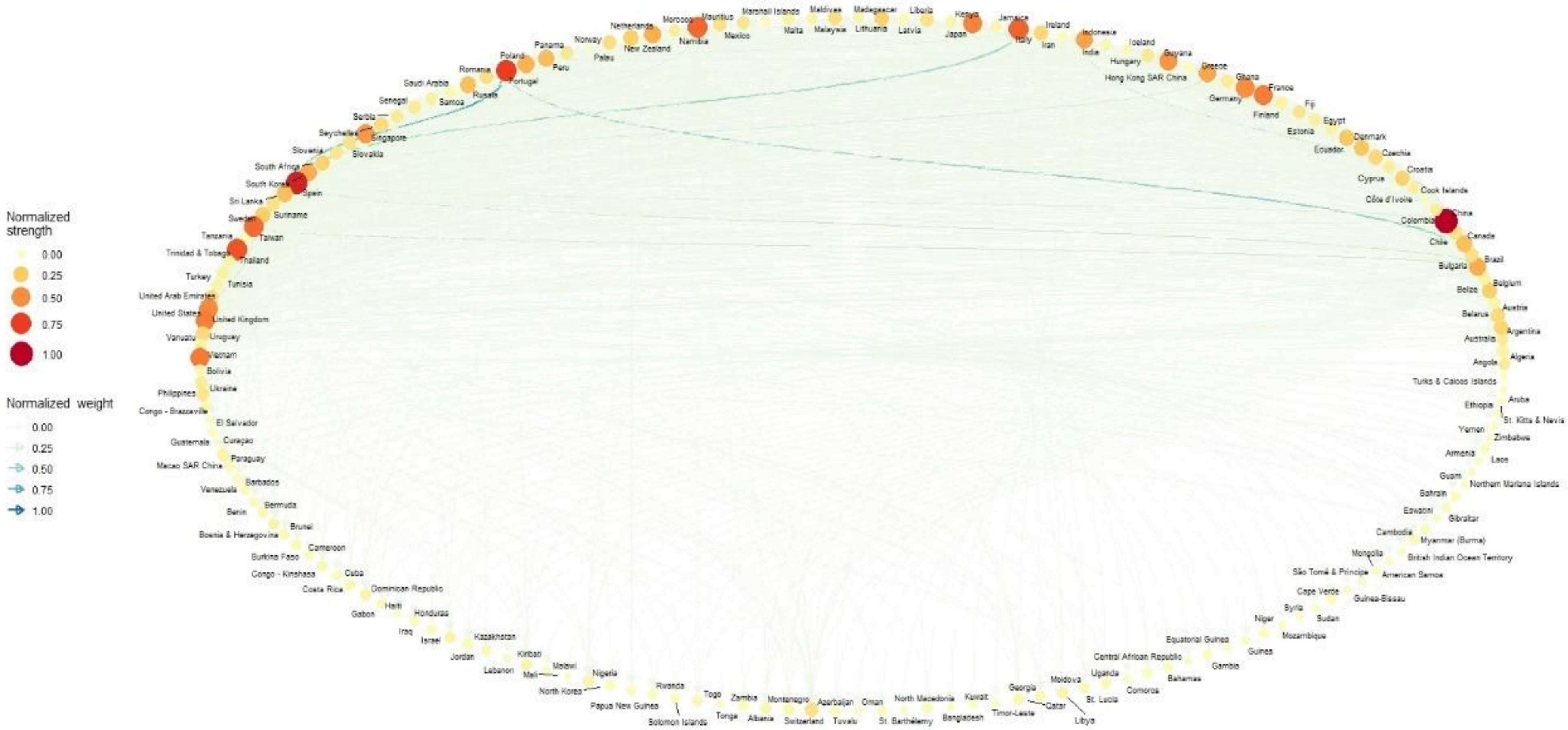


Figure D.1. Graph of world blue shark trade in weight (t) based on the ARTIS database. Normalized edge weight and node Strength were used as network centrality measures.

According to the FAO database, Spain, and Portugal to a lesser extent, were key countries in terms of the overall importance of the value of the global blue shark trade (Fig D.2).

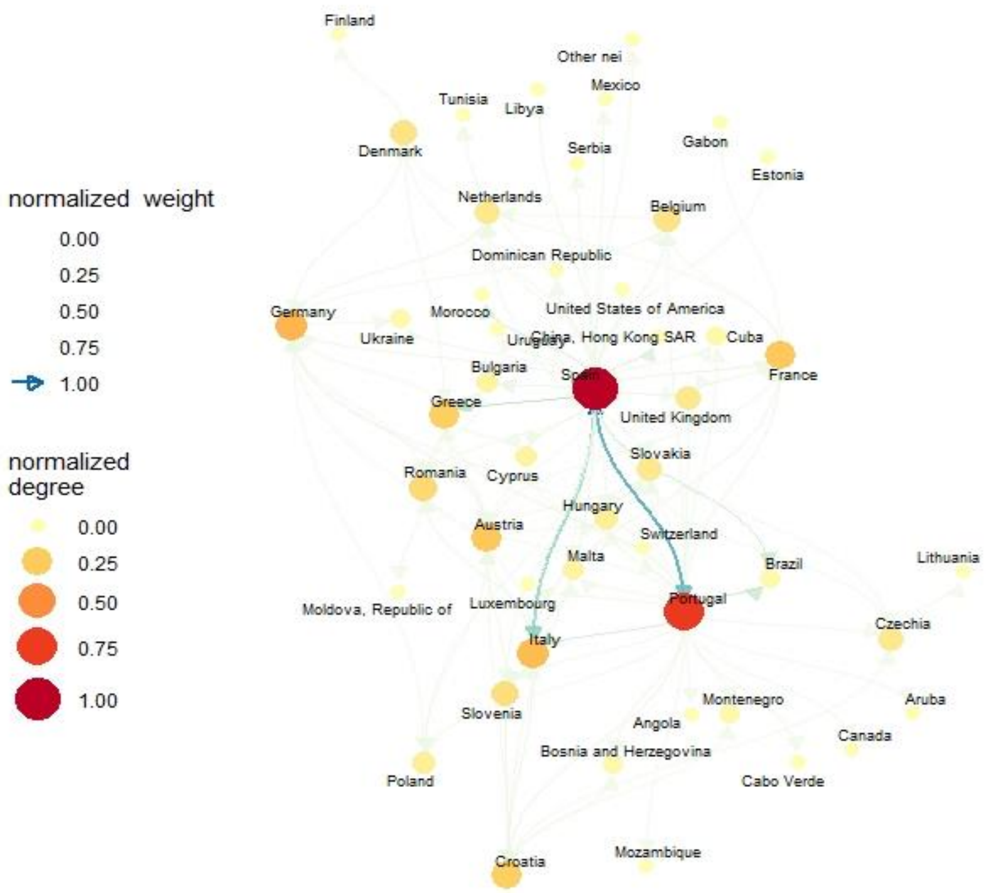


Figure D.2. Graph of world blue shark trade in value (USD) based on the FAO exports database. Edge Strength and normalized node Degree were used as network centrality measures**.**

Betweenness centrality is a measure of the influence of a node over the flow between every pair of nodes of the whole network under the assumption that flow always uses the shortest paths first. Traders with high Betweenness centralities, like China, could be seen as "bottlenecks" or "bridges" that prevent network fragmentation (Fig. 8). Other Asian traders acting as bridges between different groups of countries were Taiwan and Hong Kong, while Morocco, the USA, Spain, and Fiji were key in Africa, America, Europe and Oceania, respectively (Fig. D.3). In a similar way, edge Betweenness centrality identifies the edges of the network that are crucial for trade flows. Edges with high edge Betweenness centrality scores, like the flow from Italy to China, from Austria to Italy, or from Tunisia to Malta, represented a bridge-like connector between countries of the global market, and whose removal may affect the flow of goods between many pairs of partners through the shortest paths between them (Fig. D.3).

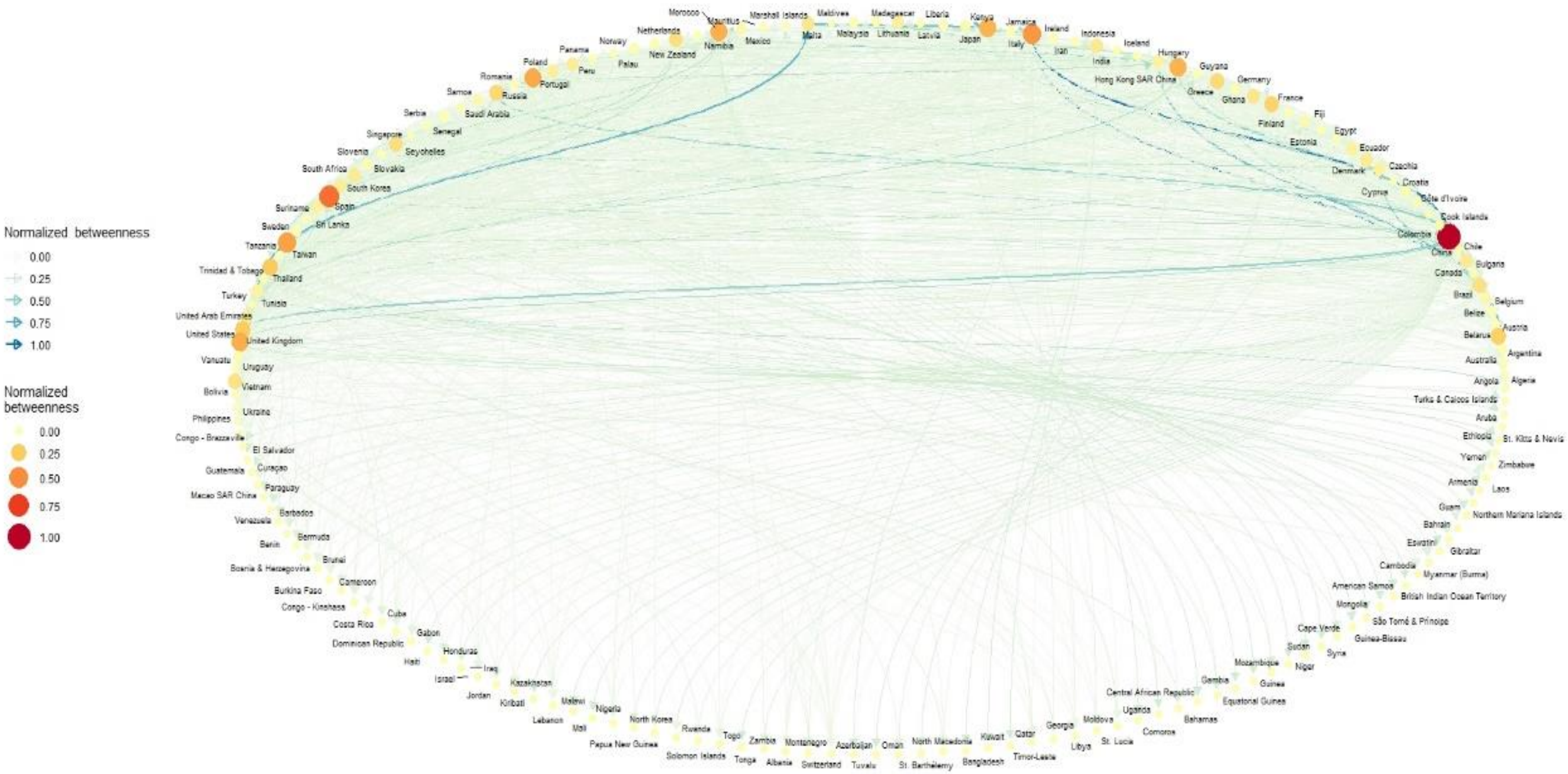


Figure D.3. Graph of world blue shark trade in weight (tonnes) based on the ARTIS database. Normalized edge and node Betweenness were used as network centrality measures.

In terms of value, and according to the FAO database, Spain was the key country preventing network fragmentation (Fig. D.4). Other relevant countries, all located in Europe, were France and Italy, followed by Germany and Portugal. Trade flow from France to Italy was the most important connection preventing network fragmentation (Fig. D.4).

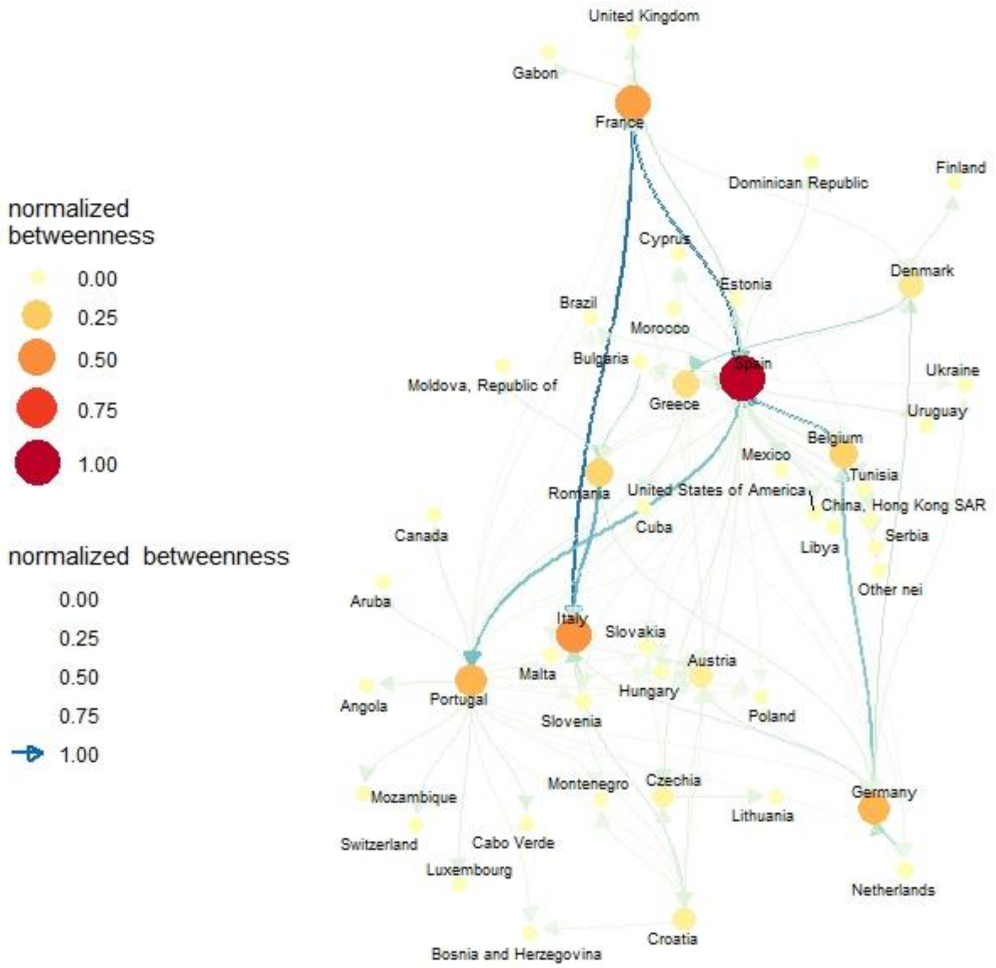


Figure D.4. Graph of world blue shark trade in value (USD) based on the FAO exports database. Normalized edge and node Betweenness were used as network centrality measures.

Finally, **PageRank** identifies key importers which are likely to introduce blue shark meat from a range of different traders in the network. In this way, European countries like Hungary, followed by Austria, Romania, Czechia, Italy and Germany showed key roles in the global blue shark meat trade because of the number and relevance of the trade flows pointing to them (Fig. D.5). Other countries outside Europe that demonstrated a high trading efficiency when importing blue shark meat goods from other countries to meet the internal demand were Tunisia, the USA, Hong Kong, and Australia, in Africa, America, Asia and Oceania, respectively (Fig. D.5).

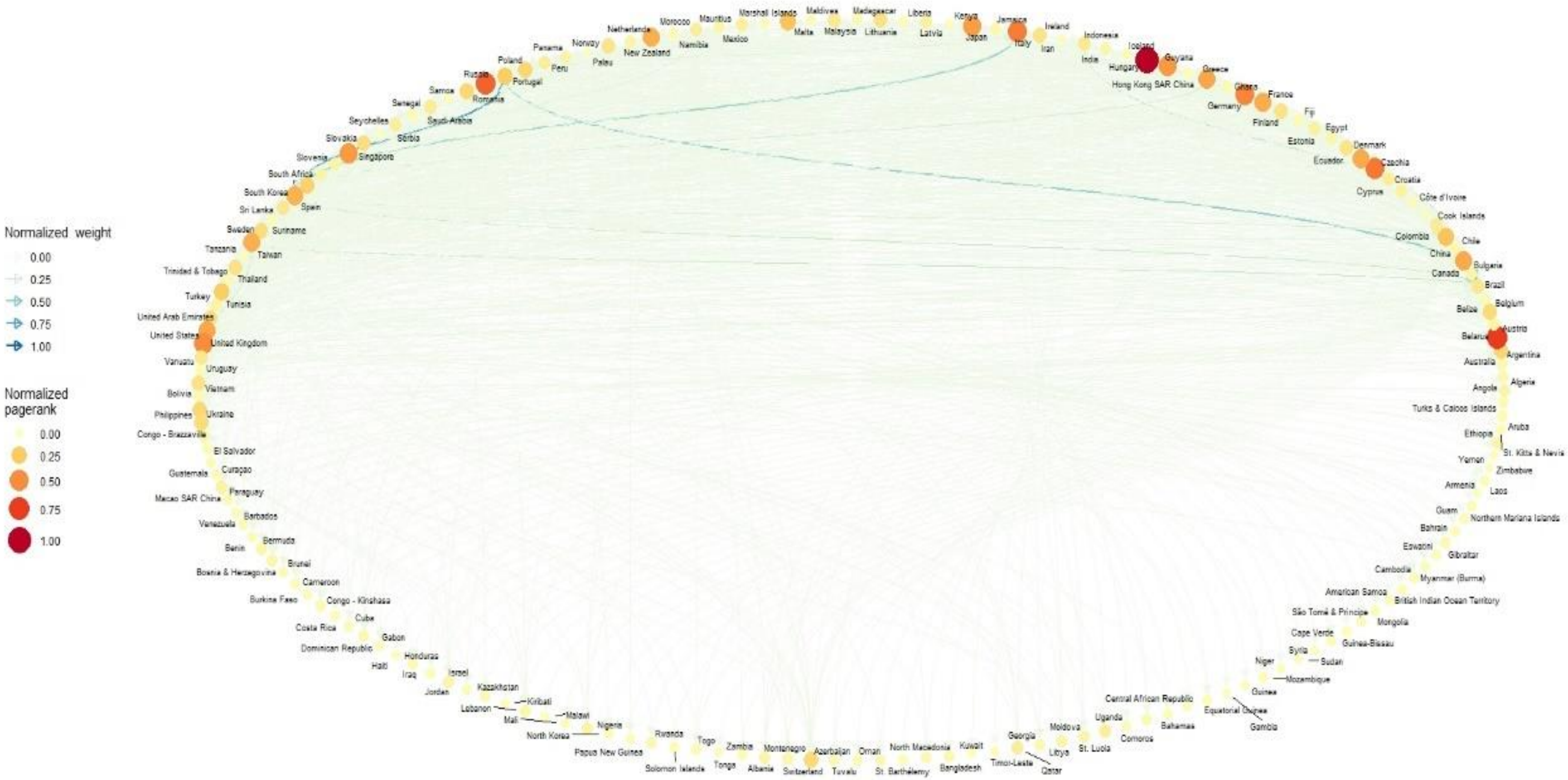


Figure D.5. Graph of world blue shark trade in weight (t) based on the ARTIS database. Normalized edge weight and node Pagerank were used as network centrality measures.

