AC33 Doc. 41 (Rev. 1)
Annex 5
English only

DEEP DIVING INTO SHARK CATCH AND TRADE MISMATCHES

Prepared under Decision 19.223 paragraph c)

Convention on International Trade in Endangered Species of Wild Fauna and Flora

Draft version 1.

Prepared under contract for the CITES Secretariat by TRAFFIC and Deakin University.

Citation: CITES Secretariat (2024). *Deep diving into shark catch and trade mismatches.*

Cover image: Adobe stock

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Acknowledgments
This study has been developed by the CITES Secretariat in accordance with Decision 19.223 paragraph c) on *Sharks and rays (Elasmobranchii spp.)* of the 19th meeting of the CITES Conference of the Parties (CoP19, Panama City, 2022).

The Secretariat appreciates the crucial role and dedication of Glenn Sant at TRAFFIC International and C. Samantha Sherman and J.J. McCausland at Movement, Ecology, and Management of Elasmobranchs Lab, Deakin Marine Research and Innovation Centre, Deakin University in the preparation of this study. Thanks are also extended to the Food and Agriculture Organization of the United Nations, Nicola Okes (TRAFFIC) and Daniel Kachelriess for their critical discussion, input and review.

Funding
The preparation of this study was made possible thanks to the generous financial contribution of the European Union.

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1. EXECUTIVE SUMMARY

Background

Since 2003 with the inclusion of the first shark species in the CITES Appendices, the number of sharks, rays, and chimaeras, hereafter 'sharks', in the CITES Appendices have increased significantly. In 2019, at the 18th meeting of the Conference of the Parties (CoP18, Geneva, 2019), CITES Parties adopted Decision 18.211 requesting a mismatch review due to concerns that trade data reported by Parties did not match expert expectations and that international trade in CITES-listed sharks may be going undetected and unreported.

In January 2022, TRAFFIC published a largely qualitative report *Missing Sharks* (Okes & Sant 2022) showing, among other findings, that there was minimal reporting of international trade for CITES-listed shark species in the CITES Trade Database compared with what was being reported by Parties as catch prior to their listing in the CITES Appendices. At the 19th meeting of the Conference of Parties (CoP19, Panama City, 2022), CITES Parties adopted Decision 19.223 paragraph c), which requested a further examination of the mismatch in data.

This study aims to provide the further study requested in Decision 19.223 paragraph c) and includes an analysis of Elasmobranchii species listed on the CITES Appendices prior to and during the 17th meeting of the Conference of Parties (CoP17, Johannesburg, 2016) and the two *Isurus* species listed at the 18th meeting of the Conference of Parties (CoP18, Geneva, 2019).

Data Used

In order to select datasets that would be most informative of catch, only catch data from FAO and the three tuna Regional Fisheries Management Organisations (RFMOs) with publicly available disaggregated catch data (catch by Flag State) were considered (Indian Ocean Tuna Commission [IOTC], Inter-American Tropical Tuna Commission [IATTC] and International Commission for the Conservation of Atlantic Tunas [ICCAT]). These four datasets include the most countries and species. Catch reporting was considered from 1993, ten years prior to the first listing of an elasmobranch on CITES, until 2021 (the most recent year with data available from all databases).

Multiple sources of international trade data for shark and ray products were used including the:

- CITES Trade Database;
- FAO Trade Database;
- Hong Kong Special Administrative Region of China Census and Statistics Department Database; and
- UN Comtrade Database.

Methods

Catch and trade were compared by country, species, and a combination of species and country to determine if certain species or countries are more likely to have catch or trade that is not accounted for. Similarly, by looking at both country and species, it could be determined if certain countries are only reporting trade of some CITES-listed species.

Identifying possible sources of mismatch was completed through three types of analyses:

- Data from pre- and post-CITES listing catch averages were compared and matched with pre- and post-CITES listing trade data. This was done for data from all sources to determine possible sources of “missing sharks”;
- Comparisons of catch, landing, and trade data reported to general categories (i.e., “shark” or “shark/ray”) pre- and post-CITES listing were compared. If reporting to general categories increased, the level of species- or genus-specific reporting over the same time period was compared. This indicates if countries are reporting their CITES-listed catches and trade to general categories post-listing; and
- Patterns in trade pre-CITES listing were compared to post-CITES listing data and the CITES trade database to identify further sources of missing sharks to indicate trade that may not be reported.

High level summary

The study identified that the possible sources of mismatch are:

- the use of different units to report shark and ray trade recorded in the CITES Trade Database and in databases managed by FAO, IOTC, IATTC and ICCAT;
- underreporting of exports and introduction from the sea of CITES-listed shark and ray species;
- lack of clarity of the requirements of reporting under various scenarios of catch in the Economic Exclusive Zone (EEZ) of a Party and in ABNJ; and
- differences in reporting of catch from territories and provinces in different databases (under CITES, the Party reports all catch from its dependent territories and provinces, but in other databases each territory may report separately).