Germany, followed by other European countries like Hungary, Austria, Italy and Romania also demonstrated high efficiency in maintaining a long-term stable import network in terms of value, as shown in the FAO database (Fig. D.6).

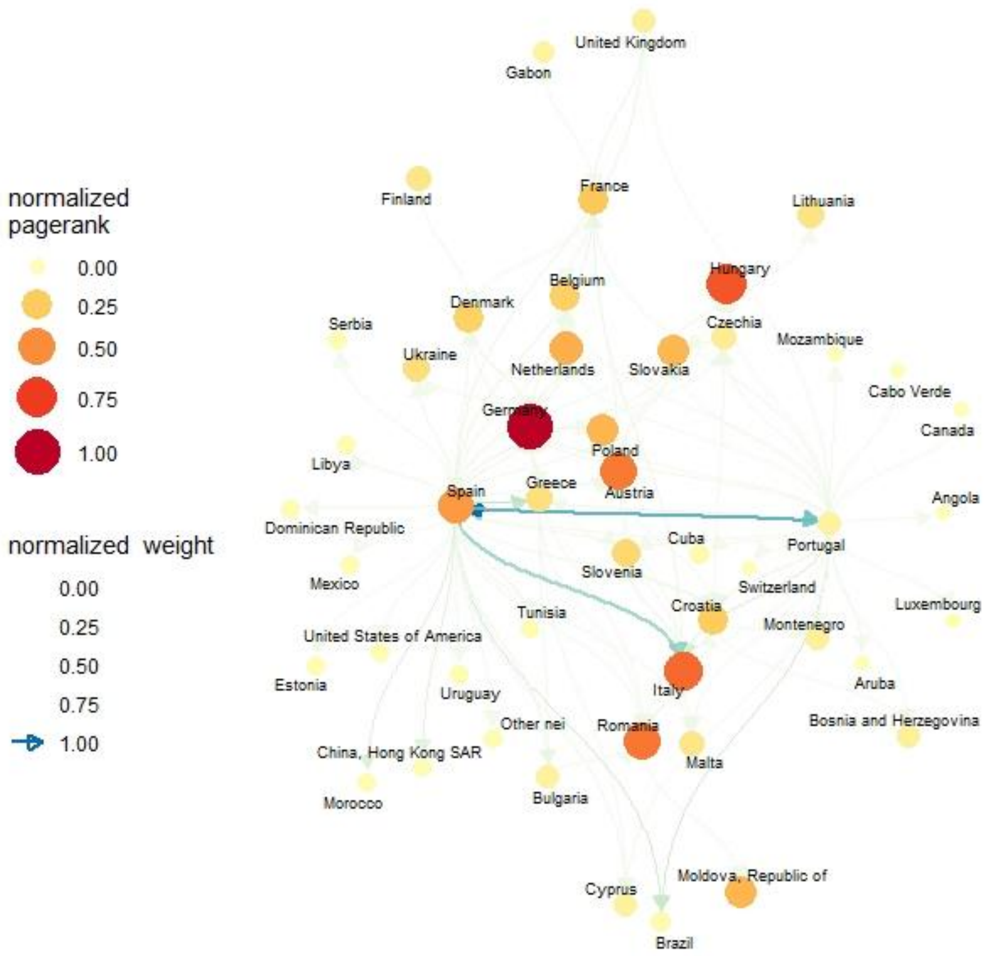


Figure D.6. Graph of world blue shark trade in value (USD) based on the FAO exports database. Edge Strength and normalized node Pagerank were used as network centrality measures.

Appendix E: Comparative value of blue shark fisheries

E.1 Valuation Methodology

The methodology used to value blue shark resources is an adaptation of that developed by Poseidon for the 'Netting Billions'[51], which produced the first global valuation of tuna fisheries in 2016 and was then updated in 2020. A global valuation of blue shark faces even more challenges than for tuna as a) Only some trade code systems have recently distinguished blue shark meat specifically and this does not cover all trade; b) shark fin trade codes differentiate by product form (fresh, dried, frozen) but not by species; and c) the price varies in relation to several product characteristics such as species, fin type, size and quality. These are in addition to more general challenges of valuing a globally traded commodity that is found to vary in price between markets.

A global valuation is estimated using the catch and trade figures calculated in the previous sections, with price data derived from various sources identified through online research, the targeted media analysis conducted and consultations with researchers and industry contacts. This financial valuation of blue shark estimates two values based on the global catch:

1. an ex-vessel price (paid to fishers) and
2. an end-use price (paid by consumers).

Both values require an understanding of the form of the shark at sale so that the product price can be amended to reflect price in relation to the live weight equivalent reported for catch.

The two values (ex-vessel and end-use) are the sum of shark meat and shark fin components as the two main components of the catch that are nearly always traded and used. The valuations are likely to be underestimates as the additional value of other shark fin products is not included. The inclusion of other shark fin products in this valuation has not been possible as there are no trade figures distinguishing shark products

Hindmarsh (2007) reviewed fin-to-body weight ratios and found it varies between studies depending on whether calculations are based on wet fin weight using the primary fin set — the first dorsal fin, both pectorals and the lower lobe of the caudal fin. Some studies, (e.g. Ariz et al. 2006), include all fins in calculating wet fin weight while in others it is not clear what fins are used (e.g. Mejuto and García Cortés 2004). Calculations that include entire fin sets will result in higher fin-carcass ratios.

There is no universally accepted conversion factors for shark species in general or blue shark specifically. This is a common issue across the seafood sector. Even for the EU, where Common Market Standards for seafood products are well established, out of the top 1600 landed species in the EU, only 629 have EU conversion factors.[52] da Silva et al (2021) note the variation in average size of blue shark between different sea basins. For the purposes of the valuation calculations, a blue shark fin to round weight ratio of 6% is applied, as this is an

[51] https://www.pewtrusts.org/en/research-and-analysis/reports/2020/10/netting-billions-2020-a-global-tuna-valuation

[52] As noted here: http://www.iuuwatch.eu/wp-content/uploads/2021/03/Conversion-factors_factsheet_FINAL.pdf

average that is reported across multiple studies[53]. Hareide et al (2007) report that the fresh weight to round weight ratio for blue shark is found to be between 6.0 and 6.66% in European fisheries, slightly more than the maximum allowed limit of 5% [specified in the EU's shark finning regulation]. The figures below illustrate the variety of primary processing (cutting) for blue shark meat and fins. There are also multiple secondary processing methods, particularly for fins.

The baseline year used for this report is 2019. Key informants in Spain and Portugal report that blue shark meat prices were on the increase in recent years. However, there was a reduction in prices in 2020 due to Covid market disruption, which saw a 23% price drop in blue shark in 2020 due to reduced demand from export markets and limited demand from Spanish hotels and restaurants[54].

As meat demand and prices have risen, prices for shark fin have reduced. A 2019 China-based survey showed that the sales volume and price of shark fin have drastically declined over time.[55] A 2022 Hong Kong-based survey indicated a reduction in the frequency of shark-fin soup consumption among the population over ten years.[56] As global demand for shark meat has risen, China participates in the processing of shark meat and other shark products that are destined for foreign markets. Nevertheless, there is still sufficient demand from Asian markets to drive the continuation of global trade, and Hong Kong remains the top trading hub for shark fins, with China and Singapore also very significant trading hubs.

For fin prices, Hong Kong market prices are used for end-user prices as HK markets are retail markets rather than many of the Chinese markets used in such surveys, which are wholesale (Shea pers. comm.). There is wider variation in shark fin end-user prices (see further detail in Appendix I) than meat prices as while fins are invariably sold in dried form, there are multiple other product characteristics (type of fin, species, size, quality). By contrast, shark meat is generally sold in frozen form (as mostly derived from DWF) and under general labels, sometimes not always identifying the product as shark meat.

According to the information provided by the experts, mean ex-vessel price of blue shark meat was around $1/kg, but this varied from a low of $0.60/kg in Spain to $1.78/kg in Ecuador (**E.2 Results**

Table E.1). These prices along with others derived from secondary sources identified have informed the ex-vessel valuation table presented overleaf.

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[53] This is consistent with WWF's recent methodological work on blue shark conversion factors: https://sharks.panda.org/images/PDF/Tools/WWF_Sharkulator_Methodology_2020.pdf

[54] La Voz de Galicia, Monday, January 4, 2021

55 李明哲, 周学红, 崔和, 王悦, 李的真, 张伟 [LI Mingzhe, ZHOU Xuehong, CUI He, WANG Yue, LI Dizhen, ZHANG Wei], 中国鱼翅消费与鲨鱼捕捞关系初步研究 [Consumption of Shark Fin in China and Global Shark Fishing], 野生动物学报 [Chinese Journal of Wildlife], 2019,40(2): 429-434.

56 https://www.greenqueen.com.hk/hong-kong-shark-fin-demand-study/

Figure E.1 Stages in the onshore processing of blue shark (source: Hareide et al, 2007)

Top left: whole; top right: gutted & headed fins on; bottom left: dressed carcass (fins, head and gut removed); bottom right: skinned carcasses.

Figure E.2 Stages in fin cutting of blue shark (source: Hareide et al, 2007)

Top left: Removal of lower caudal fin lobe only (Peru). Bottom left: Entire caudal fins removed (Spain). Right: Removal of excess flesh from crudely cut fins for export from Spain to East Asia.

E.2 Results

Table E.1 Ex-vessel price of blue shark meat and fins (source: industry interviews)

Country	Ex vessel price (USD·kg^{-1})		Trend	Source
	Meat	Fins		
Spain	0.60 – 0.89	3.97 – 6.95		Key informant
Portugal	0.78		Increase	Key informant
Ecuador	1.78	5.65		Key informant; Domínguez and Bobeña (2019)

Table E.2 Calculation of ex-vessel value for blue shark, 2019 (source: Poseidon)

	Blue shark - 2019					Ex-vessel price (per kg)						
	Row Labels	Volume	Source	Cum. (%)	Cum. (vol.)	meat	ratio to LWE	meat value	fins	ratio to LV	fin value	price source
1	Taiwan	47,685	RFMO	25.1%	47,685	$ 2.25	94%	$ 100,854,408	$ 5.00	6%	$ 14,305,590	China
2	EU Spain	47,056	FAO	49.9%	94,741	$ 1.00	94%	$ 44,232,659	$ 7.00	6%	$ 19,763,528	Pontevedra Voice, 2020; industry interviews
3	Japan	27,834	RFMO	64.6%	122,576	$ 2.25	94%	$ 58,869,475	$ 5.00	6%	$ 8,350,280	China
4	Indonesia	14,920	RFMO	72.4%	137,496	$ 2.25	94%	$ 31,556,080	$ 5.00	6%	$ 4,476,040	China
5	EU Portugal	12,018	RFMO	78.8%	149,514	$ 0.90	94%	$ 10,167,099	$ 7.00	6%	$ 5,047,496	Domínguez and Cobeña (2019),
6	Ecuador	6,685	RFMO	82.3%	156,199	$ 1.80	94%	$ 11,311,020	$ 5.70	6%	$ 2,286,270	Domínguez and Cobeña (2019)
7	Mexico	4,774	FAO	84.8%	160,973	$ 1.80	94%	$ 8,077,608	$ 12.00	6%	$ 3,437,280	Domínguez and Cobeña (2019)
8	Vanuatu	3,894	FAO	86.9%	164,867	$ 2.25	94%	$ 8,235,810	$ 7.00	6%	$ 1,635,480	China
9	Brazil	3,784	RFMO	88.9%	168,651	$ 1.80	94%	$ 6,402,985	$ 12.00	6%	$ 2,724,674	Domínguez and Cobeña (2019)
10	China	3,399	FAO	90.7%	172,050	$ 2.25	94%	$ 7,188,885	$ 5.00	6%	$ 1,019,700	COI report
11	Peru	3,362	RFMO	92.4%	175,412	$ 1.80	94%	$ 5,688,553	$ 5.70	6%	$ 1,149,814	Domínguez and Cobeña (2019)
12	Fiji	2,137	FAO	93.6%	177,549	$ 2.25	94%	$ 4,519,755	$ 5.00	6%	$ 641,100	China
13	Morocco	1,524	RFMO	94.4%	179,073	$ 1.00	94%	$ 1,432,842	$ 7.00	6%	$ 640,206	Spain
14	Côte d'Ivoire	1,449	FAO	95.1%	180,522	$ 20.00	94%	$ 27,241,200	$ 20.00	6%	$ 1,738,800	Agyeman et al, 2021
15	Seychelles	1,115	FAO	95.7%	181,637	$ 1.00	94%	$ 1,048,100	$ 7.00	6%	$ 468,300	Spain
16	Panama	936	RFMO	96.2%	182,574	$ 1.80	94%	$ 1,584,390	$ 5.70	6%	$ 320,249	Domínguez and Cobeña (2019)
17	Sri Lanka	712	FAO	96.6%	183,285	$ 1.00	94%	$ 669,092	$ 7.00	6%	$ 298,956	Spain
18	Other	629	RFMO	96.9%	183,915	$ 1.00	94%	$ 591,565	$ 7.00	6%	$ 264,316	Spain
19	France OT	619	RFMO	97.2%	184,533	$ 1.00	94%	$ 581,455	$ 7.00	6%	$ 259,799	Spain
20	Australia	536	RFMO	97.5%	185,069	$ 2.25	94%	$ 1,133,640	$ 5.00	6%	$ 160,800	China
	-39 more cour	4,714	mix	100.0%	**189,783**	$ 1.90	94%	$ 8,440,941	$ 6.21	6%	$ 1,757,251	weighted average
							Total meat	$ 339,827,562		Total fin	$ 70,745,929	
							Total ex-ves:	**$ 410,573,492**				

Table E.3 Calculation of end-user value for blue shark, 2019 (source: Poseidon)

	Blue shark - 2019					Main	Ex-vessel price (per kg)						price source	
	Row Labels	Volume	Source	Cum. (%)	Cum. (vol.)	market*	meat	ratio to LWE	meat value	fins	ratio to LWE	fin value	meat	fin
1	Taiwan	47,685	RFMO	25.1%	47,685	Brazil	$ 6.80	60%	$ 194,556,021	$ 124	0.6%	£ 35,477,863	carrefour.br	COI report
2	EU Spain	47,056	FAO	49.9%	94,741	Spain	$ 2.50	60%	$ 70,584,030	$ 124	0.6%	£ 35,009,679	industry interviews	COI report
3	Japan	27,834	RFMO	64.6%	122,576	Japan	$ 6.21	60%	$ 103,710,479	$ 124	0.6%	£ 20,708,695	https://matcha-jp.com	COI report
4	Indonesia	14,920	RFMO	72.4%	137,496	Brazil	$ 6.80	60%	$ 60,874,141	$ 124	0.6%	£ 11,100,579	carrefour.br	COI report
5	EU Portugal	12,018	RFMO	78.8%	149,514	Brazil	$ 6.80	60%	$ 49,032,820	$ 124	0.6%	£ 8,941,279	carrefour.br	COI report
6	Ecuador	6,685	RFMO	82.3%	156,199	Brazil	$ 6.80	60%	$ 27,274,800	$ 124	0.6%	£ 4,973,640	carrefour.br	COI report
7	Mexico	4,774	FAO	84.8%	160,973	Brazil	$ 6.80	60%	$ 19,477,920	$ 124	0.6%	£ 3,551,856	carrefour.br	COI report
8	Vanuatu	3,894	FAO	86.9%	164,867	Brazil	$ 6.80	60%	$ 15,887,520	$ 124	0.6%	£ 2,897,136	carrefour.br	COI report
9	Brazil	3,784	RFMO	88.9%	168,651	Brazil	$ 6.80	60%	$ 15,439,822	$ 124	0.6%	£ 2,815,497	carrefour.br	COI report
10	China	3,399	FAO	90.7%	172,050	Brazil	$ 6.80	60%	$ 13,867,920	$ 124	0.6%	£ 2,528,856	carrefour.br	COI report
11	Peru	3,362	RFMO	92.4%	175,412	Brazil	$ 6.80	60%	$ 13,717,078	$ 124	0.6%	£ 2,501,350	carrefour.br	COI report
12	Fiji	2,137	FAO	93.6%	177,549	Brazil	$ 6.80	60%	$ 8,718,960	$ 124	0.6%	£ 1,589,928	carrefour.br	COI report
13	Morocco	1,524	RFMO	94.4%	179,073	Spain	$ 2.50	60%	$ 2,286,450	$ 124	0.6%	£ 1,134,079	industry interviews	COI report
14	Côte d'Ivoire	1,449	FAO	95.1%	180,522	Ghana	$ 20.00	60%	$ 17,388,000	$ 124	0.6%	£ 1,078,056	Agyeman et al, 2021	COI report
15	Seychelles	1,115	FAO	95.7%	181,637	Spain	$ 2.50	60%	$ 1,672,500	$ 124	0.6%	£ 829,560	industry interviews	COI report
16	Panama	936	RFMO	96.2%	182,574	Brazil	$ 6.80	60%	$ 3,820,516	$ 124	0.6%	£ 696,682	carrefour.br	COI report
17	Sri Lanka	712	FAO	96.6%	183,285	Brazil	$ 6.80	60%	$ 2,904,144	$ 124	0.6%	£ 529,579	carrefour.br	COI report
18	Other	629	RFMO	96.9%	183,915	Brazil	$ 6.80	60%	$ 2,567,642	$ 124	0.6%	£ 468,217	carrefour.br	COI report
19	France OT	619	RFMO	97.2%	184,533	Brazil	$ 6.80	60%	$ 2,523,762	$ 124	0.6%	£ 460,215	carrefour.br	COI report
20	Australia	536	RFMO	97.5%	185,069	Brazil	$ 6.80	60%	$ 2,186,880	$ 124	0.6%	£ 398,784	carrefour.br	COI report
	-39 more cour	4,714	mix	100.0%	**189,783**	Brazil	$ 5.66	60%	$ 16,008,647	$ 124	0.6%	£ 3,507,216	carrefour.br	COI report
								Total meat	$ 644,500,051		Total fin	£ 141,198,745		
						*from ARTiS			190%			200%	increase from ex-vessel price	
								Total ex-vessel	**$ 785,698,796**					

E.3 Blue Shark Valuations per RFMO

The figures below present the value of blue shark per RFMO based on the proportion of global blue shark catch estimated for each RFMO area. The average global prices are used, which is appropriate given the dominance of DWF in catching blue shark (rather than coastal states) and the global nature of the blue shark trade. These regional values are compared to regional values for tuna species in Poseidon's Netting Billions report, as in the main report.

Figure E.3 Ex-vessel values of blue shark and tuna species per RFMO (source: Poseidon)

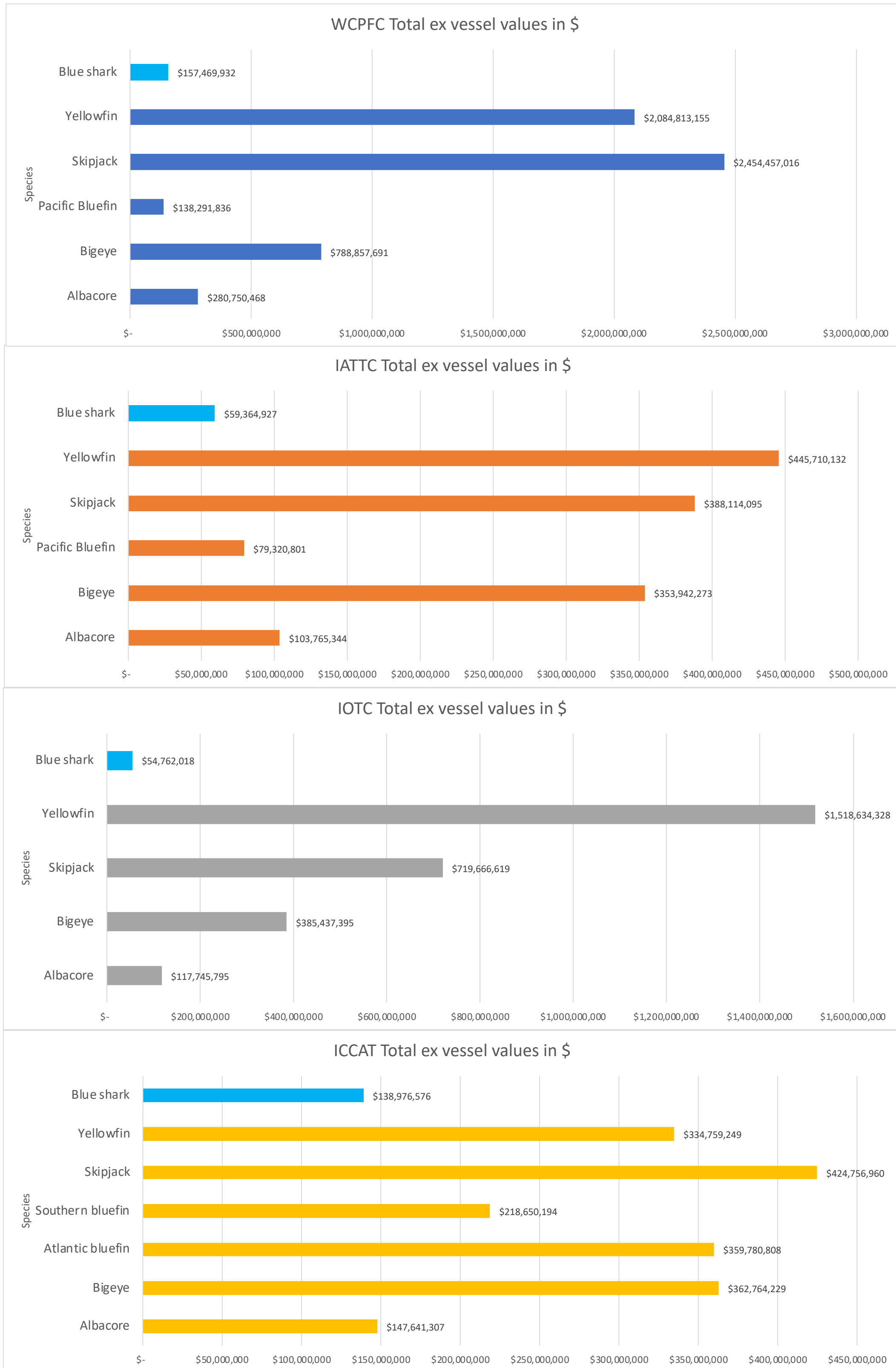
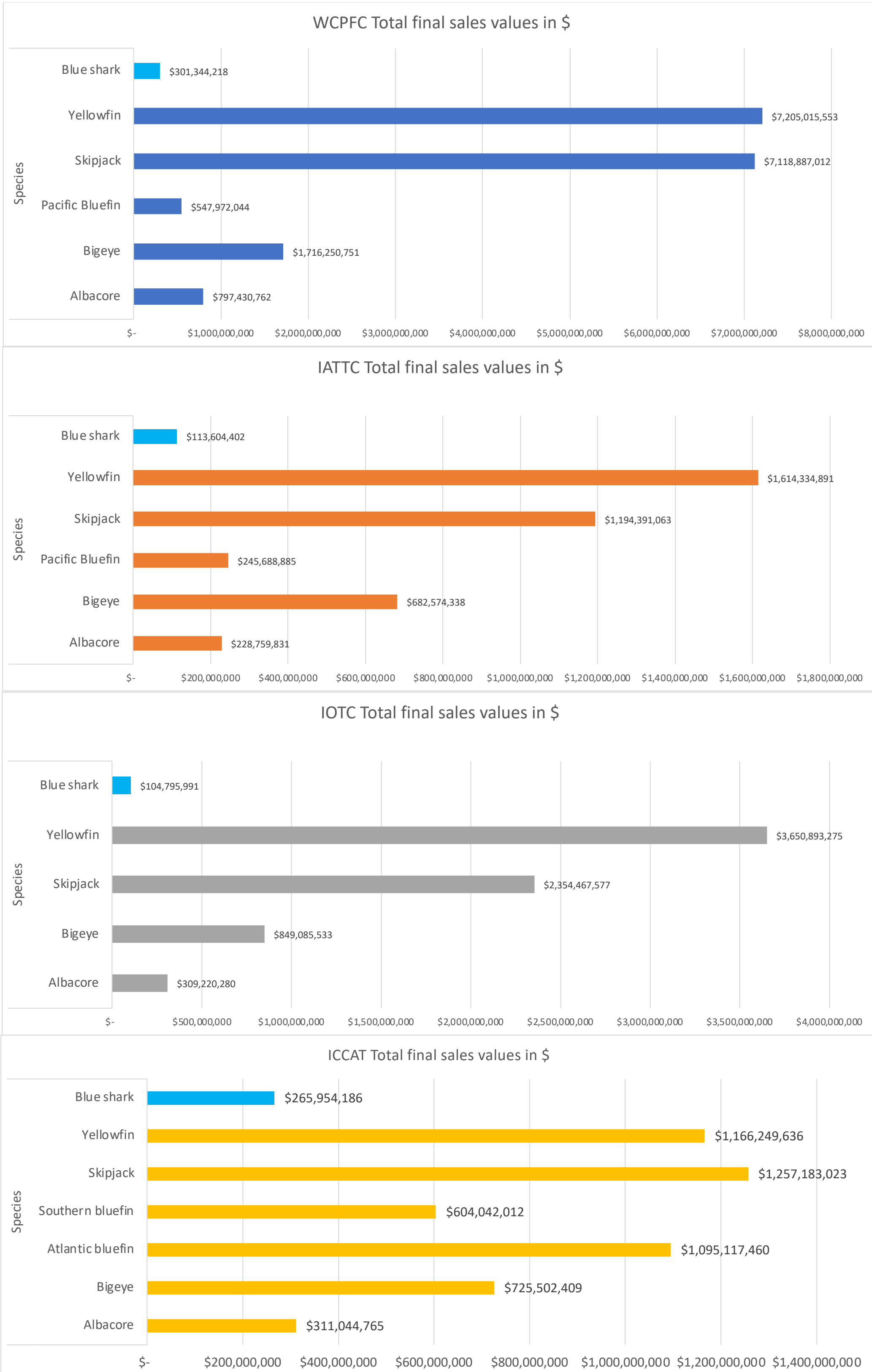


Figure E.4 End-user values of blue shark and tuna species per RFMO (source: Poseidon)



Appendix F: Blue Shark Stock Assessments

F.1 Atlantic Ocean Stocks

In 2015 the **North Atlantic stock assessment estimated that the stock was unlikely to be overfished and not subject to overfishing**, and although there was some uncertainty in the assessment, this was a similar outcome to the earlier 2008 stock assessment (ICCAT, 2015). The trend analysis of the North Atlantic spawning biomass for 1971–2013 (43 years) revealed annual rates of reduction of 2.3%, consistent with an estimated median reduction of 53.9% over three generation lengths (30 years), with the highest probability of 50–79% reduction over three generation lengths.

Although the scenarios and models explored suggested that the North Atlantic stock is unlikely to be overfished nor subject to overfishing, due to the level of uncertainty the ICCAT working group could not reach a consensus on a specific management recommendation. Some participants expressed the opinion that fishing mortality should not be increased, while others thought this was not necessary (ICCAT, 2015).

The **South Atlantic stock assessment also estimated that stock was unlikely to be overfished and not subject to overfishing**, however there was unsustainable harvest during 1991–2011, and any future increase in fishing mortality could cause the stock to be overfished and experience overfishing (Carvalho and Winker 2015, ICCAT 2015). The trend analysis of the South Atlantic exploitable biomass for 1971–2013 (43 years) revealed annual rates of reduction of 1.5%, consistent with an estimated median reduction of 38.2% over three generation lengths (30 years), with the highest probability of 30–49% reduction over three generation lengths.

Given the uncertainty in South Atlantic stock status results, the ICCAT working group could not discount that in recent years the stock may have been at a level near B_{MSY} and that fishing mortality has been approaching F_{MSY}. This implies that future increases in fishing mortality could push the stock to be overfished and experience overfishing. They therefore recommended that until this uncertainty was resolved that catch levels should not increase beyond those of recent years (ICCAT, 2015). In 2019 ICCAT decided that a total allowable catch (TAC) of 28,923 t for South Atlantic blue shark was established and updated annually (ICCAT, 2019).

Further to the above stock assessment trend analyses, steep declines have occurred in the **Mediterranean Sea.** Ferretti *et al*. (2008) compiled nine time-series of abundance indices from commercial and recreational fishery landings, scientific surveys, and sighting records, to reconstruct long-term population trends of large sharks in the north-western Mediterranean Sea. The blue shark showed an average instantaneous rate of decline in abundance of -0.06 (time range 56 years) and biomass of -0.13 (time range 49 years), which equates to an estimated decline of 96.5–99.8% in abundance and biomass since the early 19th century (Ferretti et al. 2008). In the previous ten years, a partial increase in artisanal catches has been observed in the north-western Mediterranean Sea.

F.2 Pacific Ocean stocks

The **North Pacific stock assessment indicated that the stock was not overfished and overfishing was not occurring** (ISC, 2017). The trend analysis of the North Pacific spawning biomass for 1971–2015 (45 years) revealed annual rates of change of -0.1% to +0.4% over one generation, consistent with an estimated median increase of 8.5% over three generation lengths (31.5 years), with the highest probability of an increase over three generation lengths.

Given that this stock is neither over-fished nor subject to overfishing, ISC did not recommend any specific management measures[57], but recommended improvements in the monitoring of blue shark catches and discards, through carefully designed observer programs and species-specific logbooks, as well as continued research into the fisheries, biology and ecology of blue shark in the North Pacific.

The **South Pacific stock assessment** was inconclusive and considered a work in progress (Takeuchi et al. 2017). The trend analysis of the Southwest Pacific spawning biomass for 1994–2014 (21 years) revealed annual rates of increase of 0.2%, consistent with an estimated median increase of 5.7% over three generation lengths (31.5 years), with the highest probability of an increase over three generation lengths. A more recent stock assessment in 2021 (Neubauer, Large & Brouwer, 2021) suggested that the three major CPUE time series (high-latitude fisheries around New Zealand and South-East Australia; mid-latitude EU-Spain fishery; and the high latitude and high seas Japan fishery) for blue shark in the Southwest Pacific from 1995 to 2020 indicated a consistent trend of increasing CPUE in the recent decade. This suggests the **South Pacific stock is neither overfished and overfishing is not occurring**. WCPFC's SC17 noted that blue sharks are relatively productive with fast growth and high fecundity compared to other sharks (WCPFC, 2022). In addition, the population is structured spatially with smaller fish in the higher latitudes.

Like with the North Pacific stock, WCPFC did not recommend any specific conservation management actions but recognized the inherent uncertainty in the catch and effort data. These included identifying dynamic/non-equilibrium reference points, such as $SB_{F=0}$ for shark stock status, as they may be more appropriate for fisheries with uncertain early exploitation history and strong environmental influences.

F.3 Indian Ocean stocks

The **Indian Ocean stock assessment** indicated that the stock **was not overfished but may be experiencing overfishing** (Rice 2017, IOTC 2017). The trend analysis of the Indian Ocean biomass for 1949–2016 (68 years) revealed annual rates of reduction of 0.2%, consistent with an estimated median reduction of 8.4% over three generation lengths (31.5 years), with the highest probability of a <20% reduction over three generation lengths. A new stock assessment in 2021

[57] These results should be considered with respect to the management objectives of the Western and Central Pacific Fisheries Commission (WCPFC) and the Inter-American Tropical Tuna Commission (IATTC), the organizations responsible for management of pelagic sharks caught in international fisheries for tuna and tuna-like species in the Pacific Ocean.

suggests that the **stock is currently not overfished nor subject to overfishing**, but with the trajectories showing consistent trends towards overfished (Rice, 2021). Blue sharks received a medium vulnerability ranking (No. 10) in the ecological risk assessment (ERA) rank for longline gear because it was estimated as the most productive shark species but was also characterized by the second highest susceptibility to longline gear. Blue shark was estimated as not being susceptible and thus not vulnerable to purse seine gear.

Target and limit reference points have not yet been specified for pelagic sharks in the Indian Ocean. Even though the 2021 assessment indicated that Indian Ocean blue shark are not overfished nor subject to overfishing, increasing current catches is likely to result in decreasing biomass and the stock becoming overfished and subject to overfishing in the near future. If the catches are increased by over 20%, IOTC consider that the probability of maintaining spawning biomass above MSY reference levels ($SB>SB_{MSY}$) over the next 10 years will be decreased. They recommend that the stock should be closely monitored, and whilst mechanisms exist for encouraging CPCs to comply with their recording and reporting requirements (Resolution 16/06), these need to be further implemented by the Commission, so as to better inform scientific advice in the future.

Appendix G: Hong Kong and China Catch and Trade of Blue Shark

The China Ocean Institute (COI) analysed Chinese sources on blue shark (大青鲨 or 水鲨)[58], including Chinese government laws, regulations, policies, and statements; official catch and trade data; academic literature; and information from media (including social media). This information is used to inform the relevant sections in the main report and is presented in its entirety below.

G.1 Overview of China's Role

Asian countries play a major role in the shark trade both as harvesters and as destination markets. Perched on the most fecund ocean basin, Taiwan, Japan and Indonesia are among the top five harvesters of blue shark due to their distant water fleets, including longline fleets.

Traditionally, the destination markets in Asia have been mainland China, Hong Kong, Taiwan and some Southeast Asian countries (particularly those that have overseas Chinese populations), with the shark trade being largely driven by demand for shark fin.[59] In China, shark meat and shark skins are generally not a popular food. A shark-market survey conducted from July to October 2017 in Beijing, Shanghai and Guangzhou, revealed that of 209 shark product vendors surveyed, 201 sold shark fin (with or without other shark products) and eight did not; meanwhile only 13 of the 209 vendors sold shark meat and 48 of them sold shark skin.[60] These dynamics are shifting because of policy changes on shark finning. A 2019 China-based survey showed that the sales volume and price of shark fin have drastically declined over time.[61] A 2022 Hong Kong-based survey indicated a reduction in the frequency of shark-fin soup consumption among the population over ten years.[62] However, as global demand for shark meat has risen, China participates in the processing of shark meat and other shark products that are destined for foreign markets.

Shark in China is sourced from domestic marine fisheries, DWF catch, and imports.[63] Landing of blue shark in China's domestic marine fisheries is negligible, and thus blue shark mainly comes from China's DWF industry and from imports. According to a 2019 source, China was not among

58 On Chinese names of blue shark, see https://www.21food.cn/offerdetail/5265203.html.

59 Mainland China, Hong Kong and Taiwan have different administrative systems (for both management/regulation and data collection. Because of these different systems, in this report, "China" refers to the People's Republic of China or mainland China, and does not include Hong Kong or Taiwan.

60 李明哲 [Li Mingzhe], 中国内地鱼翅贸易对鲨鱼保护的影响研究 [Study on the Impact of Shark Fin Trade in Mainland China on Shark Conservation], Master dissertation, 2019, Northeast Forestry University.

61 李明哲, 周学红, 崔和, 王悦, 李的真, 张伟 [LI Mingzhe, ZHOU Xuehong, CUI He, WANG Yue, LI Dizhen, ZHANG Wei], 中国鱼翅消费与鲨鱼捕捞关系初步研究 [Consumption of Shark Fin in China and Global Shark Fishing], 野生动物学报 [Chinese Journal of Wildlife], 2019,40(2): 429-434.