2. INTRODUCTION

Since 2003 with the inclusions of the first shark species in the CITES Appendices, the number of sharks, rays, and chimaeras, hereafter 'sharks'[1], in the CITES Appendices have increased significantly. In 2019, at the 18th meeting of the Conference of the Parties (CoP18, Geneva, 2019), CITES Parties adopted Decision 18.211 requesting a mismatch review due to concerns that trade data reported by Parties did not match expert expectations and that international trade in CITES-listed sharks may be going undetected and unreported:

Directed to the Secretariat

18.221 *The Secretariat shall, subject to external funding, and in collaboration with relevant organizations and experts:*

a) *conduct a study to investigate the apparent mismatch between the trade in products of CITES-listed sharks recorded in the CITES Trade Database and what would be expected against the information available on catches of listed species; and*

b) *bring the results of the study in paragraph a) to the attention of the Animals Committee or Standing Committee, as appropriate.*

In January 2022, TRAFFIC published a largely qualitative report *Missing Sharks* (Okes & Sant 2022) showing, among other findings, that there was minimal reporting of international trade for CITES-listed shark species in the CITES Trade Database compared with what was being reported by Parties as catch prior to their listing within the Appendices of CITES. A summary of the report was shared with the 74th meeting of the Standing Committee in document SC74 Doc. 67.2 Annex 3 and the full report as information document SC74 Inf. 24.

At the 19th meeting of the Conference of Parties (CoP19, Panama City, 2022), CITES Parties adopted Decision 19.223 paragraph c), which requested a further examination of the mismatch in data:

Directed to the Secretariat

19.223 *Subject to external funding, the Secretariat shall*

c) *conduct a further study to look into the apparent mismatch between the trade in products of CITES-listed sharks recorded in the CITES Trade Database and what would be expected against the information available on catches of listed species, building on the study entitled Missing sharks: A country review of catch, trade and management recommendations for CITES- listed shark species and share both studies with proposed solutions to resolve this issue to the Animals Committee and Standing Committee, in a timely manner;*

In addition, the 32nd meeting of the Animals Committee (AC32, Geneva, June 2023) invited the CITES Secretariat to:

> *"consider the issues raised regarding the apparent mismatch between the trade in products of CITES-listed sharks recorded in the CITES Trade Database and what would be expected against*

[1] This follows the approach agreed by CITES Parties CITES Resolution Conf. 12.6 (Rev. CoP18) on the Conservation and management of sharks (see footnote therein).

the information available on catches of listed species in information document AC32 Inf. 3 when implementing Decision 19.223 paragraph c)"

This study aims to provide the further study requested in Decision 19.223 paragraph c) and includes an analysis of Elasmobranchii species listed on the CITES Appendices prior to and during the 17th meeting of the Conference of Parties (CoP17, Johannesburg, 2016), the two *Isurus* species listed at the 18th meeting of the Conference of Parties (CoP18, Geneva, 2019). This therefore also included an analysis of *Carcharhinus longimanus*, Oceanic whitetip shark, which was the focus of information document AC32 Inf. 3.

To investigate the apparent mismatch referred to in the decision, information available on catches of CITES listed-species in particular from international fisheries organisations (RFMO/FAO) and trade data from various sources were compared to identify mismatches. Shark catch data was identified from FAO and the three tuna RFMOs, which have publicly available data. For trade data, the CITES Trade Database, FAO Trade Database, Hong Kong Special Administrative Region (SAR) of China Census and Statistics Department and UN Comtrade Databases were considered. No attempt was made to convert product weights to live weights to compare catch and trade volumes. Similarly, no attempts were made to convert numbers of individuals caught to weights using conversion factors as was done by Pavitt et al. (2021) and Fordham et al. (2023) or reconstructed fisheries catches (i.e., Sea Around Us, 2016). There is known under-reporting in the databases used, however, the most conservative approach is to only include absolute data and not extrapolate as estimates are likely to vary in their precision between species and countries. Therefore, all discrepancies reported in this study are likely smaller than the true differences in catches and trades. As such, the results are firmly rooted in existing, well recognized data, but are limited to where such data is or has been available. For example, the study can identify cases where a country has reported species-specific catch of CITES-listed species pre-listing and then the share of species-specific reporting changes or stops. The study cannot identify or make assumptions about whether any country catches and or trades in CITES-listed species but has never reported it (except when reported by the importer).

3. METHODS

3.1 Definitions

The terms used in this study and their definitions can be found in the table below:

Term	Definition
Catch	All captured individuals (nominal catch)
Landings	All individuals landed
Discards	All individuals returned to the sea and not brought back to port
Aggregated Catch	Catches not specific to either a country or species (i.e. tonnage reported together with no way to determine the proportion caught by each country or caught of each species)
Disaggregated Catch	Specific catches to country or species level
NEI	not elsewhere included
Broad Group	group reporting of either genus or family level that cannot be disaggregated to species
Flag State	The flag being flown by a fishing vessel, regardless of the fishers nationalities

3.2 Species included in the analysis

For this report, Elasmobranchii species listed in the CITES Appendices prior to and during the 17th meeting of the Conference of Parties (CoP17, Johannesburg, 2016) and the two *Isurus* species listed at the 18th meeting of the Conference of Parties (CoP18, Geneva, 2019) were included. This included *Carcharhinus longimanus* (Oceanic whitetip shark), which is the focus of the recommendation by AC32. The full list of species included in this review and their entry into force date is shown in **Table 1**. These species were chosen by taking into consideration the length of time the species has been on the CITES Appendices to ensure availability of data, but also, the level of commercial trade to ensure that the top traded species were included. Species names across the different datasets were standardized to those in Table 1 to ensure comparison despite different standard nomenclature adopted by different entities. Different countries and databases change to the current names at different times, therefore, all names including synonyms and previous names are summed to avoid biases between databases or countries referring to the same species differently.