62 Joe Tanuvi, "The World's Biggest Shark Fin Importer, Hong Kong, Sees Demand Dip In Favor of Conservation," Green Queen, 21 June 2021, https://www.greenqueen.com.hk/hong-kong-shark-fin-demand-study/.

63 中国水产流通与加工协会 [China Aquatic Products Processing and Marketing Alliance/CAPPMA], *我国鲨鱼资源利用及监管机制现状* [*The current situation of shark resources utilization and regulatory mechanism in China*], 中国农业出版社 [China Agricultural Press], 2015.

the top 20 shark harvesters between 2007 and 2017, and ranked 10 in the reconciled/combined dataset (Table 11 of main report).[64] However, China ranked third as an importer of shark fin products over 2000–2016 among six regions (Hong Kong, Malaysia, China, Singapore, Taiwan and others), indicating both its importance as a destination market for shark fin and the importance of imports.[65] Over 2008–2017, China ranked fifth in the top 20 importers of shark meat and ninth in the top ten exporters of shark meat to the top 20 importers, which is likely due to the role China plays in the processing and re-export of shark meat.[66]

A 2013 Chinese news report identified smuggling of shark fin from Hong Kong as an important source of shark fin in mainland China. Smuggling may occur because the shark is a CITES species (for which trade is illegal), or in the case of blue shark (which is not a CITES species) because China has a high tariff rate on shark-fin imports while Hong Kong does not.[67]

G.2 China tuna fisheries and catch/landing of blue shark

Up to 90 percent of the marketed shark fin products in China come from sharks caught as bycatch in tuna fisheries.[68] Because China's tuna fisheries are predominantly DWF, most of China's shark catch comes from DWF. However, China does not report shark catch data in its fishery statistical yearbooks.

Blue shark is the dominant bycatch shark species in Chinese tuna longline fisheries. Silky shark is the dominant species in the shark bycatch of purse seine tuna fisheries, but blue shark bycatch in purse seine tuna fisheries is negligible.[69] In 2019, nearly 90 percent of the total retained shark bycatch (by weight) in Chinese longline tuna fisheries in the Western Central Pacific Ocean (WCPO) was blue shark.[70] The percentage of blue shark of the all shark bycatch in Chinese longline tuna fisheries in the WCPO increased over 2015–2018, rising to 46.12 percent in 2018 from 8.85 percent in 2015.[71] A 2006 study found that, of all shark bycatch in operations in the

[64] N. Okes and G. Sant, 2019. An overview of major shark traders, catchers and species. TRAFFIC, Cambridge, UK.
[65] *Ibid*.
[66] *Ibid*.
[67] 王晓易 [Wang Xiaoyi], 那些年,与鱼翅贸易有关的真相 [In those years, the truth about the shark fin trade], 法制网-法制日报 [Legal Network-Legal Daily], 12 January 2013, https://www.163.com/news/article/8L0ME8KG00014AED.html; personal communication from Stan Shea.
[68] 禁鱼翅能否保护鲨鱼争议升温 [Debate over Whether Forbidding Sharkfinning Will Protect Shark Heats Up], 东方早报 [Eastern Morning Post], 11 September 2012, https://www.shou.edu.cn/2012/0911/c147a23801/page.htm.
[69] Martin Hall and Marlon Roman, Bycatch and non-tuna catch in the tropical tuna purse seine fisheries of the world, FAO Fisheries and Aquaculture Technical Paper No. 568, 2013, Rome, FAO., Chapter 12: Sharks and Rays, https://www.fao.org/3/i2743e/i2743e05.pdf.
[70] China report to the WCPFC 2020 at https://www.spc.int/DigitalLibrary/Doc/FAME/Meetings/WCPFC/SC16/AR_CCM_03_China_Rev.01_0.pdf.
[71] 孙康, 戴小杰, 吴峰, 高春霞 [SUN Kang, DAI Xiaojie, WU Feng, GAO Chunxia], 中西太平洋延绳钓兼捕大青鲨渔获率、性比及叉长分析研究 [A study on catch rate, sex ratio and fork length of blue shark (Prionace glauca) in longline fishing in Western and Central Pacific Ocean], 南方水产科学 [South China Fisheries Science], 2021, 17(2):28-35.

eastern Pacific Ocean high seas, blue shark accounted for 76.5 percent by weight and 50.4 percent by number.[72]

Chinese longline tuna fisheries in the WCPO had a shark bycatch percentage (relative to total catch) of 4.55 percent in 2016, 7.55 percent in 2017 and 2.12 percent in 2018.[73] Thus, the average percentage is 4.74 percent, amounting to 4.74 t of shark bycatch per 95.26 t of tuna catch, or 4.98 t of shark bycatch per 100 t of tuna catch, which is consistent with a Chinese government media report that 3–5 t of sharks are caught per 100 t of tuna catch, and consistent with reports from other countries.[74] Assuming that 90 percent (by weight) of all shark bycatch in longline tuna fisheries is blue shark, 4.48 t (=4.98 * 0.90) of blue shark are caught as bycatch per 100 t of tuna catch for Chinese longline tuna fisheries.

Catch per unit effort (CPUE), defined as the number of sharks per 1000 hooks, for blue shark differs depending on ocean basin. For Chinese longline tuna fisheries in the WCPO in 2015–2018, the monthly average catch per unit effort (CPUE) of blue sharks was 0.28, 0.26, 0.36, 0.44, 0.31 and 0.34 for each month September–February, respectively.[75] CPUE did not vary significantly from month to month, averaging 0.33. For Chinese longline tuna fisheries in the tropical Atlantic Ocean between December 2007 and March 2008, blue shark had an average CPUE of 1.524 and accounted for 76.2 percent of total shark catch by weight.[76] This is consistent with a later statement in 2012 that approximately 80 percent of shark bycatch in tuna fisheries was blue shark.[77]

The total catch of blue shark was estimated using the tuna catch data for Chinese longline tuna fisheries, by multiplying the longline tuna catch data by the bycatch rate of 4.48 percent for blue shark. China reports the total tuna catch in its fishery statistical yearbooks, but not catch based on longline versus purse seine operations. However, a 2019 news article stated that China had 591 tuna fishing vessels, of which 35 were purse seiners, meaning that the number of longline vessels was the remaining 556.[78] In 2019, 364 Chinese longline vessels operated in the WCPFC

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72 戴小杰 许柳雄 宋利明 刘一淳 [DAI Xiaojie, Xu Liuxiong, SONG Liming, LIU Yichun], 东太平洋金枪鱼延绳钓兼捕鲨鱼种类及其渔获量分析 [Analysis on shark species and catch by tuna longline fishery in the Eastern Pacific Ocean], 上海水产大学学报 [Journal of Shanghai Fisheries University], 2006, 15(4): 509-512.

73 SUN et al., A study on catch rate, sex ratio and fork length of blue shark.

74 李燕 [Li Yan], 没有买卖就没有杀害？专家：“误捕”鲨鱼不吃也浪费 [Is Not Trading Not Killing? Expert: "Accidental Catching" Shark But Not Eating Is Also Waste], 东方网 [East Day], 11 September 2012, http://scitech.people.com.cn/n/2012/0911/c1007-18975060.html.

75 SUN et al., A study on catch rate, sex ratio and fork length of blue shark.

76 姜润林，戴小杰，许柳雄 [JIANG Run-lin, DAI Xiao-jie, XU Liu-xiong], 热带大西洋金枪鱼延绳钓兼捕鲨鱼种类组成和渔获率及其与表温的关系 [Species composition and catch rate of bycatch sharks captured by tuna longline fishery and their relationship with sea surface temperature in the tropical Atlantic Ocean], 海 洋 渔 业 [Marine Fisheries], Vol. 31, No. 4, Nov. 2009.

77 Li, Is Not Trading Not Killing?

78 水产前沿杂志 [Aquatic Products Frontier Magazine], 全球捕鱼活动恐已减少约6.5％！中国远洋捕捞渔业如何“破冰”? [Global fishing activity is likely to have decreased by about 6.5%! How can China's distant-water capture fisheries "break the ice"?], 新浪网 [Sina.com], 28 September 2020, http://k.sina.com.cn/article_1612816271_60219f8f02000rhft.html#/.

waters and caught 45,292 t of tuna and tuna-like species, meaning an average of 124.4 t of tuna and tuna-like species per vessel.[79] China thus caught an estimated 3,098 t of blue shark in 2019 (=556 x 124.4 x 4.48%). This number is closer to the 3,399 t reported to FAO than to the 2,511 t estimated using RFMO data (see main report).

G.3 China's shark market, processing and trade

China's supply of shark comes from its own fleet through DWF and from imports.

Main shark food products

The main shark food products on the Chinese domestic market are shark fins and shark skins (which are traditionally known as "shark lips" made from the skin of the upper lip or the skin of the nose, eyes and gills of sharks, though in some Chinese regions they are made from the tail skins of sharks).[80] Blue shark is the dominant species of shark lip products on mainland China's market, accounting for 65.5 percent of 252 shark lip samples investigated.[81] Shark meat products mainly target foreign markets, as indicated by the fact that there is little sales information about shark meat on Chinese language-based e-commerce websites targeting China's domestic buyers (e.g., https://item.jd.com/). In contrast, abundant sales information about shark meat on English language-based e-commerce websites targets foreign buyers (e.g., https://www.made-in-china.com).

When processing raw fins into consumable fin products, raw fins are generally first subjected to a drying step, which leads to an approximately 70 percent loss in total weight, and second subjected to skinning, cleaning, deboning, and drying steps, which further reduce weight by approximately 70 percent, reportedly leading to approximately 10 kilograms of secondary-processed fins per 100 kilograms of raw fins.[82] These secondary-processed fins are the dominant form of shark fin products on the Chinese market.[83]

The large attrition ratio leads to a high sale price for secondary-processed shark fin products, which was generally CNY 1,000 to 2,000 (USD 150–300, assuming 1CNY = 0.15 USD[84]) per

[79] China report to the WCPFC 2020 at https://www.spc.int/DigitalLibrary/Doc/FAME/Meetings/WCPFC/SC16/AR_CCM_03_China_Rev.01_0.pdf

[80] 魚唇並非是鯊魚的嘴唇，而是鯊魚尾部的皮 [Fish lips are not shark lips, but the skin of the shark's tail], 每日頭條 [KK News], 23 March 2017, https://kknews.cc/food/gvx9bpy.html.

[81] Zhang, X., Armani, A., Wen, J., Giusti, A., Zhao, J. and Li, X., 2021. DNA barcoding for the identification of shark lips (鱼唇): A nationwide survey for analyzing a never investigated product in the Chinese market. Food Control, 126, p.108075.

[82] 八项规定已冰封鱼翅内销，当地怎还能"年屠600条鲸鲨"？ [Eight regulations have frozen shark fin for domestic sales, how can the local people "slaughter 600 whale sharks a year"?], 新闻晨报 [Morning News], 25 February 2014, https://www.tech-food.com/news/detail/n1076139.htm.

[83] 杭州酒店暗访：做上百元鱼翅就像泡"方便面" [Hangzhou hotel secret visit: making hundreds of yuan from shark fin soup is like soaking "instant noodles"], 新浪网 [Sina.com], 14 May 2004, http://news.sina.com.cn/c/2004-05-14/14463230817.shtml.

[84] https://themoneyconverter.com/CNY/USD

kilogram in 2014, depending on the shark species.[85] The price decreased to CNY 600 to 1,000 (USD 90–150) per kilogram in 2019, with the price of high-quality shark fin products reaching CNY 2,000 per kilogram.[86]

For shark lips, the sale price was CNY 99.80 per 250 grams, or CNY 399.2 (USD 60) per kilogram.[87]

Secondary-processed blue shark fins on Chinese, Hong Kong, and Taiwanese markets are mainly sold under the vernacular name *ya jian fins* (牙揀翅). In 2016, ya jian fins fetched a retail price of USD 62–123 per kilogram in Shenzhen, Guangdong Province; USD 67 per kilogram in Beijing and Shanghai; USD 124 per kilogram in Hong Kong, and USD 382–668 per kilogram in Taipei and Kaohsiung of Taiwan.[88]

The retail price of ya jian fins also depends on fin size. For example, 250 grams and 500 grams of ya jian fins measuring 14–16 *cun* (寸, a traditional Chinese unit for length equal to 3.33 cm) are sold on a Chinese e-commerce website for a retail price of USD 117.67 and USD 217.26, respectively, while 250 grams and 500 grams of ya jian fins of the same size of 20–22 cun are sold for a retail price of USD 135.75 and USD 248.38, respectively.[89]

As far as wholesale price is concerned, a 2018 market survey showed that the average wholesale price of ya jian fins in Yide Lu seafood market (一德路海味批发市场) in Guangzhou, Guangdong Province—the largest dried-seafood wholesale market in China—was approximately USD 200 per kilogram.[90] The 2022 wholesale price of ya jian fins on this market is CNY 570 per 500 grams (USD 171/kg) for 20–22 cun, CNY 550 per 500 grams (USD 165/kg) for 18–20 cun and CNY 530 per 500 grams (USD 159/kg) for 16–18 cun.[91]

Ya jian fins are not exclusively associated with a specific fin position on the shark. Any blue shark fin—whether the pectoral fin, caudal fin, or dorsal fin—may be sold under the name ya jian fins

[85] 张英俊 [Zhang Yinghou], “中国最大鲨鱼加工基地”已没落 ["China's largest shark processing base" has declined], 中新网 [Xinwen], 25 February 2014, http://mobile.rmzxb.com.cn/tranm/index/url/www.rmzxb.com.cn/c/2014-02-25/297210.shtml.

[86] 鱼翅价格多少一斤？它的营养价值是什么？ [How much does shark fin cost a pound? What is its nutritional value?], 14 November 2019, https://k.sina.cn/article_7034662884_1a34c6fe400100nago.html.

[87] 鱼唇皮佛跳墙材料鲨鱼皮沙鱼皮干货海鲜海产品干货250克鱼唇干货, 京东 [JD.com], https://item.jd.com/69071487094.html?cu=true&utm_source=www.baidu.com&utm_medium=tuiguang&utm_campaign=t_1003608409_&utm_term=33213e330ce34bbb82a43e36149b0e13#product-detail.

[88] Wu, J. Y. (2016). Shark fin and mobulid ray gill plate trade in mainland China, Hong Kong and Taiwan, https://194.158.18.86/library/sites/library/files/documents/Traf-138.pdf.

[89] 酒店专用牙拣翅20到22寸95干超大翅针干货滋补煲汤鱼胶海参佛跳墙 14-16寸牙拣翅250克, 京东 [JD.com], https://item.jd.com/10055280256015.html#crumb-wrap.

[90] Hau, Cheuk Yu, Abercrombie, Debra L., Ho, Ka Yan Kathleen, Shea, Kwok Ho Stan, “King of Shark Fins” not quite sharks... so what is in my shark fin soup?: A rapid survey on the availability of Shark-like batoid fins in Hong Kong SAR and Guangzhou, China retail markets, Bloom and HK Shark Foundation, 2018, http://www.bloomassociation.org/en/wp-content/uploads/2018/12/King-of-shark-fins-not-quite-sharks.pdf.

[91] 一德路海味渠道, 每天公布货源 [Yi De Lu Seafood Channel, Daily Announced Sources], 牙拣鱼翅 [Ya jian fins], http://www.ydlhw.com/wap/show.asp?id=94942.

on the Hong Kong market.[92] Ya jian fins prepared from the caudal fin—or more precisely, the lower part of the caudal fin[93]—are believed to have higher price, as there is a consensus that fin products prepared from the lower part of the caudal fin are better quality than those from other fins, regardless of shark species.[94]

Blue shark fin is eventually consumed in the form of shark fin soup as the end-product (which is true for all shark fin products regardless of shark species). Each bowl of shark fin soup is prepared with 25 to 50 grams of secondary-processed shark fins with other ingredients, implying that every one ton of secondary-processed blue shark fins sold in the market would result in 26,667 bowls of shark fin soup, assuming a rate of 37.5 grams of second-processed shark fin per bowl.[95] Considering the sale price of shark fin soup at Chinese restaurants ranges generally from CNY 400 to 600 per bowl, we estimate that the above number of bowls would total CNY 13,333,500 (USD 2,000,025), including value added, assuming a mean price of CNY 500 per bowl.[96]

Processed blue shark meat products were sold for CNY 12,200 (USD 1,830) per ton as frozen fillets and CNY 20,000 (USD 3,000) per ton as dry meat in 2015.[97] These products are currently sold for USD 1,500–2,000 as various forms of frozen meat products (headed/gutted/tailed bodies, fillets, steaks, loins), as is the case with Fujian Haoyuan Food Co., Ltd. (see below).[98]

DWF-sourced blue shark raw materials

Blue shark captured by the Chinese fleet is transported back to China where the fins are processed and mostly consumed on the domestic market, though some volume is exported. The remaining blue shark bodies are largely exported as meat or skin.

Before export, the finless shark body is subjected to primary processing into a headed, gutted and tailed (HGT) form. The shark is either exported in frozen HGT form or in further processed

[92] Clarke, S.C., McAllister, M.K. and Michielsens, C.G., 2005. Estimates of shark species composition and numbers associated with the shark fin trade based on Hong Kong auction data. Journal of Northwest Atlantic Fishery Science, 35, pp.453-465.

[93] The upper part of the caudal fin is not used to produce fin products, see 官一教学：鱼翅小一百科 [Guan Yi Lesson: Shark Fin Encyclopedia], 官一食品有限公司 [Guan Yi Food Company, Ltd.], https://guanyifood.cn/h-nd-23.html#skeyword=%E7%BF%85&_np=0_35 and http://www.doc88.com/p-273181813288.html.

[94] 生活中你不知道的海味干货常识！[Common sense for daily life that you didn't know about dried seafood!], 知乎 [Zhihu.com], 3 November 2019, https://zhuanlan.zhihu.com/p/89892989.

[95] 北京鱼翅消费1天1个亿 一碗价格1800元 [Beijing Shark Fin Consumption is 100 Million a Day, Each Bowl is 1800 Yuan], 安徽网 [Anhui Net], 5 September 2012, http://www.ahwang.cn/p/1191673.html.

[96] 鱼翅汤多少钱一碗? [How Much Does a Bowl of Shark Fin Soup Cost?], 百度问一问 [Baidu Questions], 28 January 2022, https://wen.baidu.com/question/464570971437492965.html.

[97] CAPPMA, *The current situation of shark resources.*

[98] Fujian Haoyuan Food Co., Ltd. List of Products, https://fjhaoyuan.en.made-in-china.com/product-list-1.html.

form as frozen fillets, steaks or skins.[99] For blue shark, the frozen HGT form accounts for 55–60 percent of the total weight of the raw shark.[100] Here, we use the mean percentage of 57.5 percent.

If China's DWF catch of blue sharks in 2019 was 3,399 t according to FAO, and if blue shark fin and blue shark meat accounted for 5 percent and 55 percent of the total weight of blue shark, respectively, DWF-sourced blue shark raw materials were processed into an estimated 170 t (=3,399 x 5%) and 1,869 t (=3,399 x 55%) shark fin and meat products, respectively.[101]

Assuming all fresh blue shark fin is eventually processed into dry fin products at a dry-to-fresh weight ratio of 10 percent, the 170 t of blue shark raw materials were expected to lead to 17 t of blue shark fin on the market, which is negligible compared to imports.

For all shark species, the purchase prices of DWF-sourced shark raw materials range from CNY 13,000 to 15,000 (USD 1,950–2,250) per ton for a shark body without fins, and CNY 20,000 (USD 3,000) per ton for a shark body with fins attached.[102]

Given the fact that blue shark is not a CITES-listed species and is the dominant bycatch shark species in Chinese DWF, plus the fact that shark meat products (regardless of shark species) are not as popular as shark fin products on the Chinese market, it is reasonable to assume that when fins are removed, the remaining blue shark bodies may be purchased at relatively low prices compared to other shark species that are either endangered or less frequently captured (thus commanding higher prices). Therefore, the lower price of USD 1,950 per ton (from a price range of USD 1,950–2,250 per ton) was taken as the purchase price for blue shark bodies without fins.

The current purchase price for a blue shark body with fins attached is comparable to the 2015 price of CNY 20,000 (USD 3,000) per ton. In 2020, blue shark (in the round, as implied by the images of the report) had a wholesale price of CNY 10–20 per kilogram in a local seafood market in Mawei, Fujian Province.[103] Therefore, we take the mean price of CNY 15 per kilogram (USD 2,250 per ton) as the rough purchase price in 2022 for DWF-caught blue shark in the round.

The landing prices for fresh shark fin as raw material range from CNY 42,000 to CNY 96,000 (USD 6,300 to 14,400) per ton, depending on shark species and the weight of processed fins as a percentage of fresh fin weight.[104] Although the average landing price of DWF-sourced fresh blue shark fin is not available through an open-source search, it is likely in the range of USD 6,300–14,400 per ton, and likely to be in the middle between the two extremes—or USD 10,350 per

[99] See, for example, the e-commerce platform Made-in-China, https://www.made-in-china.com/products-search/hot-china-products/Frozen_Blue_Shark.html.

[100] 財政部南區國稅局 [Taiwan Ministry of Finance National Taxation Bureau of the Southern Area], 冷凍食品業之製造業原物料耗用通常水準調查報告 [Survey report on the usual level of raw material consumption in the frozen food manufacturing industry], 2017, https://www.ntbsa.gov.tw/download/1623c0a76ee000001caacd25246ffa5a.

[101] CAPPMA, *The current situation of shark resources.*

[102] *Ibid*. At 1CNY = 0.15 USD, https://themoneyconverter.com/CNY/USD.

[103] 福州人最爱的美味回来了！[Fuzhou Residents' Favorite Thing To Eat Is Back!], 福建广播FM [Fujian Radio FM], 26 August 2020, https://new.qq.com/omn/20200826/20200826A0OHOG00.html. "Round fish" or fish that is "in the round" refers to fish with head, viscera, tail and so on still intact, see J.J. McDonnell & Co., https://www.jjmcdonnell.com/product-forms.

[104] CAPPMA, *The current situation of shark resources.*

ton—given that blue shark is among the most common sources for shark fin products on the Chinese mainland market and mostly sold within a moderate price range (e.g., ya jian fins) compared to the most expensive shark fin products (e.g., jin shan fins).[105] This assumption is backed by a report that in Taiwan, the landing price of DWF-sourced fresh blue shark fin is Taiwanese Dollar (TWD) 330 per kilogram or USD 11,071 per ton[106]

Further analysis suggests that China-based blue shark meat processors are unlikely to purchase round blue sharks with fins attached as raw material. The purchase price for shark in this form is significantly higher than the sale prices for blue shark meat products—USD 1,500–2,000 per ton (for blue shark bodies, steaks, and loins) and USD 2,000–3,000 per ton (for blue shark fillets).[107] And there is no public evidence that China's major blue shark meat processors, as represented by two Fujian-based enterprises (see below), also sell blue shark fin products. Therefore, China's blue shark meat processors likely use DWF-caught blue shark raw material without fins for subsequent processing.

Imported blue shark raw materials

While China's General Administration on Customs provides some trade data on shark, the data are not provided at the species level. There is no rigorous reporting (if any reporting) on the amount of blue shark commodities traded. We also collected data on Hong Kong's shark trade for years 2017–2021, which are not provided at the species level either.[108]

However, evidence from the media indicates that China indeed imports blue shark for its domestic market. For example, Quanzhou city, Fujian Province, imports Taiwan-caught frozen blue shark into the Chinese mainland market.[109] Here we present a rough estimate of the imports of frozen blue shark to the Chinese mainland market in 2019.

A 2021 report that used DNA barcoding to investigate the shark species composition of shark lips on the Chinese market reveals that blue shark accounts for 65.5 percent of such products.[110] This percentage is dramatically lower than China's landing of blue shark as a percentage (i.e., 76.97 percent) of the all-shark species caught by China in 2019 according to FAO data (see Poseidon Shark Landings Database), where China is reported to have landed 4,416 t of all-shark species, including 3,399 t of blue shark. Given that shark lips are mainly produced using non-fin skins, it is

[105] Wu, J. Y. (2016). Shark fin and mobulid ray gill plate trade in mainland China, Hong Kong and Taiwan, https://194.158.18.86/library/sites/library/files/documents/Traf-138.pdf.
[106] 楊智強 [Yang Zhiqiang], 獨家授權：非法魚翅　漏網的罪惡美味 [Exclusive Licensing: Illegal Shark Fin Is an Evil Delicacy Slipping through the Net], 蘋果新聞網 [Apple Daily], 1 February 2021, https://www.appledaily.com.tw/life/20210201/3XYBFA4KJFEF3IJJHBFKSSKX2U. Exchange rate of 1 TWD= 0.03355 USD, https://themoneyconverter.com/TWD/USD
[107] Fujian Haoyuan Food Co., Ltd., https://www.made-in-china.com/multi-search/blue%2Bsharks/F1--CD_Agriculture-Food-Catalog/1.html.
[108] Hong Kong SAR, Census and Statistics Department, Trade and Cargo Statistics, https://www.censtatd.gov.hk/en/page_97.html.
[109] 泉州口岸 再添冰鲜水产新品种 [Quanzhou Port Adds New Types of Chilled Aquatic Products], 农业产业信息网 [Agriculture Production News], 18 March 2016, http://www.d1cy.com/news/201603/18/602309.html.
[110] Zhang et al., DNA barcoding for the identification of shark lips.

necessary to analyse China's imports of raw shark material (e.g., frozen and fresh/chilled shark bodies) aside from shark fin.

Analysis of Chinese 2019 import data (Table 7) reveals that China imported 5,344.9 t of frozen and fresh/chilled shark. Assuming that this amount contains x tonnes as blue shark, total China-caught raw blue shark and China-imported raw blue shark is (3,399 + x) tonnes, while total frozen and fresh/chilled raw shark entering the Chinese mainland market is 9,760.9 (i.e., 4,416 + 5,344.9) tonnes. Therefore, the following equation holds: (3,399 + x)/ 9,760.9=65.5%, where we assume that the weight proportion of shark lips with respect to the total body weight is the same across different shark species. The equation is solved for x, which is 2,994 t. Thus an estimated 56 percent (=2,994/5,344.9) of the imported frozen and fresh/chilled raw shark in 2019 was blue shark.

In addition to frozen and fresh/chilled raw blue shark, China also directly imports blue shark fin, as indicated on social media, but the proportions of different types of blue shark fin products (e.g., frozen raw fin versus processed fin) are unclear.[111]

In addition to shark fin, China also imports shark bodies and processed shark meat (e.g., fillets). Table G.1 lists China's imports of shark products in 2019, by product type, by exporter, and by trade mode. The data indicate that Singapore and Spain are the top shark fin exporters to China, while Indonesia and Taiwan are the top shark body exporters to China. Singapore does not have its own large industrial/DWF fleet, but imports fins largely from Spain, Namibia, Uruguay, Taiwan, and Indonesia.[112]

Table G.1 China's imports of shark products in 2019 (source: HK, China Customs)

Product	Exporter	Trade mode	Weight (kilo)	Value (USD)
frozen dogfish and other sharks	Indonesia	General Trade	3,499,714	4,674,193
frozen shark fins	Singapore	General Trade	1,586,747	9,238,176
frozen shark fins	Spain	General Trade	1,004,999	10,471,276
frozen dogfish and other sharks	Taiwan	General Trade	900,935	660,152
frozen dogfish and other sharks	Taiwan	Other	788,904	608,491
Shark fins dried, salted, in brine or smoked	Senegal	General Trade	349,028	3,793,784
frozen shark fins	Vietnam	General Trade	127,740	798,378
frozen shark fins	Portugal	General Trade	104,740	514,765
frozen dogfish and other sharks	Singapore	General Trade	95,521	161,746
frozen meat of dogfish and other sharks	Taiwan	General Trade	69,673	49,411
frozen shark fins	Indonesia	General Trade	64,997	440,304
frozen fillets of dogfish, other sharks, stingrays and rays	Pakistan	General Trade	46,320	67,366
fresh or chilled dogfish and other sharks	Taiwan	Other	29,700	35,743
Shark fins dried, salted, in brine or smoked	Spain	General Trade	24,550	442,164

111 揭开鱼翅的面纱|聊聊进口鱼翅那些事 [Unveiling Shark Fin | Discussing Aspects of Shark Fin Imports], 知乎 [Zhihu.com], 8 March 2021, https://zhuanlan.zhihu.com/p/355647098.
112 Okes and Sant, An overview of major shark traders.

frozen dogfish and other sharks	Malaysia	General Trade	18,830	28,330
Shark fins dried, salted, in brine or smoked	Japan	General Trade	16,318	454,389
frozen shark fins	Japan	General Trade	9,825	139,715
frozen dogfish and other sharks	New Zealand	General Trade	9,298	10,195
Shark fins dried, salted, in brine or smoked	Singapore	General Trade	4,984	55,984
frozen fillets of dogfish, other sharks, stingrays and rays	Russian	General Trade	4,340	11,753
Shark fins dried, salted, in brine or smoked	Hong Kong	Transit Goods for the Special Supervision Zone of the Customs	1,877	32,800
frozen fillets of dogfish, other sharks, stingrays and rays	France	General Trade	1,643	23,090
Shark fins dried, salted, in brine or smoked	Indonesia	General Trade	1,580	31,695
frozen dogfish and other sharks	New Zealand	Transit Goods for the Bonded Supervision Zone of the Customs	1,368	1,643
frozen fillets of dogfish, other sharks, stingrays and rays	Iceland	Transit Goods for the Bonded Supervision Zone of the Customs	1,170	1,053
fresh or chilled dogfish and other sharks	Taiwan	General Trade	630	958
frozen shark fins	Taiwan	Other	85	170
frozen fillets of dogfish, other sharks, stingrays and rays	Taiwan	Other	20	16

Table G.2 China's imports of shark products other than shark fins, 2019 (source: HK/China Customs)

Product	Exporter	Weight (in kilo)	Value (in USD)
frozen dogfish and other sharks	Indonesia	3,499,714	4,674,193
frozen dogfish and other sharks	Taiwan	1,689,839	1,268,643
frozen dogfish and other sharks	Singapore	95,521	161,746
frozen meat of dogfish and other sharks	Taiwan	69,673	49,411
frozen fillets of dogfish, other sharks, stingrays and rays	Pakistan	46,320	67,366
fresh or chilled dogfish and other sharks	Taiwan	30,330	36,701
frozen dogfish and other sharks	Malaysia	18,830	28,330
frozen dogfish and other sharks	New Zealand	10,666	11,838
frozen fillets of dogfish, other sharks, stingrays and rays	Russian	4,340	11,753
frozen fillets of dogfish, other sharks, stingrays and rays	France	1,643	23,090
frozen fillets of dogfish, other sharks, stingrays and rays	Iceland	1,170	1,053
frozen fillets of dogfish, other sharks, stingrays and rays	Taiwan	20	16

Imported shark (including blue shark) is processed into various forms of meat products, skin products, and fin products for the domestic market. For example, frozen blue shark imported into

Quanzhou city, Fujian Province, from Taiwan is processed into meat balls, which are a type of popular shark food in the locality.[113]

Meanwhile, some imported raw materials may be processed and re-exported, but the imports intended for subsequent re-export are low, as exemplified by the year 2019 (table G.1). In 2019, China imported a total of 8,765,536 kilograms of shark products globally, including 4,415 kilograms as transit goods from Hong Kong, New Zealand, and Iceland. The trade mode was dominated by "General Trade," which are imported goods destined for the domestic market and subject to import tariffs. None of the shark trade was categorized as "Contract Processing" (来料加工) or "Import Processing" (进料加工)—tariff-exempt classifications applied to imports intended for processing and re-export—meaning that the shark imports are mainly targeting the domestic market.[114]

G.4 Shark Fin

There is a high interconnectivity between the shark fin markets of Hong Kong and Guangzhou, Guangdong Province, with blue shark being the major species for shark fin trimmings in both markets—36.11 percent in Guangzhou and 39.01 percent in Hong Kong.[115] Shea report showed that blue sharks accounted for 49.0 percent on average of the fin trimmings in Hong Kong in 2014–2015.[116]

We combined China and HK as a single "market" to find out how much shark fin, especially frozen shark fin, is imported from the "external" world outside the market. There are several reasons for doing this—China and HK play a dominant role in the global shark fin trade; the weight of frozen shark fin can be used to estimate how much shark has been killed, based on the weight ratio of raw shark fin to the whole shark body, which is generally 0.05;[117] and we want to compare the estimated weight of shark killed to the global catch of shark.

In 2019, China imported 2,899,133 kilograms of frozen shark fin (table G.1) and HK imported 766,227 kilograms (table G.3) from all other countries/regions for a total of 3,665,360 kilograms, while mutual imports of frozen blue shark were 0 (table G.5). Imports of 3,665,360 kilograms of frozen shark fin would be from an estimated 73,307,200 kilograms of shark. In 2019, the global catch of all shark species amounted to 431,908 t. Using the reconciled estimate of 189,783 t of global blue shark catch and assuming that 40 percent of the imported frozen shark fins were blue

[113] Quanzhou Port Adds New Types of Chilled Aquatic Products.

[114] 进出口业务中来料加工与进料加工的区别 [The difference between incoming processing and incoming processing in import and export business], 正保会计网校 [Zheng Bao Accounting Web School], 1 November 2017, https://www.chinaacc.com/shuishou/nsfd/qi1711018832.shtml. Because data are included for Contract Processing" and Import Processing" for other fishery species, like squid, it is likely that data for shark imports under these categories are negligible.

[115] Cardeñosa, D., Fields, A.T., Babcock, E.A., Shea, S.K., Feldheim, K.A. and Chapman, D.D., 2020. Species composition of the largest shark fin retail-market in mainland China. Scientific reports, 10(1), pp.1-10.

[116] Fields, A.T., Fischer, G.A., Shea, S.K., Zhang, H., Abercrombie, D.L., Feldheim, K.A., Babcock, E.A. and Chapman, D.D., 2018. Species composition of the international shark fin trade assessed through a retail-market survey in Hong Kong. Conservation biology, 32(2), pp.376-389.

[117] 李明哲 [Li Mingzhe], 中国内地鱼翅贸易对鲨鱼保护的影响研究 [Study on the Impact of Shark Fin Trade in Mainland China on Shark Conservation], Master dissertation, 2019, Northeast Forestry University.

shark fins, the 73,307 t would account for 39 percent of global blue shark catch in 2019 and 17 percent of global all-shark trade.[118]

For 2018, the China-HK single market imported 3,836 t of frozen shark fins from the rest of the world, amounting to 76,721 t of sharks killed. If the global catch of all-shark species 2018 was 431,995, the 76,721 t of sharks accounted for 17 percent of global shark catch.

G.5 Main shark trading enterprises

In China, Fujian Province is the hub for the processing and distribution of DWF-caught shark, and the processed products are mainly shark meat for export. For example, in 2013 Fujian exported 2,680 t of DWF-sourced shark meat products, which included 2,000 t (74.6 percent) as frozen blue shark fillet.[119] Two Fujian-based enterprises are the main actors in this industry.

The first company is China Shark Products Cooperative (中国鲨鱼产品合作社), which is located inside the Mawei Free Trade Zone, Fujian Province, and claims to be China's largest provider of shark raw materials (including blue shark), collaborating with multiple Chinese DWF vessels and providing some processed shark products.[120] The blue shark products, as shown on its website, are shark bodies (in HGT form), fillets, steaks, and loins. Unfortunately, the prices of these products are not openly disclosed on its website or any other website, to the best of our knowledge as of 26 July 2022.

Members of the Cooperative may also have been involved in the notorious illegal shark-transporting case of the FU YUAN YU LENG 999—a reefer depicted in an image on the company's website—in the vicinity of the Galapagos Islands in 2017.[121] The shark species seized on this vessel include several species listed by CITES such as scalloped hammerheads, oceanic whitetip sharks and thresher sharks. Thresher sharks were still advertised for sale on the company website as of 26 July 2022.[122]

The second company is Fujian Haoyuan Food Co., Ltd. (福建豪源食品有限公司), which is also located in Mawei, and it sells blue shark products such as bodies, steaks, loins and fillets on e-commerce platforms.[123]

In addition to the two Fujian-based entities, Wenzhou Haideli Shark Products Co. Ltd. (温州海德力鲨鱼制品有限公司), a Zhejiang-based entity seems to be engaged in processing DWF-caught

118 Cardeñosa, D., Shea, S.K., Zhang, H., Fischer, G.A., Simpfendorfer, C.A. and Chapman, D.D., 2022. Two thirds of species in a global shark fin trade hub are threatened with extinction: Conservation potential of international trade regulations for coastal sharks. Conservation Letters, p.e12910. Report states that fin trimmings of blue shark account for approximately 40 percent of all-shark fin trimmings in the retailer market of Hong Kong.