Table 1. Shark and ray species considered in this study. All species listed on CITES Appendix I and II prior to 2019 are included in addition to the two *Isurus* species (Mako shark species) listed at CITES CoP18. Names in brackets indicate previous names or synonyms and are all included in the summed catches as all databases and countries do not uniformly refer to these species.

Common Name	Latin Name	Appendix	Entry Into Force Date
Reef Manta Ray	*Mobula alfredi* (previously *Manta alfredi*)	II	14/09/2014
Oceanic / Giant Manta Ray	*Mobula birostris* (previously *Manta birostris*)	II	14/09/2014
Spinetail Devil Ray	*Mobula mobular* (synonym *Mobula japanica*)	II	04/04/2017
Bentfin Devil Ray	*Mobula thurstoni*	II	04/04/2017
Shorthorned Pygmy Devil Ray	*Mobula kuhlii*	II	04/04/2017
Munk's Pygmy Devil Ray	*Mobula munkiana*	II	04/04/2017
Longhorned Pygmy Devil Ray	*Mobula eregoodoo* (previously *Mobula eregoodootenkee*)	II	04/04/2017
Atlantic Pygmy Devil Ray	*Mobula hypostoma*	II	04/04/2017
Sicklefin Devil Ray	*Mobula tarapacana*	II	04/04/2017
Pelagic Thresher	*Alopias pelagicus*	II	04/10/2017
Common Thresher	*Alopias vulpinus*	II	04/10/2017
Bigeye Thresher	*Alopias superciliosus*	II	04/10/2017
Scalloped Hammerhead	*Sphyrna lewini*	II	14/09/2014
Great Hammerhead	*Sphyrna mokarran*	II	14/09/2014
Smooth Hammerhead	*Sphyrna zygaena*	II	14/09/2014
Longfin Mako	*Isurus paucus*	II	26/11/2019
Shortfin Mako	*Isurus oxyrinchus*	II	26/11/2019
Largetooth Sawfish	*Pristis pristis* (synonyms *Pristis microdon, Pristis perotteti*)	I	13/09/2007
Green Sawfish	*Pristis zijsron*	I	13/09/2007
Smalltooth Sawfish	*Pristis pectinata*	I	13/09/2007
Dwarf Sawfish	*Pristis clavata*	I	13/09/2007
Narrow Sawfish	*Anoxypristis cuspidata*	I	13/09/2007
Basking Shark	*Cetorhinus maximus*	II	13/02/2003
Whale Shark	*Rhincodon typus*	II	13/02/2003
Oceanic Whitetip Shark	*Carcharhinus longimanus*	II	14/09/2014
Silky Shark	*Carcharhinus falciformis*	II	04/10/2017
Porbeagle	*Lamna nasus*	II	14/09/2014
White Shark	*Carcharodon carcharias*	II	12/01/2005

3.3 Fisheries Catch

Only catch data from FAO and the three tuna Regional Fisheries Management Organisations (tRFMOs) with publicly available disaggregated catch data (catch by Flag State) were used (Indian Ocean Tuna Commission [IOTC], Inter-American Tropical Tuna Commission [IATTC] and International Commission for the Conservation of Atlantic Tunas [ICCAT]) in the study, but various sources were identified and reviewed. The following section contains a detailed description of the process followed to determine which databases with global coverage and publicly available disaggregated catch data for most countries and species could be used to inform the study.

To identify catch and landing data for the CITES-listed Elasmobranchii species in Table 1, international databases and publicly available sources were identified and searched. Catch data disaggregated by flag state were available and accessible from the following eight international databases and the FAO:

- FAO - Food and Agriculture Organisation
- GFCM - General Fisheries Commission for the Mediterranean
- IATTC - Inter-American Tropical Tuna Commission
- ICCAT - International Commission for the Conservation of Atlantic Tunas
- ICES - International Council for the Exploration of the Sea
- IOTC - Indian Ocean Tuna Commission
- NAFO - Northwest Atlantic Fisheries Organization
- SEAFDEC - Southeast Asian Fisheries Development Center
- SPRFMO - South Pacific Regional Fisheries Management Organisation

Access dates and sites used for the datasets reviewed are available in **Table 2**.

CCSBT (Commission for the Conservation of Southern Bluefin Tuna) and WCPFC (Western & Central Pacific Fisheries Commission) have relevant datasets but requests for access were denied for this study. Some of these datasets, (i.e., FAO, GFCM, ICCAT, IOTC, and SEAFDEC) allowed for the selection of catch statistics according to a broad 'sharks and rays' category, whereas all other datasets necessitated manual attempts to filter out non-elasmobranch species. All code used for filtering datasets is available in a GitHub repository (https://github.com/sammsherman27/MissingSharks2).