119 CAPPMA, *The current situation of shark resources.*

120 中国鲨鱼产品合作社, http://www.china-shark.com/.

121 Chen Zhou, The Truth Behind The Intrusion Of A Chinese Vessel Carrying More Than 6000 Sharks Into The Galápagos Marine Reserve In 2017, 29 July 2020, https://tangchuanc.medium.com/the-truth-behind-the-intrusion-of-a-chinese-vessel-carrying-more-than-6000-sharks-into-the-2cae00bcb4d0.

122 中国鲨鱼产品合作社, http://www.china-shark.com/pr.jsp.

123 福建豪源食品有限公司, http://ruby2021.haichaninfo.com/; see 福建豪源食品有限公司 on Made-in-China, https://www.made-in-china.com/multi-search/blue%2Bsharks/F1--CD_Agriculture-Food-Catalog/1.html.

blue shark as well, although it does not mention blue shark on its website.[124] The company is located in Puqi Town under the administration of Leqing City, Zhejiang Province. This town is long known as the shark processing centre in China, processing 70~80 percent of shark catches from Chinese coastal waters.[125] Headquartered in this town, Haideli sources shark raw material from both China's domestic marine fisheries and DWF, as well as from other countries/regions, and provides processed shark fin as the main shark product, as indicated on its website.

G.6 Review of policy and associated catch and bycatch measures for blue shark

The Chinese government does not allow DWF that mainly target shark, and in accordance with RFMO requirements, imposes rigorous regulations on tuna fisheries for handling of shark bycatch at sea, mainly requiring that except for the head, skin and intestines, the caught sharks should be retained onboard with fins attached, tied, or correspondingly marked until landing in port; that the weight of retained shark fin should not exceed five percent of shark body weight; and encouraging full utilization of the shark bycatch of tuna fisheries (except for the shark species whose capture and utilization are prohibited by the RMFO).[126]

However, these regulations do not mention blue shark—Chinese government does not limit the landing or trade of blue shark because blue shark is not an endangered species.

This situation has changed recently. A 2022 policy issued by the Chinese government caps the total bycatch of blue shark by tuna fishing vessels operating in the Atlantic Ocean at 106.8 and 85.8 t in the North and South Atlantic, respectively.[127] The quota will be divided among tuna fishing enterprises and their vessels, but details remain unknown to the public.

124 中国鲨鱼产品合作社, http://www.chinashark.com/en/about/?2_1.html.

125 CAPPMA, *The current situation of shark resources.*

126 农业农村部办公厅 [Ministry of Agriculture and Rural Affairs General Office], 关于进一步严格遵守金枪鱼国际管理措施的通知 [Notice on Further Strict Compliance with International Management Measures for Tuna], 7 January 2019, http://www.moa.gov.cn/nybgb/2019/201902/201905/t20190518_6309471.htm.

127 农业农村部办公厅 [Ministry of Agriculture and Rural Affairs General Office], 关于做好金枪鱼渔业国际履约工作的通知 [Notice of Successful Compliance with the International Agreement on Tuna Fisheries], 农办渔 (2022) 1号 [MARA 2022 No. 1], 7 March 2022, http://www.moa.gov.cn/nybgb/2022/202204/202206/P020220608343607927153.pdf.

Table G.3 Chinas imports of shark fin 2017–2021

	2017		2018		2019		2020		2021	
	weight	value	weight	value	weight	value	weight	value	weight	value
Frozen	1,132,284	6,754,196	1,774,552	11,989,669	2,899,133	21,602,784	2,193,000	16,220,657	1,924,039	17,488,507
Dried, salted, in brine or smoked	46,170	723,097	650,382	7,187,496	398,337	4,810,816	298,202	3,241,289	287,432	4,002,480
Fresh or chilled	7,000	56,000	0	0	0	0	0	0	0	0
Total	1,185,454	7,533,293	2,424,934	19,177,165	3,297,470	26,413,600	2,491,202	19,461,946	2,211,471	21,490,987

Table G.4 China's exports of shark fin 2017–2021

	2017		2018		2019		2020		2021	
	weight	value	weight	value	weight	value	weight	value	weight	value
Frozen	1,132,284	6,754,196	1,774,552	11,989,669	2,899,133	21,602,784	2,193,000	16,220,657	1,924,039	17,488,507
Dried, salted, in brine or smoked	46,170	723,097	650,382	7,187,496	398,337	4,810,816	298,202	3,241,289	287,432	4,002,480
Fresh or chilled	7,000	56,000	0	0	0	0	0	0	0	0
Total	1,185,454	7,533,293	2,424,934	19,177,165	3,297,470	26,413,600	2,491,202	19,461,946	2,211,471	21,490,987

Table G.5 Hong Kong's imports of shark fin 2017–2021[128]

	2017		2018		2019		2020		2021	
	weight	value	weight	value	weight	value	weight	value	weight	value
Frozen	2,141,640	23,946,910	2,061,500	27,395,810	766,227	11,507,730	277,972	3,862,300	254,749	4,750,850
Dried, salted, in brine or smoked	2,834,806	99,405,410	2,544,320	106,054,260	2,012,178	97,456,840	1,384,510	69,479,930	1,689,284	92,926,860

[128] Note: the value in HK's original data is reported in HKD'000, and is converted to USD in this report using 1 HKD=0.13 USD (https://themoneyconverter.com/HKD/USD); some data are not available in the original database and here assumed to be zero.

Prepared or preserved	2,804	83,460	0	0	0	0	0	0	0	0
Total	4,979,250	123,435,780	4,605,820	133,450,070	2,778,405	108,964,570	1,662,482	73,342,230	1,944,033	97,677,710

Table G.6 Hong Kong's exports of shark fin 2017–2021[129]

	2017		2018		2019		2020		2021	
	weight	value	weight	value	weight	value	weight	value	weight	value
Frozen	356,143	4,591,990	541,606	9,691,760	253,141	6,582,810	18,448	965,770	12,488	884,260
Dried, salted, in brine or smoked	1,075,416	20,580,820	1,157,225	25,612,600	729,640	17,757,220	62,504	3,593,070	37,062	3,512,600
Prepared or preserved	575	62,660	0	0	0	0	0	0	0	0
Fresh or chilled	1,412	33,410	0	0	0	0	0	0	0	0
Total	1,433,546	25,268,880	1,698,831	35,304,360	982,781	24,340,030	80,952	4,558,840	49,550	4,396,860

Table G.7 Mutual imports of shark fin 2017–2021

China's imports from HK	2017	2018	2019	2020	2021
Frozen	0	0	0	0	0
Dried, salted, in brine or smoked	6,365	4,916	1,877	2,715	0
Prepared or preserved	0	0	0	0	0
Fresh or chilled	0	0	0	0	0
Total	6,365	4,916	1,877	2,715	0

[129] Note: the value in HK's original data is reported in HKD'000, and is converted to USD in this report using 1 HKD=0.13 USD (https://themoneyconverter.com/HKD/USD); some data are not available in the original database and here assumed to be zero.

HK's imports from China	2017	2018	2019	2020	2021
Frozen	0	0	0	0	2,835
Dried, salted, in brine or smoked	0	0	0	0	0
Prepared or preserved	95,624	72,648	80,480	91,647	29,144
Fresh or chilled	0	0	0	0	0
Total	95,624	72,648	80,480	91,647	31,979
Mutual imports combined	2017	2018	2019	2020	2021
Frozen	0	0	0	0	2,835
Dried, salted, in brine or smoked	6,365	4,916	1,877	2,715	0
Prepared or preserved	95,624	72,648	80,480	91,647	29,144
Fresh or chilled	0	0	0	0	0
Total	101,989	77,564	82,357	94,362	31,979

G.7 Taiwan

The dynamics of production, processing, trade and consumption of blue shark in East Asia are deserving of further research moving forward. Consumption of shark fin soup in China has fallen by around 80 percent since 2011, but has increased elsewhere in Asia, including in Thailand, Vietnam, Indonesia and Macao.[130] Japan, Taiwan and Indonesia are large producers of blue shark. While Japan and Taiwan both harvest blue shark as bycatch in distant-water tuna longline fisheries, Japan and Indonesia also have commercial fisheries that target blue shark specifically. All three countries also have domestic shark fisheries. With the world's largest shark fishery, there is an increase in consumption of shark meat in Indonesia (along with the global trend).[131] Sharks are caught and processed by countries such as Taiwan, Indonesia, India, and Spain and sent to trading hubs like Hong Kong and Singapore for further trade. Hong Kong is the largest shark-fin trader, followed by Singapore.[132] In August 2020, of identifiable tissue samples of shark fin in Singapore, only five percent were blue shark. Of the 102 identifiable shark species in Singapore in 2017–18, 14 were blue shark.[133]

Blue shark was 23 percent of 548 samples collected in Taiwan from June 2011 to January 2013, and therefore might be the most consumed shark species on Taiwan's domestic market. In 1996–2006, annual Taiwanese shark landings averaged between 39,000 and 55,000 t. Blue shark consisted of 44.54 percent of sales for two major Taiwanese fish markets in 2001–2010. (with an average 2525 t in total annual landings).[134]

Taiwan reported a catch of 28,320 t of blue shark for 2019. In contrast, the FAO only reported 4,910 t, while the reconciled amount in the main report was 47,685.3 t. For all shark species, Taiwan reported 34,977 t, whereas the FAO reports 37,787 t and the RFMO amount was 52,209.6 t for Taiwan.

Blue shark accounted for 47.2 percent of 231 port landing samples investigated.[135] If FAO data on all-shark landings by Taiwan 2019 (37,785 t) is true, then estimated 17,834 t of blue shark was landed by Taiwan. The figure 28,320 t is 53 percent of the all-shark total of 52,209.6 t. And 47,685.3 t is 91 percent of 52,209.6 t.

In 2019, Taiwan's imports and exports of frozen fin were 489.739 t and 419.553 t, respectively. Imports and exports of shark bodies were 5,442.96 t and 10,994.103 t, respectively. While imports and exports of frozen fin were relatively low and comparable to each other, imports and exports of shark bodies were relatively high, with exports being more than twice the amount of imports.

[130] Even as China says no to shark fin soup, dish gaining popularity elsewhere in Asia，The Straits Times, 15 February 2018, https://www.straitstimes.com/asia/east-asia/even-as-china-says-no-to-shark-fin-soup-dish-gaining-popularity-elsewhere-in-asia.

[131] ASADATUN ABDULLAH et al., DNA-based analysis of shark products sold on the Indonesian market towards seafood labelling accuracy program, B IOD I V E R S I T A S, Volume 21, Number 4, April 2020, 1385-1390 DOI: 10.13057/biodiv/d210416.

[132] C.J.N. Liu et al., Sharks in hot soup: DNA barcoding of shark species traded in Singapore, Fisheries Research 241 (2021).

[133] Wainwright, B.J., Ip, Y.C.A., Neo, M.L. *et al.* DNA barcoding of traded shark fins, meat and mobulid gill plates in Singapore uncovers numerous threatened species. *Conserv Genet* **19**, 1393–1399 (2018). https://doi.org/10.1007/s10592-018-1108-1.

[134] Shang-Yin Vanson Liu et al., DNA Barcoding of Shark Meats Identify Species Composition and CITES-Listed Species from the Markets in Taiwan, PLOS One, Vol. 8, No. 11, November 2013.

[135] Chuang, P.S., Hung, T.C., Chang, H.A., Huang, C.K. and Shiao, J.C., 2016. The species and origin of shark fins in Taiwan's fishing ports, markets, and customs detention: A DNA barcoding analysis. PloS one, 11(1), p.e0147290.

Brazil, mainland China and Uruguay were the top three destination countries for frozen shark exports from Taiwan, receiving 77 percent of the exports combined. Brazil's imports accounted for 52 percent of the exports, which were more than twice the amount of China's and Uruguay's imports.

Brazil, Trinidad and Tobago, and China were the top three destination countries for frozen shark fillet exports from Taiwan, with Brazil again playing a dominant role in the trade, receiving 77 percent of the exports.

Singapore, China, and Hong Kong were the top (and only) three destination countries/regions for shark fin, with Singapore receiving 84 percent of the exports.

Given the large quantities of Taiwan's catch of blue shark (see the main report; note: blue shark export/import data are not specified in the trade database of Taiwan), the total of the above three types of exports (frozen shark + frozen shark fillets + frozen shark fins, with other shark products omitted due to their low export quantities as shown in the spreadsheet) is small (11,982,163 kilo), implying that the majority of Taiwan's catch of blue shark stays in Taiwan for domestic consumption (this being said, the possibility that some of the blue shark catch is smuggled to other countries cannot be entirely ruled out).

Table G.8: Taiwan Exports and Imports of Shark Products, 2019[136]

Item	Exports		Imports	
	Value in USD1000	Weight in kg	Value in USD1000	Weight in kg
Dogfish and other sharks fresh or chilled	32	31,500		
Dogfish and other sharks frozen	14,125	10,912,603	5,147	5,442,960
Shark fins frozen	2,739	419,553	2,952	489,739
Dogfish other sharks rays and skates fillets frozen	1,414	648,202	291	223,767
Dogfish other sharks rays and skates fillets frozen	1	1,805		
Dogfish and other sharks meat (whether or not minced) frozen	30	11,340	812	1,064,613
Shark fins dried	2,540	230,470	1,922	43,443
Shark fins salted or in brine	6	7,560		
Shark fins prepared or preserved frozen	2	100		
Shark fins prepared or preserved canned	97	1,058		
Other shark fins prepared or preserved	6	394		
Shark tail frozen			4	698
Upper lobe of shark caudal fin frozen			512	493,905
Upper lobe of shark caudal fin smoked dried or salted			107	10,020

136 財政部關務署 (Taiwan Ministry of Finance, Customs Office), https://portal.sw.nat.gov.tw/APGA/GA30E.

Table G.9: Taiwan Exports of Shark Products, 2019

Item	Country (Area)	Value in USD1000	Weight in kg
Dogfish and other sharks, frozen	Brazil	8,113	5,656,046
	China	1,338	1,624,931
	Uruguay	1,106	1,140,878
	Korea, Republic of	2,285	1,085,024
	Thailand	507	583,768
	South Africa	370	481,466
	Mexico	113	108,724
	Viet Nam	84	60,300
	Trinidad and Tobago	63	55,387
	Morocco	39	54,000
	Greece	88	38,029
	Indonesia	19	24,000
	Mauritius	0	50
	Total	14,125	10,912,603
Dogfish, other sharks, rays and skates fillets, frozen	Brazil	1,045	499,300
	Trinidad and Tobago	306	109,770
	China	22	28,305
	Puerto Rico	32	10,932
	Australia	10	1,700
	Total	1,415	650,007
Shark fins, frozen	Singapore	2,331	353,568
	China	284	47,555
	Hong Kong	124	18,430
	Total	2,739	419,553
Shark fins, dried		2,540	230,470
Dogfish and other sharks, fresh or chilled		32	31,500
Dogfish and other sharks meat (whether or not minced), frozen		30	11,340
Shark fins, salted or in brine		6	7,560
Shark fins, prepared or preserved, canned		97	1,058
Other shark fins, prepared or preserved		6	394
Shark fins, prepared or preserved, frozen		2	100
Grand Total		20,992	12,264,585

Appendix H: Global shark conservation policy frameworks

H.1 IPOA-Sharks

The 1999 International Plan of Action for the Conservation and Management of Sharks (IPOA-Sharks) was developed by FAO within the framework of the 1995 FAO Code of Conduct for Responsible Fisheries and is a voluntary instrument. It provides a blueprint for coastal and flag States to transpose the plan into a national context, setting out to improve the conservation and management status of shark resources targeted by national fleets.

Countries and regions have since developed NPOA-Sharks or RPOA-Sharks, respectively. FAO provides a map-based interface showing which countries and regions have developed plans.[137] Where plans have been developed, they signal that the country and/or the region has recognized the need to improve the protection for these species and that actions are planned.

An update to the list of NPOAs published by IUCN in 2016 shows that by mid-2022, at least 56 NPOA-Sharks, and 8 RPOA-Sharks are under various stages of development and implementation (table below). NPOA-Sharks have almost doubled since 2016 and the number of RPOA-Sharks has also grown considerably (+33%). Given that there are some 150 coastal States worldwide, more than 1 in 3 had developed an NPOA-Sharks by 2022. Regional POAs like the EU's imply direct engagement from Member States, meaning that effectively more than 1 in 2 coastal States worldwide are now engaged in implementing some of the tenets of the IPOA-Sharks.[138] Given that the CITES and CMS appendices were only populated with sharks after 2000 (see below), and that NPOAs and RPOAs were also all developed following the turn of the millennium, a lot of progress on policy to improve shark management and conservation has been made in the last 20 years.

Updated table showing the regional and national shark action plans developed by 2022 (by year of publication):

United States (2001)	Japan (2001 revised 2009 and 2016)	the Mediterranean Sea (2003)	Namibia (2003)	West Africa (2003)
Australia (2004 revised 2012)	Mexico (2004)	the United Kingdom (2004 revised 2011)	Belize (2005 revised 2015)	Brazil (2005 revised 2014)
Honduras (2005 - draft)	Sierra Leone (2005)	Chile (2006)	Ecuador (2006)	Guinea (2006)
Malaysia (2006 updated 2014)	Nicaragua (2006)	Thailand (2006)	Taiwan (2006)	Seychelles (2007)

[137] See: https://www.fao.org/ipoa-sharks/national-and-regional-plans-of-action/en/. Given the map-based nature of the interface, the interface requires clicking through all countries and regions to raise a list manually. The list of NPOA-Sharks could not be accessed (on 10/06/2022): https://www.fao.org/ipoa-sharks/tools/ipoa-sharks-documents/en/

[138] Note that not a single EU Member State – with the exception of the UK at the time – has developed an NPOA-Sharks; they are all guided by the EUPOA instead.

Canada (2007)	Senegal (2007)	El Salvador (2008)	Guatemala (2008)	Guinea-Bissau (2008)
Mauritania (2008)	New Zealand (2008)	South Pacific (2008)	Uruguay (2008 revised 2015)	Argentina (2009 revised 2015)
the European Union (2009)	the Philippines (2009)	Venezuela (2009)	Colombia (2010)	Costa Rica (2010)
the Gambia (2010)	Indonesia (2010 revised 2015)	Bay of Bengal (2011)	Central America (2011)	Korea (2011)
Sri Lanka (2013)	South Africa (2013 revised 2018)	Tonga (2013)	Venezuela (2013)	Bangladesh (2014 - draft)
Peru (2014)	Vanuatu (2014)	Cuba (2015)	India (2015)	the Maldives (2015)
Myanmar (2015)	Cape Verde (2016)	Mauritius (2016)	Mozambique (2016)	Antigua & Barbuda (2017)
Kenya (2017 – draft)	Oman (2017 – draft)	Pakistan (2017)	Panama (2018)	Río de la Plata Treaty (2018)
UAE (2018)	WECAFC (2018 – draft)	Tanzania (2019 – draft)	Madagascar (2021)	Papua New Guinea (2021).

H.2 CITES

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an international agreement between governments that entered into force in 1975. It aims to ensure that international trade in specimens of wild animals and plants does not threaten the survival of listed species. CITES currently counts 184 Parties, making it the conservation agreement with the largest membership. Taiwan, the world's most important blue shark fishing nation in 2019, is not a party.

Species subject to fisheries exploitation and covered by CITES include sturgeons, rays, sharks, sawfishes, whales and marine turtles. Certain shark species were added in early 2003, including the basking shark (*Cetorhinus maximus*) and whale shark (*Rhincodon typus*). In 2007 all seven species of sawfishes (*Pristidae* spp.) – belonging to the same subclass of fish as sharks and rays – were added. By October 2017, 12 species of sharks[139] and all manta and devil rays had been included.[140]

CITES listed silky and oceanic whitetip sharks in 2017, close cousins of the blue shark, and some of the most important species harvested worldwide. Blue shark is not listed in a CITES Appendix, but could be added, should its conservation status further deteriorate (see IUCN Red List below). An Appendix II (vulnerable) listing would still allow for trade in blue shark, but it would also immediately place increased requirements on exporting States to ensure the legality of catches. Traded products of Appendix II-listed species require a certificate that the

[139] Basking shark (*Cetorhinus maximus*); whale shark (*Rhincodon typus*); great white shark (*Carcharodon carcharias*); oceanic whitetip shark (*Carcharhinus longimanus*); porbeagle shark (*Lamna nasus*); scalloped hammerhead shark (*Sphyrna lewini*); great hammerhead shark (*Sphyrna mokarran*); silky shark (*Carcharhinus falciformis*); thresher sharks – all three species (*Alopias* spp.).

[140] See: https://www.cites.org/eng/prog/shark/more.php

exported specimens were caught legally / under sustainable conditions, referred to as a "Non-Detriment Finding". This provides an immediate avenue and incentive for exporting nations (and RFMOs) to develop sustainable management regimes for thus listed sharks.

Recently, European fishing representative group Europeche opposed Panama's proposal to include blue sharks in CITES Appendix II, urging the EU not to co-sign it.[141]

H.3 CMS

The Convention on the Conservation of Migratory Species of Wild Animals (CMS) is an environmental treaty of the United Nations, launched in Bonn in 1979. It provides a global platform for the conservation and sustainable use of migratory animals and their habitats. CMS brings together "Range States" (i.e. States through which migratory animals pass) and lays the legal foundation for internationally coordinated conservation measures throughout a migratory range. Like CITES, it operates a set of Appendices in which endangered (Appendix I) and vulnerable (Appendix II) species are listed.

The CMS contains a Sharks MOU, comprising of an international Conservation Plan forming the basis of the work under the MOU. It calls for cooperation among governments, fishing industry, NGOs, local communities and scientists. The Advisory Committee of the MOU delivers expert advice and suggests new approaches for the implementation of the Conservation Plan.

Blue shark was listed in the CMS Appendix II in October 2017 (and updated in 2020), based on the proposal by Samoa and Sri Lanka.[142] Appendix II covers migratory species that have an unfavourable conservation status and that would significantly benefit from (or would require) international agreements and the resulting international cooperation for their conservation and management. The Convention encourages the Range States of species listed in Appendix II to conclude global or regional Agreements for the conservation and management of individual species or groups of related species.

This implies that the CMS is already exerting some demands on its Members to address and improve the conservation and management measures of blue shark through existing or novel multilateral mechanisms. RFMOs are the go-to option to implement such resolutions for highly migratory and straddling fish species.

H.4 IUCN Red List

IUCN's[143] Red List of Threatened Species[144] was established in 1964 and has evolved to become the world's most comprehensive information source on the global extinction risk status of animal, fungus and plant species. Currently, some 142,500 species are listed, with more than 40,000 species threatened with extinction. These include 37% of all sharks and rays, 33% of all reef building corals, and 26% of all mammals. The list uses the following nine

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[141] See: www.undercurrentnews.com/2022/05/27/europeche-urges-eu-not-to-add-blue-sharks-to-endangered-species-treaty/

[142] See: https://www.cms.int/sites/default/files/basic_page_documents/appendices_cop13_e_0.pdf

[143] The International Union for the Conservation of Nature or the World Conservation Union

[144] IUCN. 2021. The IUCN Red List of Threatened Species. Version 2021-3. https://www.iucnredlist.org. Accessed on 09th June, 2022.

increasing threat levels to classify the status of a species: not evaluated (NE); data deficient (DD); least concern (LC); near threatened (NT), vulnerable (VU); endangered (EN); critically endangered (CE); extinct in the wild (EW); and extinct (EX).

Blue shark was last assessed globally on 6th November 2018. Blue shark maintained its NT listing, first received in 2009, and is nearing the threshold for a *Vulnerable* listing.[145] This ranking owes largely to the dismal status of blue shark in the Mediterranean – where it may be facing extinction – and the embattled status of north and south Atlantic blue shark populations which have been substantially diminished over the last 30 years.

While blue shark is one of the more resilient shark species, whose stocks are faring better than others in the face of sustained high fishing pressure, its global population is in decline, and the IUCN Red List provides one of the most authoritative sources to remind us of the need for better management and improved management outcomes for this species.

H.5 Market measures: Eco-labels and third-party certification programs

The blue logo of the Marine Stewardship Council (MSC) is the best-known consumer-facing label, assuring consumers that they are buying sustainably harvested seafood. The current MSC Fisheries Standard (v2.01) explicitly considers shark finning within one of its performance indicators, with the 'pass' level requiring that "*It is highly likely that shark finning is not taking place*". The MSC Standard's expectation is that either all sharks are landed with fins naturally attached or that if sharks are processed on board, there are regulations in place governing the management of sharks, there is full documentation of the destination of all shark bodies and body parts or good external validation of the vessels' activities is available to confirm that it is highly likely that shark finning is not taking place[146]. The new MSC Fisheries Standard (v3.0, currently in draft) has similar requirements, but also includes the requirement that the fishery client is not convicted of a shark finning violation in the last two years.

There is currently one MSC certified shark-directed fishery, the US Atlantic spiny dogfish, winter skate and little-skate multi-gear (otter trawl, longlines and gillnets) fishery that mainly supplies the EU with fillets. However, many other certified fisheries, both pelagic and demersal, have sharks as bycatch that are subject to some degree of scrutiny. There are multiple tuna fisheries now certified and many have had to improve bycatch reporting and, if significant, implement measures to reduce that bycatch, including of shark.

MSC fisheries audits undergo a rigorous process of peer review and public consultation but are still subject to NGO scrutiny and criticism. A recent report (Schwenzfeier *et al*., 2022[147]) alleges that MSC-certified purse seiners operating under the Solomon Islands bilateral fishing licenses and the FSMA license continue to violate the MSC certification guiding principles, including shark finning.

[145] See: https://www.iucnredlist.org/species/39381/2915850#assessment-information

[146] MSC (2021). MSC Fisheries Standard Version 2.01, 31 August 2018.

[147] Schwenzfeier J., S. Hardisty and A.Hofford (2022). Slipping through the Net - Reported but ignored. Infringements in the MSC tuna fisheries of the Western and Central Pacific. Shark Guardian May 2022. https://06cb1a73-e04f-4016-af0b-25cf996d1360.usrfiles.com/ugd/06cb1a_0955b4a3cb0a4e27b100a7ed8c37126c.pdf

A pre-cursor to MSC certification is entering a fishery into a Fishery Improvement Project (FIP) process in which an initial assessment is carried out that informs an action plan to address any shortcomings identified. The FIP Progress Tracking Database & Tools, Fisheryprogress.org, lists a single FIP directly targeting blue shark, i.e. the Spanish 'Atlantic Ocean blue shark and swordfish - surface longline (FIP-BLUES) project'.[148] Its stated objective is to "*address all of the fishery's environmental challenges necessary to achieve a level of performance consistent with an unconditional pass of the Marine Stewardship Council Fisheries Standard for target species blue shark (Prionace glauca) and swordfish (Xiphias gladius) in Atlantic Ocean (North and South stocks) by December 2024.*"

There is also a Japanese FIP for blue shark and swordfish involving the 12 longline vessels of the Kesennuma Distant-Water Fisheries Cooperative[149]. In 2019, 73 percent of Japan's total catch of swordfish was landed in Kesennuma, and its landings of blue shark (Prionace glauca) are also the highest in the country. The FIP reports blue shark production of 3,706t in 2019. This represents 13% of the total Japanese catch of blue shark reported to RFMOs.

Most other third-party fisheries standards also deter sourcing from fisheries with shark finning. Fair Trade's Capture Fisheries Standard (v2.0.0, effective January 2022[150]) simply requires that "*There is no evidence that individuals within scope of the Certificate are participating in any form of shark finning*". Friend of the Sea requires that "*the fleet shall use non entangling FADs only, to avoid entanglement of sharks, turtles and other non-target species*" and that "*Accidental catches (bycatch) shall not include species listed in the IUCN red list of endangered species as Vulnerable or higher risk*"[151].

H.6 Other relevant initiatives by States, industry, or civil society

Shark sanctuaries

Shark sanctuaries are shark-focused marine protected areas (MPAs) with generally zero- or no-take regulations and strict bans on recreational and/or commercial exploitation of given species have arisen in recent decades as one tool to confer protection to given marine species, or groups of species. These sanctuaries are generally put in place by individual coastal States.

Pew summarized the shark sanctuaries that were in place by early 2018.[152] The first shark sanctuary was created by Palau in 2009, followed by the creation of a further 16 sanctuaries across the Atlantic Ocean (concentrated in the Caribbean) the South Pacific Ocean and one in the Indian Ocean. From this was born the first regional sanctuary in the world, created in Micronesia in 2015, resulting from the fusion of the sanctuaries of Palau, the Federated States

[148] See: https://fisheryprogress.org/fip-profile/atlantic-ocean-blue-shark-and-swordfish-surface-longline

[149] https://umitopartners.com/works/

[150] See: https://assets.fairtradecertified.org/image/upload/v1655234707/Standards/Capture%20Fisheries%20Standard/FTUSA_STD_CFS_EN_2.0.0.pdf

[151] Friend of the Sea Standard, v3.1, 2017

of Micronesia, the Marshall Islands and Kiribati. Collectively, these 17 sanctuaries cover a surface area of 19.4 square million kilometres – or twice the size of continental Europe (see figure H.1 overleaf).

Pew notes that: "*Sanctuary designations typically prohibit the commercial fishing of all sharks, the retention of sharks caught as bycatch, and the possession, trade, and sale of sharks and shark products within a country's full exclusive economic zone (EEZ)*." The sanctuaries of the Maldives and French Polynesia, as two examples, have enacted total bans on shark fishing and on shark trade – understood to confer solid protections for sharks in those waters. Others may have enacted more stringent gear regulations only, doing away with gears typically used to target sharks.

In addition to this, marine protected areas in which shark fishing is simply banned (and not claiming the title of shark sanctuary) also exist, notably in Colombia, Costa Rica, Ecuador, Guinea Bissau and Mauritania.[153] The impact of these (often quite recently established) sanctuaries and marine protected areas on shark populations still needs to be determined. Ward-Paige & Worm (2017) found that results varied by country, but there were some general trends:

i) shark sanctuaries showed less pronounced shark population declines, fewer observations of sharks being sold on markets, and lower overall fishing threats compared to non-shark sanctuaries,

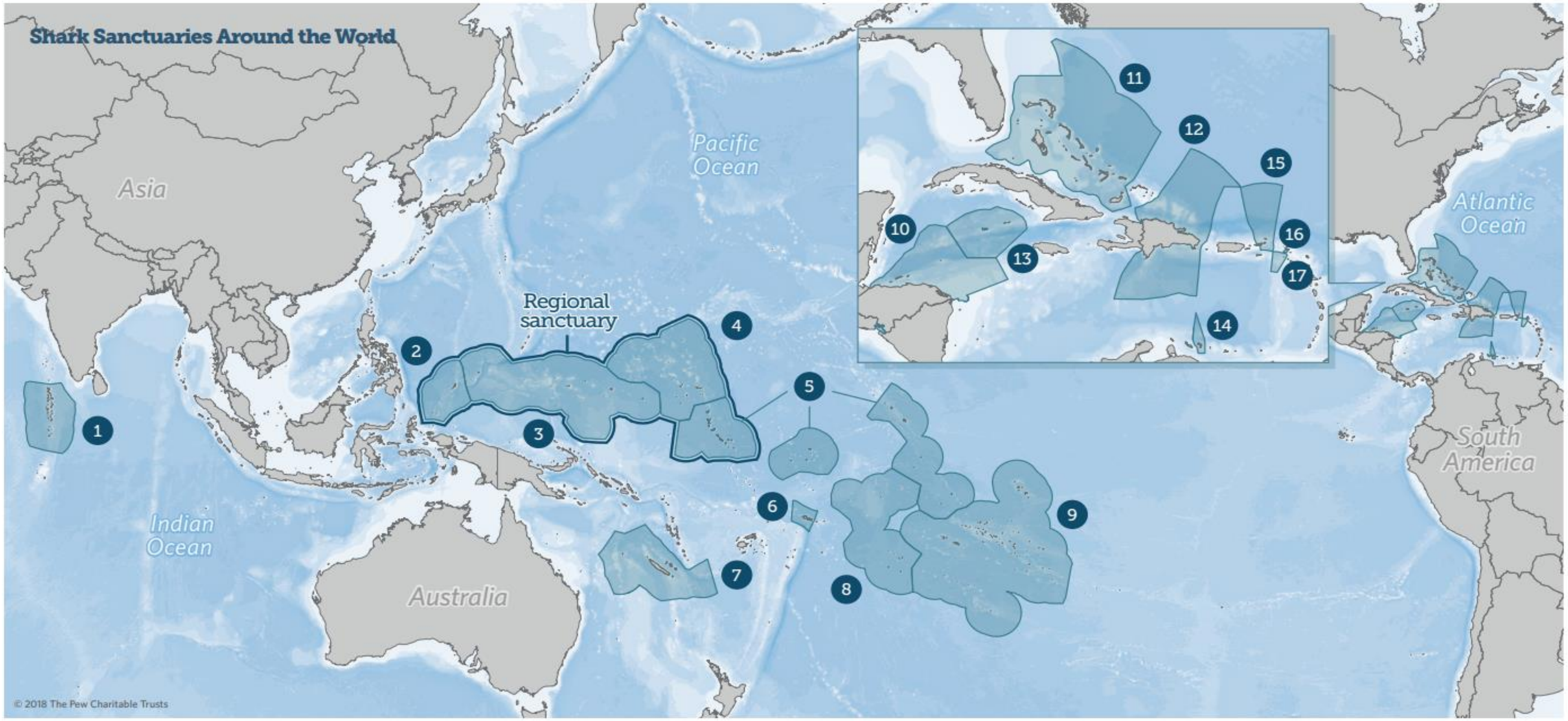
ii) bycatch, ghost gear, marine debris and habitat destruction are significant threats that are often not addressed by sanctuary regulations and need to be resolved in other ways, and

iii) participants in sanctuaries were more optimistic about the survival of shark populations in local waters, but also highlighted the need for further conservation efforts.

These results suggest that shark sanctuaries, as seen through the lens of local experts, may be a helpful conservation tool but likely not sufficient in isolation (Ward-Paige & Worm, 2017). The success of these protected area schemes ultimately depending on the effectiveness of the related monitoring and enforcement frameworks applying in such waters (Vianna *et al.* 2016), which are known to vary tremendously between countries, sanctuaries and MPAs.

[153] See: https://www.globalsharksraysinitiative.org/_files/ugd/5c8a4b_c347861e6a3b4902b7a01fab2e3d5208.pdf

Figure H.1. Shark Sanctuaries around the world (source: Pew)



1. Maldives
916,189 sq. km. (353,742 sq. mi.)
Established 2010
2. Palau
604,289 sq. km. (233,317 sq. mi.)
Established 2009
3. Federated States of Micronesia
2,992,597 sq. km. (1,155,448 sq. mi.)
Established 2015
4. Marshall Islands
1,992,232 sq. km. (769,205 sq. mi.)
Established 2011
5. Kiribati
3,437,132 sq. km. (1,327,084 sq. mi.)
Established 2015
6. Samoa
128,000 sq.km. (49,421 sq.mi.)
Established 2018
7. New Caledonia
1,245,000 sq. km. (480,697 sq. mi.)
Established 2013
8. Cook Islands
1,960,135 sq. km. (756,812 sq. mi.)
Established 2012
9. French Polynesia
4,767,242 sq. km. (1,840,642 sq. mi.)
Established 2012
10. Honduras
240,240 sq. km. (92,757 sq. mi.)
Established 2011
11. The Bahamas
629,293 sq. km. (242,971 sq. mi.)
Established 2011
12. Dominican Republic
269,489 sq. km. (104,050 sq. mi.)
Established 2017
13. Cayman Islands
119,134 sq. km. (45,998 sq. mi.)
Established 2015
14. Bonaire
9,706 sq. km. (3,747 sq. mi.)
Established 2015
15. British Virgin Islands
80,117 sq. km. (30,933 sq. mi.)
Established 2014
16. St. Maarten
499 sq. km. (193 sq. mi.)
Established 2016
17. Saba
8,033 sq. km. (3,102 sq. mi.)
Established 2015

(Source: https://www.pewtrusts.org/-/media/assets/2018/02/shark_sanctuaries_2018_issuebrief.pdf)

Trade bans & other initiatives

As seen in the previous section, many countries adopt national measures setting out to increase the protection conferred upon sharks. In June 2019, Canada became the first country of the G7 group to ban shark fin imports on its territory.