The catch reporting differed between databases for species and catch type (i.e., retained/landed, discarded, or both combined). There were differences in which species were reported, as well as the taxonomic resolution of reporting (**Table 3**). For example, ICCAT and SPRFMO reported catch with separate datasets for each of retained and discarded catch. Several organisations offered multiple separate datasets, with IATTC providing a broader dataset of 'various sharks' catch dating back to 1918, SPRFMO providing a higher species resolution dataset dating back to 1987 (but not containing discards) and a newer dataset dated 2007-current with more limited species containing both disaggregated harvest and discard. ICES provided two datasets, a historical record from 1950-2010 and contemporary statistics from 2006-2021. However, the level of duplication contained within these datasets is unclear, particularly given their overlapping years, which limited their use as an aggregated summary of catch. Similarly, in some databases, discards were separated from retained catch. However, in others, the total catch is reported (including discards). Additionally, there have been clear differences in the reporting requirements and detail through time. In some databases, these differences are dealt with through multiple datasets being available, though comparisons across the two datasets may not be informative (**Table 3**). Species not included in Table 3 were not mentioned in the FAO and RFMO databases and so were only included in the analysis as broad groups (e.g. Pristidae species are not found in the database but included under Pristidae spp.

Table 2. Access dates and sources for catch data reviewed for possible use to inform this study

Database	Access Date	Link / Source
Indian Ocean Tuna Commission (IOTC) Catch Data	25/10/2023	https://iotc.org/
FAO Catch Statistics	18/10/2023	FishStat J
International Convention for the Conservation of Atlantic Tuna (ICCAT) Catch Data	26/10/2023	https://www.iccat.int/en/accesingdb.HTML
Inter-American Tropical Tuna Commission (IATTC) Catch Data	25/10/2023	https://www.iattc.org/
Southeast Asian Fisheries Development Center (SEAFDEC) Catch Data	30/10/2023	http://www.seafdec.org/
International Council for the Exploration of the Sea (ICES) Catch Data	27/10/2023	https://www.ices.dk/
General Fisheries Commission for the Mediterranean (GFCM) Catch Data	3010/2023	https://www.fao.org/gfcm/en/
Northwest Atlantic Fisheries Organization (NAFO) Catch Data	29/10/2023	https://www.nafo.int/
South Pacific Regional Fisheries Management Organisation (SPRFMO) Catch Data	29/10/2023	https://www.sprfmo.int/

Table 3. Species level reporting of each database as well as if the data included discards. Though a database may contain species-specific reporting of a species, catches of this species may also be found in broader, aggregated categories. Y - yes, N - no, M - maybe (i.e., some countries report with, some without discards).

Species	FAO	IATTC	ICCAT	IOTC	ICES	GFCM	NAFO	SEAFDEC	SPRFMO
Alopias pelagicus	Y	N	Y	Y	N	N	N	N	N
Alopias superciliosus	Y	N	Y	Y	Y	Y	N	N	N
Alopias vulpinus	Y	N	Y	Y	Y	Y	N	N	Y
Carcharhinus falciformis	Y	Y	Y	Y	Y	N	N	N	N
Carcharhinus longimanus	Y	Y	Y	Y	Y	N	N	N	Y
Carcharodon carcharias	Y	N	Y	N	Y	N	N	N	Y
Cetorhinus maximus	Y	N	Y	N	Y	Y	Y	N	Y

Isurus oxyrinchus	Y	Y	Y	Y	Y	Y	Y	N	Y
Isurus paucus	Y	N	Y	Y	Y	N	N	N	Y
Lamna nasus	Y	N	Y	Y	Y	N	Y	N	Y
Mobula birostris	Y	N	Y	Y	N	N	N	N	N
Rhincodon typus	Y	N	Y	Y	N	N	N	N	N
Sphyrna lewini	Y	Y	Y	Y	Y	N	N	N	N
Sphyrna mokarran	Y	Y	Y	Y	N	N	N	N	N
Sphyrna zygaena	Y	Y	Y	Y	Y	N	N	N	Y
Includes discards?	N	M	Y	N	N	M	N	N	Y
Includes EEZ catch?	Y	Part	Part	Part	Y	Y	Part	Y	Y

Having considered all the catch datasets, there are few that include global catch with high resolution of both species and country-specific catches. Therefore, only the databases with global coverage with publicly available disaggregated catch data were considered: FAO and three of the tuna RFMOs. These four datasets include the most countries and species. Similarly, there is no overlap between the three RFMOs (IATTC, IOTC, ICCAT), as their fishing grounds are distinct, split by ocean basin and collectively have global coverage (IOTC: Indian Ocean; IATTC: Eastern Pacific Ocean, from Canada, in the north, to Chile, in the South; ICCAT: Atlantic Ocean and Mediterranean Sea). Other global datasets (i.e., FAO Catch Statistics) may include duplicates of catch reports to the tRFMOs. Catch reporting was considered from 1993, ten years prior to the first listing of an elasmobranch on CITES, until 2021 (the most recent year with data available from all databases).