Recent policies enacted across a number of individual States in the United States of America provide such an example, where individual States are now banning the shark fin trade.[154]

Oceanic whitetip sharks were listed as threatened under the US Endangered Species Act in 2018. Being listed as threatened under the US Endangered Species Act implies that the import, export, or taking of species that are listed as threatened or endangered is proscribed, killing the market (and thus the financial incentives) to harvest such species for placing on that market.

A shark fin trade ban is in the process of being introduced by the United Kingdom[155], and a European Citizens Initiative to introduce a trade ban received over 1.2 million signatures, more than half coming from German and French citizens[156]. This exceeded the 1 million signature sought and is now being considered by EU decision-makers but will face stiff opposition from Spanish shark fishing interests.

On the industry-led side, the operators of longliners in Hawaii recently announced to voluntarily switch from steel wire leaders to using nylon leaders to save sharks. The deep-set longline fishery targets bigeye tuna and is voluntarily setting aside the wire tracers as part of an effort to conserve oceanic whitetip sharks.[157]

[154] See: https://usa.oceana.org/press-releases/texas-becomes-10th-state-ban-trade-shark-fins/

[155] See: https://www.sharkguardian.org/post/breaking-uk-shark-fin-ban-moves-forward

[156] See: https://europa.eu/citizens-initiative/initiatives/details/2020/000001_en

[157] See: https://www.undercurrentnews.com/2022/05/25/hawaii-longliners-voluntarily-using-nylon-leaders-to-save-sharks

Appendix I: Regional shark conservation management frameworks

I.1 Targeted blue shark management measures at the RFMO level

With the very recent exception of ICCAT, no other RFMOs have management rules that limit the extraction of any pelagic shark resources, including blue shark.

ICCAT has recently started to put in place direct management measures, including TACs and quotas, for blue shark in its area of competence. All other tuna RFMOs may have generic or more species-specific bycatch and finning rules in place (generally referred to as conservation measures), but these do not include output limits to regulate fleets targeting sharks or encountering them as bycatch. As a result, the scale of harvesting blue shark (and other pelagic sharks) in most Areas Beyond National Jurisdiction (ABNJ) remains unmanaged.

There are conservation-type measures in place for given shark species, generally setting out to protect them as bycatch in fisheries targeting tuna and tuna-like resources. However, these measures can and do include bans on retaining given species as bycatch aboard tuna fishing vessels and are covered in the following sub-section on conservation measures.

The blue shark populations of the Mediterranean and the Atlantic Ocean are those faring worst globally,[158] driving ICCAT to move into new territory for t-RFMOs, the development of output management measures for this species.

In 2018 the General Fisheries Commission for the Mediterranean (GFCM) provided Recommendation GFCM/42/2018/2 on fisheries management measures for the conservation of sharks and rays in the GFCM area of application prohibiting finning and preventing inshore trawling amongst others.

I.2 Shark bycatch conservation measures

Compared to the very limited adoption of output limits described above, which is only by ICCAT and limited to blue shark, there is a relatively large group of conservation type measures related to shark, which cover data reporting rules, gear setting and avoidance rules, gear specification rules, no retention rules, live release rules and the all-important finning rules.

The table below summarizes the most important rules applying to the conservation of sharks as bycatch across the four t-RFMOs (as opposed to "management" rules for target catch), indicating to which sharks they apply.

Regarding shark data reporting, a number of rules are in place across the four t-RFMOs. Importantly, in all four t-RFMOs, blue shark fall directly and specifically under given data recording and reporting routines that are either the same as those applied to tuna, or have been specifically called for under CMMs covering subject matters not directly related to data reporting. This leads to a situation where blue shark reporting is covered globally, possibly

[158] A similar finding applies to shortfin mako sharks, whose Atlantic population is also doing especially poorly. The embattled status of the two species, blue shark and shortfin mako, led to the first-time ever adoption of pelagic shark management measures by a t-RFMO in the same year.

with IATTC presenting the weakest framework for blue shark reporting across the field of t-RFMOs.

Gear setting and shark avoidance rules exist in three out of four t-RFMOs, calling on CPCs not to set on whale sharks. Blue sharks are not mentioned in avoidance-type rules.

Three out of four t-RFMOs have put in place gear specification rules setting out to minimize shark bycatch (or targeted catch). IAATC and WCPFC prohibit shark lines (directly attached to floats in LL fisheries), while the prohibition of steel leaders is considered in IATTC under specific circumstances (that are very difficult to enforce). Non-entangling FADs are invariably showcased as a shark mortality reduction measure, pursued by IOTC and WCPFC, and from which blue sharks benefit naturally.

In terms of zero retention rules, many sharks are targeted across all t-RFMOs, but blue shark is not included in those measures. The most commonly protected sharks under this rule are oceanic whitetip, silky shark and whale sharks. This underlines the fact that blue shark has not achieved the same worrisome conservation status as other oceanic sharks have.

Live release rules almost invariably apply to all zero-retention rule species, while IATTC also orders purse seine vessels to release all sharks, and WCPFC requires CPC vessels to also live release all unwanted sharks, whether falling under a zero-retention rule, or simply being unwanted bycatch. The IATTC and WCPFC rules on live release directly benefit blue shark also, while those of ICCAT and IOTC do not. Most CMMs also provide for CPCs to ensure that shark handling equipment allowing for the safe and live release of sharks be kept onboard.

Importantly, finning rules – all banning the practice of finning – apply across the four t-RFMOs. This directly benefits blue sharks also, and the fact that the rule is expressed in the same way – with minor differences in wording – makes it easy to apply worldwide (for instance, by port State inspections). Wherever shark fins arrive detached from their carcasses, and/or in the absence of carcasses in the indicated ratio, it is clear that illegal harvesting of shark fins has occurred and should lead to immediate sanctioning. Given that shark finning was (and remains) a potent driver in the difficult-to-quantify overharvesting of shark resources in general, this united front on finning rules displayed across the four t-RFMOs is essential in driving the improved conservation of sharks – including that of blue sharks. However, finning bans are unlikely to have much additional impact when demand for the meat is high and a profitable trade is established.[159]

Gear specifications are a regulatory shark conservation area that is currently under-used and could lead to significant reductions in shark bycatch. Deterrence mechanisms for sharks in gillnet fisheries[160] – of critical importance in the Indian Ocean – the use of specific types of

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[159] "*Bans on shark finning* […] *have been adopted by the relevant RFMOs and scores of countries. These bans could reduce Mako Shark fishing mortality in cases where enforcement levels are high and interest in the species' meat is low. Many finning ban enforcement standards, however, are weak and demand for Mako Shark meat is high*." (Source: Fact sheet for the 18th Conference of Parties (CoP18) to CITES. Listing Proposal 42. https://www.globalsharksraysinitiative.org/files/ugd/ 5c8a4b_c347861e6a3b4902b7a01fab2e3d5208.pdf)

[160] No effect from rare-earth metal deterrent on shark bycatch in a commercial pelagic longline trial. https://www.conservationevidence.com/individual-study/8342. Proposed action: Attach an electropositive deterrent to fishing gear. https://www.conservationevidence.com/actions/2696.

hooks,[161] the use of wire traces (or steel leaders), non-entangling FADs, etc. all have the potential to be further researched, and to be rolled out in a manner that is more globally consistent, emulating the t-RFMO approach to finning.

I.3 Catch or Trade Documentation Schemes

Several t-RFMOs developed trade documentation schemes (TDS) in the late nineties, initially trying to gain a better understanding of the supply chain. After these instruments proved useful to detect non-authorized fishing operations, TDS evolved into an enforcement tool and then into more powerful Catch Documentation Schemes (CDS). The latter set out to ensure that illegally harvested products cannot be put to market. The first CDS adopted were for Patagonian toothfish and bluefin tuna. TDS remain in place, covering various tuna species only.

Japan has proposed to subject sharks to t-RFMO CDS in the past.[162] Today, no RFMO-operated TDS or CDS cover any shark species, while calls to enact such trade-based schemes go well beyond those of single RFMO Members.[163]

[161] Shark catch in a pelagic longline fishery: comparison of circle and tuna hooks. https://www.conservationevidence.com/individual-study/8395. Proposed action: Use a different hook type. https://www.conservationevidence.com/actions/2698.

[162] At the 17th Special Meeting of ICCAT (2010), the 81st Meeting of IATTC (2010) and the 14th Session of IOTC (2011), Japan proposed the introduction of a CDS covering sharks also, to prevent the putting to market of IUU products. None of these proposals were adopted due to opposition from other Parties. ICCAT eventually rolled out its CDS in 2010, covering bluefin tuna only.

[163] Bräutigam *et al.* (2015) identify responsible trade regulation as one of four pillars for shark conservation, calling on major importers and exporters to champion/enact trade-related measures (e.g. certification schemes) to block IUU-products from markets.

Appendix J: National shark conservation and management rules

J.1 EU – Spain and Portugal

The European Union developed a "EUPOA-Sharks" (based on FAO's IPOA-Sharks) in 2009,[164] and has also developed a shark finning regulation which must be transposed by member States into national law. Given Spain's and Portugal's important contribution to total global blue shark catch (but also that of France and the UK to a lower extent), the rules adopted by the EU Council of Ministers in this matter are/were[165] of interest. Also, other EU legislation, notably Regulation (EU) No 1379/2013 of the European Parliament and of the Council of 11 December 2013 on the common organization of the markets in fishery and aquaculture products, provides that that non-prepared or preserved shark products, including steaks and fins, "*may be offered for sale to the final consumer or to a mass caterer only if appropriate marking or labelling indicates* […] *the commercial designation of the species and its scientific name*", implying that a solid traceability framework must be in place throughout the supply chain. Council Regulation (EC) No 1224/2009 of 20 November 2009 establishing a Community control system for fisheries (i.e. "the control regulation") requires all lots to be clearly labelled, allowing to identify the species and the vessel of origin throughout the supply chain. In combination with the tenets of the EU IUU Regulation (Council Regulation (EC) No 1005/2008) covering foreign consignments imported into the EU market, traceability requirements for all shark products within, or headed to, the EU market are encompassing and tightly regulated. However, it should be added that the same strictures do not apply to shark fins exported from the EU to Asian markets, the final link in the arguably most important supply chain – something that may be changing following the revision of the control regulation, which has been underway for a few years already.

Council Regulation (EC) No 1185/2003 on the removal of fins of sharks on board vessels, amended by Regulation (EU) No 605/2013, has now been in place for nearly two decades, making the EU one of the early regulators in this domain.[166] The amended regulation prohibits the removal of fins, and requires EU Member States to report annually on the implementation of the regulation (covering landings statistics, inspections, infringements and penalties issued). A 2019 STECF monitoring report[167] details how many times EU MS complied with their reporting requirements in the five-year period 2015 to 2019 inclusive, giving rise to the following score (only countries listed that caught blue shark in 2019, in descending order of compliance):

Spain	5/5
Portugal	4/5
UK	4/5

[164] See: https://ec.europa.eu/oceans-and-fisheries/ocean/marine-biodiversity/sharks_en and https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52009DC0040&from=EN

[165] The binding nature of these lapsed for the UK following Brexit.

[166] Canada enacted a full finning ban for vessels flying its flag in 1994, applying within and beyond its EEZ, likely making it the first country worldwide to do so.

[167] See: https://publications.jrc.ec.europa.eu/repository/handle/JRC119051

France (including OT):	1/5
Malta	0/5
Italy	0/5

The above list shows that compliance with EU-internal reporting requirements differs between States. The two fully Mediterranean EU Members – coastal States co-hosting the only commercially extinct blue shark population worldwide – lead actors in the most recent illegal Atlantic bluefin tuna trade scandal (and partly facilitators by failing to investigate and to enforce EU and ICCAT rules),[168] arise as weak EU performers in the domain of shark protection also, while Spain emerges as the most pro-active and responsible State player.

The 2013 amendment of the regulation merely added that fins could be partially sliced so as to fold them against the carcass (article 3.(1a.)), but still prohibiting their detachment, and prohibiting the retention onboard, transhipment or landing of detached fins. The same prohibition applies to the marketing of fins removed on board or supplied in a manner in violation with the regulation. This regulation applies to all EU vessels, regardless of the waters where they fish, and supersedes any and all RFMO resolutions that are of lower tenor.

J.2 EU Catch Documentation Scheme (CDS) and US Seafood Import Monitoring Program (SIMP)

Two sets of unilateral market-based programs aiming to forgo the importation of illegally harvested fisheries resources have been put in place by the European Union – implemented by all its member States individually – and the United States of America.

The EU IUU Regulation and its catch documentation scheme (CDS) covers all harvested marine resources caught by a fishing vessel not flying an EU member State flag, and naturally covers all species of sharks. All such products imported into the territory of the EU must be accompanied by mandated and duly validated catch certificates – and processing certificates in cases where the products have undergone processing before importation.

The US-SIMP currently covers 13 groups or species of marine resources, of which sharks is one. While the SIMP is not based on a certification system that spans the entire supply chain, seafood importers are obliged to exercise due diligence, and to know (and document) from which fisheries and which vessels the imported catches have been derived.[169]

Criticisms have been leveraged at both these programs over the years, arguing that the traceability systems on which they are built are too easy to fraud, and that their capacity to effectively lower the importation of IUU-products is limited (and has not been demonstrated), and that the multilateral catch documentation schemes are better positioned to achieve the expected results (*e.g.* Hosch, 2016). It is unlikely that these programs provide great protection to sharks, while currently no multilateral CDS covering sharks exist.

[168] See: https://timesofmalta.com/articles/view/eu-starts-legal-action-against-malta-over-bluefin-tuna-irregularities.792323

[169] See: https://www.fisheries.noaa.gov/international/seafood-import-monitoring-program

Both Japan[170] and Korea are in the process of developing their unilateral CDS programs also. The Japanese program is currently the most advanced and should come online by the end of 2022. It is currently not poised to cover any shark species.

J.3 Asia – Taiwan, Japan and Indonesia

These three Asian nations account for an estimated 48% of global blue shark catches.[171] Japan was the first of these to develop its NPOA-Sharks in 2001, updating it twice since, once in 2009, and then again in 2016. Indonesia also has one in place, developed in 2010, and revised in 2015. Taiwan developed its NPOA-Sharks in 2006, and it does not appear to have been revised or updated since. These plans, and their revisions, show that a certain amount of stock-taking with regards to the conservation and management of shark resources has been occurring in these important shark fishing nations for well over a decade already. The improved collection of shark data (harvest and trade) are ubiquitous monitoring measures proposed in these instruments.

Since 2008, a regulation has been in force in Taiwan, which prohibits the targeted catching of a number of threatened sharks by ocean basin / RFMO competence. None of these includes blue shark. Since 2013, shark finning aboard Taiwanese fishing vessels is also banned, and sharks must be landed with fins naturally attached. Earlier (2004-2008) ultra-low shark CPUE data in Indian ocean longline fisheries suggest that finning, discarding and misreporting was a very serious challenge in Taiwanese longline fisheries (Worm *et al*. 2013) before the instruments above were put in place. Importantly, Taiwan underwent a profound regulatory reform following its EU yellow card in 2015 (lifted in 2019), resulting in heavy fines for IUU operators in distant water fisheries.[172]

Japan also has in place a finning ban, requiring operators to land shark with fins naturally attached. Japan has also, throughout the years, proposed several shark conservation and management measures in t-RFMOs (e.g. at the 82nd meeting of IATTC in 2011, Japan submitted the proposal to prohibit retaining onboard Oceanic Whitetip Sharks), including – as noted above – subjecting sharks to CDS-regimes.

Indonesia has been protecting a range of threatened sharks by prohibiting their exportation through legislation that is periodically reviewed since 2014. This does not cover blue shark but shows that unilateral trade-related measures focusing on the banning of given domestic exports within the national market can – and are being trialled.

[170] See: http://www.seafdec.org/documents/2022/04/54cm-wp07-5.pdf

[171] Estimate as per this study

[172] Penalties are laid down in Chapter IV (Penal Provisions) of the Distant Water Fishing Act of 2016. They include prison terms of up to 3 years, compounded by "criminal fines" set between EUR178,000 and EUR1,780,000. Such sanctions reflect those of other countries sometimes provided for foreign poaching in national waters. Penalties for serious infringements (including illegal transshipments) are layered by vessel tonnage (art. 36), and include very stiff fines of the order indicated above, a suspension of the fishing license for up to 2 years – or a permanent revocation – and in cases where the catch is worth more than the maximum penalty, the penalty is set at 5 times the value of the catch. Also, the catch, the fishing gears and the fishing vessel used in the commission of a serious offence may be confiscated also.

J.4 Congo and Ghana: developing countries with major shark fisheries

The Congo and Ghana are examples of developing countries with major shark fisheries. Congo has been the 4th largest hammerhead sharks (NEI) harvester globally since 2007. Ghana has one of the most important shark meat markets in West Africa where shark meat commands a high price. Ghana is a member of ICCAT, but Congo is neither a contracting, nor a cooperating non-contracting party. Many developing countries lack the resources to actively engage with regional management fora. Ghana is a member of 1 ICCAT committee, while developed fishing nations are members of 4. Were NPOAs to be adopted (as many developing countries have), these states face many challenges in effectively implementing the NPOA. Staff resource, capacity and budget constraints mean that they struggle to collect and report detailed and complete catch data for many species, including shark, which cannot then inform effective, sustainable management of their shark fisheries.

Congolese fishermen target and catch important volumes of shark – 1,767 t in 2017[173] – 95% of which are caught by artisanal fishermen and representing one third of the overall annual small-scale harvest. 15 of the 42 species of sharks and rays landed are listed in CITES Appendix II, while many more are listed as threatened on the IUCN Red List. Blue shark is understood to be a minor species in the catch, which is dominated by hammerhead shark species (Momballa, 2022).

The Congo is a party to both CITES and the CMS, as well as being a signatory to the related Sharks MOU (see above). Still, despite the paramount environmental, social and economic importance of sharks to the Congo, the administration has yet to provide a framework for the biological management of the resource, and/or to translate the provisions of CITES and the CMS into national law, and/or to develop an NPOA-Sharks, first envisaged 22 years ago (Momballa, 2022). Seidu *et al*. (2022) report a very similar situation for Ghana, with the difference that blue shark is the most important species harvested in the west of the country.

[173] Note that of this catch, only 471 t (*i.e*. 26.7%) were reported to FAO, and no catch to ICCAT as Congo is neither a contracting, nor a cooperating non-contracting party.

Windrush, Warborne Lane
Portmore, Lymington
Hampshire SO41 5RJ
United Kingdom

Telephone: +44 1590 610168
rod@consult-poseidon.com
http://www.consult-poseidon.com