IATTC, IOTC and ICCAT data were merged into a single RFMO dataset containing reported catch from 1993-2021, despite some differences in the species reported and group names for non-species-specific catch (**Table 4**). Several assumptions were made in the merging of this data:

- *Longline datasets* - merging of IATTC's two longline datasets (metric tonne and number of individuals) would introduce duplication - as such, only the metric tonne data was incorporated into the purse seine catch statistics. IATTC was contacted for clarification on this interpretation and validated that some duplication would be incurred through the use of both metric tonne and numbers-recorded data. However, this also means not all catches are captured in the catch statistics used in this report.
- *Catch referred to nominal catch* - IATTC confirmed that ambiguity exists within their data as to a sharks' fate (i.e., retained, live discards, or dead discards), and that 'catch' may be interpreted differently between countries to either include or omit discard. Given the reporting of IATTC shark data in both number and weight formats, the omission of a dataset necessitated some data loss. For IOTC, it was similarly assumed that catch referred to nominal catch, as is referenced in Resolution 10/02 - *Mandatory Statistical Requirements for IOTC Members and Cooperating Non-Contracting Parties (CPC's).* In several instances, catch was recorded as "NEI.FRESH", "NEI.FROZEN," or "NEI.PARTYA.EEZ" as opposed to the normal recording as a country. An

explanation for this was not found, therefore, these were revised to “Unrecorded” for the first two and “Party A” for the last one. Unrecorded matches with other catches in the IOTC database that were not reported as being caught by any country. Therefore, those data were not used in this report.

- *Countries had not reported the same catch to multiple RFMO’s* – countries had not reported the same catch to multiple RFMO’s, hence inducing duplication given the geographic separation of the Convention areas. Similarly, it was assumed that the RFMO catch was contained within the catch reported to FAO. RFMO catches include catch in ABNJs and catch within EEZs of both the reporting country and their flagged vessels operating in other countries’ EEZs.
- *Location of catch* - FAO data is reported as the total catch of vessels flagged to the reporting country, regardless of where the catch is occurring (i.e. including foreign EEZs and ABNJs)

Table 4. List of reported CITES-listed species in each dataset considered (FAO, IATTC, ICCAT, and IOTC). The aggregated categories column includes a list of the reporting terms used by the database that were included in this report for genus or family level analyses.

Species / Group	Database	Species-Specific Reporting	Aggregated Categories
Sphyrnidae	FAO	*Sphyrna mokarran; Sphyrna lewini; Sphyrna zygaena*	Hammerhead sharks nei; hammerhead sharks, etc. nei
	IATTC	*Sphyrna mokarran; Sphyrna lewini; Sphyrna zygaena; Sphyrna tiburo; Sphyrna corona; Sphyrna media*	Hammerhead sharks nei
	ICCAT	*Sphyrna mokarran; Sphyrna lewini; Sphyrna zygaena; Sphyrna tiburo*	*Sphyrna* spp.; Sphyrnidae
	IOTC	*Sphyrna mokarran; Sphyrna lewini; Sphyrna zygaena*	Hammerhead sharks nei; hammerhead sharks, etc. nei
Alopias spp.	FAO	*Alopias superciliosus; Alopias pelagicus; Alopias vulpinus*	Thresher sharks nei
	IATTC	*Alopias pelagicus*	Thresher sharks nei
	ICCAT	*Alopias superciliosus; Alopias pelagicus; Alopias vulpinus*	*Alopias* spp.
	IOTC	*Alopias superciliosus; Alopias pelagicus; Alopias vulpinus*	Thresher sharks nei
Isurus spp.	FAO	*Isurus paucus; Isurus oxyrinchus*	Mako sharks

Species / Group	Database	Species-Specific Reporting	Aggregated Categories
	IATTC	*Isurus paucus;* *Isurus oxyrinchus*	Mako sharks nei
	ICCAT	*Isurus paucus;* *Isurus oxyrinchus*	Only species-specific reporting - mako nei possibly included in broader shark and ray nei categories
	IOTC	*Isurus paucus;* *Isurus oxyrinchus*	Mako sharks
Mobulidae	FAO	*Mobula birostris*	Mantas, devil rays nei; mantas, devil rays etc. nei
	IATTC	None	No reporting - possibly included in broader shark and ray nei categories
	ICCAT	*Mobula birostris;* *Mobula thurstoni;* *Mobula tarapacana;* *Mobula mobular*	Mobulidae
	IOTC	*Mobula birostris*	Mantas, devil rays nei; Mobula nei
Pristidae	FAO	*Pristis pristis;* *Pristis clavata*	Sawfishes
	IATTC	None	No reporting - possibly included in broader shark and ray nei categories
	ICCAT	None	No reporting - possibly included in broader shark and ray nei categories
	IOTC	None	No reporting - possibly included in broader shark and ray nei categories
Cetorhinus maximus	FAO	Yes	N/A
	IATTC	No	
	ICCAT	Yes	
	IOTC	No	
Carcharodon carcharias	FAO	Yes	N/A
	IATTC	Yes	
	ICCAT	Yes	
	IOTC	No	
Rhincodon typus	FAO	Yes	N/A
	IATTC	No	

Species / Group	Database	Species-Specific Reporting	Aggregated Categories
	ICCAT	Yes	
	IOTC	Yes	
Lamna nasus	FAO	Yes	N/A
	IATTC	No	
	ICCAT	Yes	
	IOTC	Yes	
Carcharhinus longimanus	FAO	Yes	N/A
	IATTC	Yes	
	ICCAT	Yes	
	IOTC	Yes	
Carcharhinus falciformis	FAO	Yes	N/A
	IATTC	Yes	
	ICCAT	Yes	
	IOTC	Yes	

All shark and ray catch data from FAO was sourced through the FishStatJ software with the Global Capture Production dataset (1950-2021) (accessed October 18, 2023), referred to as the FAO Catch Statistics throughout this report.

In order to compare reporting of the catch of CITES-listed species, both species-specific reporting and "groupings" needed to be considered. Two-thirds of reported shark catch to FAO is reported as "Chondrichthyhan" or "elasmobranch" (Sherman *et al.* 2023). Similarly, there is a large amount of broad reporting to the RFMOs (either at the genus or family level). However, reporting requirements of different species differ through time and between RFMOs (**Supplementary Table 1**). Reporting categories that could only include the family or genus in question were considered. For example, broad hammerhead categories included "hammerheads nei," "*Sphyrna* spp.," and "Sphyrnidae" but did not include "large sharks," or "sharks nei," though these groupings may also include hammerheads. Therefore, the broad shark groupings beyond family level were not considered in analyses. This means the values presented in this report indicate the *minimum* catch / trade of CITES-listed species. Catch reporting to FAO should include *all* catch, therefore, the FAO dataset was compared to an aggregation of the three tuna RFMOs with publicly available data (IATTC, ICCAT, and IOTC).

3.4 Shark and Ray Trade

Multiple sources of international trade data for shark and ray products were identified. Some databases were identified where data were not publicly available or there was a low level of detail available publicly. Therefore, only four databases were used:

- CITES Trade Database

- FAO Trade Database
- Hong Kong SAR of China Census and Statistics Department
- UN Comtrade

To compare trade between all databases, species names were standardized to those in **Table 1**. For example, all records of *Pristis microdon* in all databases were converted to *Pristis pristis* even though the CITES standard nomenclature consider the two to be separate species.

The full list of databases used for this study and the access dates and sites used for the datasets are available in **Table 5**.

Table 5. Access dates and sources for the trade data used in this report.

Database	**Access Date**	**Link / Source**
FAO Trade Statistics	18/10/2023	FishStat J
CITES Trade Database	1/11/2023	Provided by CITES Secretariat
UN Comtrade Database	09/11/2023	https://comtradeplus.un.org/
Hong Kong SAR of China Customs and Excise Department - Shark Trade	13/11/2023	https://www.customs.gov.hk/en/home/index.html

CITES Trade Databases

All international trade of sharks and rays listed on the CITES Appendices requires the issuance of permits or certificates by the respective CITES Party. CITES definition of international trade includes "import, export, re-export, and introduction from the sea".

The Convention requires Parties to maintain records of international trade in CITES-listed species, including permits and certificates issued, and provide annual reports of that information to the Secretariat. The information in the annual reports is entered into the CITES Trade Database.

The CITES Trade Database includes fields for importer, exporter, origin, whether the trade was reported by the importer or exporter ('reporter'), the amount traded, unit, specimen type and the source and purpose codes.

Specimens of CITES-listed species taken from areas beyond national jurisdiction (ABNJ) is reflected in multiple ways in the CITES Trade Database. For the one-state transactions, where the same Party takes and subsequently transports specimens of CITES-listed species into its own territory, "HS" (=High Seas) is used as the exporter and the "State of introduction" as importer, with source code "X" for "specimens taken in the marine environment not under the jurisdiction of any State"[2]. In some cases, one state transactions were identified with the exporter being "HS" with source code "W".

For two-state transactions, where a Party takes specimens of CITES-listed species in ABNJ and subsequently transports and/or lands then at a different Party's territory, reporting in the CITES Trade

[2] CITES Guidelines for the preparation and submission of Annual reports (November 2023) (https://cites.org/sites/default/files/eng/reports/annual/E-AR-Guidelines-SC77.pdf) & A guide to using the CITES Trade Database Version 9 – September 2022 (https://trade.cites.org/cites_trade_guidelines/en-CITES_Trade_Database_Guide.pdf)

Database can be identified as follows: the Party taking specimens from ABNJ is the exporter and the Party in which the specimens are landed are importers with source code “X”.

For export and import, where one Party exports specimens of CITES-listed species and another Party imports them, two transactions could be recorded - one by the exporter and one by the importer. Importers are not required to issue import permits for CITES Appendix II listed species and therefore not all importers have reported imports in the CITES Trade Database. However, for all trade transactions involving two Parties, discrepancy between exporter-reported and importer-reported trade could be identified if an imported reported the transaction. This also allowed identification of transactions where the exporters had not reported international trade in CITES-listed species, but importers had.

For these analyses, all exports discussed in the Results section also include re-exports. One-state introduction from the sea transactions were not included in the analyses of whether countries were or were not reporting because this is a one-state transaction with no “importing” Party with which to compare the transactions.

Additionally, there are eleven instances where imports for purpose code “Q” (Circus or travelling exhibition) and purpose code “S” (Scientific) are included in the CITES Trade Database, but the exporter is listed as unknown. These rows only include importers and, therefore, were also not included in analyses of countries reporting export.

To determine the volume of international trade of CITES-listed sharks, the reported weights in the CITES Trade Database were used. This required cleaning of the database for multiple reasons. First, while the *Guidelines for the preparation and submission of CITES annual reports* requests that “For sharks and rays (Elasmobranchii spp.), weight (kg) should be used rather than number of items”, over half of the entries in the CITES Trade Database do not include traded weight (49.0%, n = 8.398 of 17,133 shipments). For this report, only trade reported with weights was used. Over one-third (34.7% of shipments) did not include any units and so assumed to be “number” (e.g. number of live animals) as per the Guidelines, 16.2% of shipments were recorded as number of specimens and the remaining shipments had units of either cm^3 or ml. In some cases, quantities are reported with no units by an exporter, but reported with units by the importer. In these cases, the unit reported by the importer was used for analyses. In some cases, the importer and exporter reported different species. Most of these cases are trade in Mobulids, where the exporter reports at the species level and the importer reports at the genus level. In these cases, the species reported by the exporter was used for analyses. In one case, under the same permit, the exporter reported a shipment of 135.5 kg of *Sphyrna lewini* and 30.3 kg of *Sphyrna mokarran*, but the quantities were reversed when reported by the importer. In this case, the quantities reported by the exporter were used for analyses.

Duplicates were removed from the database manually by excluding shipments with identical species, quantity, importer, exporter, and permit number. Duplicated rows included shipments reported by both the importer and exporter, therefore, their inclusion would have led to double counting of this trade. Rows with no permit numbers were all included as there is no way to determine if these are identical shipments or not. Duplicates. Duplicates included cases with rounding errors (e.g., reported by the exporter as 501.5 kg and the importer as 502 kg), cases where multiple shipments under the same permit were combined by one Party but reported separately by the other (e.g., two shipments under the same permit of the same species with volumes of 10 and 20 kg reported by the exporter, but only one shipment of 30 kg reported by the importer), and shipments with large differences in volumes reported by both Parties. In the latter cases, the value reported by the importer was used, as it was assumed to be the more accurate value. A full table of differences in shipment weights (>5 kg difference) under the same permit is available in **Supplementary Table 2**. Some differences are suspected to be due to human error when entering data. For example, one shipment of *Carcharhinus falciformis* is reported as 1,225.05 kg by the exporting Party and 1,255.05 kg by the importing Party. The difference in the 2 and 5 in the tens position may have been a typing error as the

numbers preceding and proceeding this were 2 and 5, respectively. Other discrepancies in the CITES Trade Database include the same permit numbers being used by different exporters and/or importers. A full list of discrepancies and the rows included in analyses is available in **Supplementary Table 3**.

To determine where missing catches and/or trade of sharks were, both catch from FAO and RFMOs and the cleaned data extracted from the CITES Trade Database were used. Weight recorded in the CITES Trade Database was converted to metric tonnes to allow for direct comparison with the catch reporting in the RFMO and FAO databases. As this comparison is for fishing-related trade, only rows with the 'purpose' codes "T" - Commercial, or blanks were used. Similarly, only rows with source codes "U" - source unknown, "W" - specimens taken from the wild, "X" - specimens taken in the marine environment not under the jurisdiction of any State, and blanks were considered. There were some instances where the same permit number was reported as "O" - pre-Convention specimens by one Party, but as another 'source' code by the other. In these cases, the precautionary approach was used, and the uncertainty of their pre-Convention status meant they were included in analyses. Some shipments are coded as "C" - animals bred in captivity. However, based on the size of the species, their husbandry requirements, and volume of trade, it is highly unlikely these were bred in captivity. There were only seven shipments coded as captive bred for commercial purposes. The shipments totalled 4,512.5 kg of skins, gill plates and fins of *Alopias* spp., Manta spp., *Sphyrna lewini,* and *Carcharhinus falciformis*. These were excluded from analyses as they are not coded as "W", "X" or "U".

The cleaned data extracted from the CITES Trade Database was analysed to determine the volume exported or re-exported of each species, by each country. These volumes were then compared to the catches reported by each country to FAO and the RFMOs with publicly available catch data.

In the cleaned data extracted from the CITES Trade Database, the trade by Parties and the dependent territories are reported together. However, for the three tRFMOs and in the FAO Catch Statistics, the catches for Parties and their dependent territories are reported separately. For these analyses, all catches in the RFMO/FAO databases were aggregated to the CITES Party names.

UN Comtrade

International trade information was downloaded through the 'advanced search' function from the United Nations Comtrade Database (hereafter, "Comtrade") database (https://comtradeplus.un.org/). Harmonized System (HS) codes that could only contain shark and ray species were considered when determining trade volumes. The full list of HS codes and search parameters are included in **Table 6**.

Table 6. Search parameters and Harmonized System codes included in the search for international trade of shark and ray products.

Parameter	**Selection**
Type of Product	Goods
Frequency	Annual
Classifications	HS

HS (as reported) Commodity Codes	• 030265
	  ○ Dogfish & other sharks, fresh/chilled (excl. fillets/other fish meat of 03.04/livers & roes)
	• 030281
	  ○ Fish; fresh or chilled, dogfish and other sharks, excluding fillets, fish meat of 0304, and edible fish offal of subheadings 0302.91 to 0302.99

	• 030282
	  ○ Fish; fresh or chilled, rays and skates (Rajidae), excluding fillets, fish meat of 0304, and edible fish offal of subheadings 0302.91 to 0302.99
	• 030292
	  ○ Fish; fresh or chilled, shark fins
	• 030375
	  ○ Dogfish & other sharks, frozen (excl. fillets/other fish meat of 03.04/livers & roes)
	• 030381
	  ○ Fish; frozen, dogfish and other sharks, excluding fillets, fish meat of 0304, and edible fish offal of subheadings 0303.91 to 0303.99
	• 030382
	  ○ Fish; frozen, rays and skates (Rajidae), excluding fillets, fish meat of 0304, and edible fish offal of subheadings 0303.91 to 0303.99
	• 030392
	  ○ Fish; frozen, shark fins
	• 030447
	  ○ Fish fillets; fresh or chilled, dogfish and other sharks
	• 030448
	  ○ Fish fillets; fresh or chilled, rays and skates (Rajidae)
	• 030456
	  ○ Fish meat; excluding fillets, whether or not minced; fresh or chilled, dogfish and other sharks
	• 030457
	  ○ Fish meat; excluding fillets, whether or not minced; fresh or chilled, rays and skates (Rajidae)
	• 030488
	  ○ Fish fillets; frozen, dogfish, other sharks, rays and skates (Rajidae)
	• 030496
	  ○ Fish meat, excluding fillets, whether or not minced; frozen, dogfish and other sharks
	• 030497
	  ○ Fish meat, excluding fillets, whether or not minced; frozen, rays and skates (Rajidae)
	• 030571
	  ○ Fish; edible offal, shark fins
	• 160418
	  ○ Fish preparations; shark fins, prepared or preserved, whole or in pieces (but not minced)

Reporters	All
Trade Flows	All
Periods (year, month)	1993-Current
Partners	All
2nd Partner	All
Modes of Transport	TOTAL modes of transport
Customs Codes	TOTAL customs procedure codes
Breakdown Mode	Plus
Aggregate By	Mode of Transport; Customs Code

Hong Kong, SAR of China - Census and Statistics Department

Hong Kong, SAR of China, is a well-known hub for trade of shark products, in particular shark fins (Cardeñosa, *et al.* 2022; Clarke *et al.* 2006; Fields *et al.* 2018). Available import data from the Hong Kong SAR of China Census and Statistics Department (https://www.censtatd.gov.hk/en/) on all shark fin imports (2012-2022) were downloaded. This data included the exporting country, which could then be compared to export reported to the UN Comtrade database.

3.5 Analysis for mismatch in data

To determine where missing catches and/or trade of sharks were, both catch and trade databases were used. Data is available only by calendar year, therefore, catch and trade from the first full year in which the CITES listing was effective for each species was considered. Exceptions were made for *Carcharodon carcharias, Cetorhinus maximus*, and *Rhincodon typus*, for which CITES-listings were all in effect by mid-February of their respective listing years.

Catch and trade were compared by country, species, and a combination of species and country to determine if certain species or countries are more likely to have catch or trade that is not accounted for. Similarly, by looking at both country and species, it could be determined if certain countries are only reporting trade of some CITES-listed species.

Identifying possible sources of mismatch was completed through three types of analyses:

1. Data from pre- and post-CITES listing catch averages were compared and matched with pre- and post-CITES listing trade data. This was done using FAO Catch Statistics and RFMO catches to determine possible sources of “missing sharks.”

2. Comparisons of catch and trade data reported to broad categories (i.e., “hammerhead nei” or “shark”) pre- and post-CITES listing were compared. If reporting to general categories increased, the level of species- or genus-specific reporting over the same time period was compared. This indicates if countries are reporting their CITES-listed catches and trade to more broad categories post-listing.

3. Patterns in trade pre-CITES listing were compared to post-CITES listing data and the CITES trade database to identify further sources of missing sharks to indicate trade that may not be reported.

4. RESULTS

4.1 Species-Specific Catch and Trade

Sphyrnidae

Reporting of Sphyrnidae to both FAO and RFMOs was largely done using broad categories, rather than species-specific ones (**Figure 1**). Figure 1 shows the percentage of Sphyrnidae catch reporting by category pre- and post-CITES listing in 2014 to FAO and RFMOs. After listing, the proportion of reporting to the broad category in FAO increased by 5%, while species-specific catch improved in RFMOs by 7%. There are however different patterns between FAO and RFMO in the way countries report, and which countries report to species levels (**Figure 2**). For example, Sri Lanka reported the majority of their Sphyrnidae catch to RFMOs at the species level. However, only a small amount is available in FAO to species level with a large portion of the Sri Lanka Sphyrnidae catch being grouped (**Figure 2** - pale yellow). Indonesia reports all Sphyrnidae catch to both FAO and RFMOs only as a broad grouping (**Figure 2** - bright blue). Oman began reporting their Sphyrnidae catch to RFMOs once they were listed on Appendix II. They report to species in most years, however, some years only report to the Sphyrnidae group (**Figure 2** - hot pink). Brazil reported Sphyrnidae catch to species level to FAO until the CITES-listing and reported to RFMOs at both the species and general group level until the CITES-listing, after which only general group level reporting was done. They have not reported any hammerhead catch since listing and do have a national ban on hammerhead retention (**Figure 2** - aqua green).

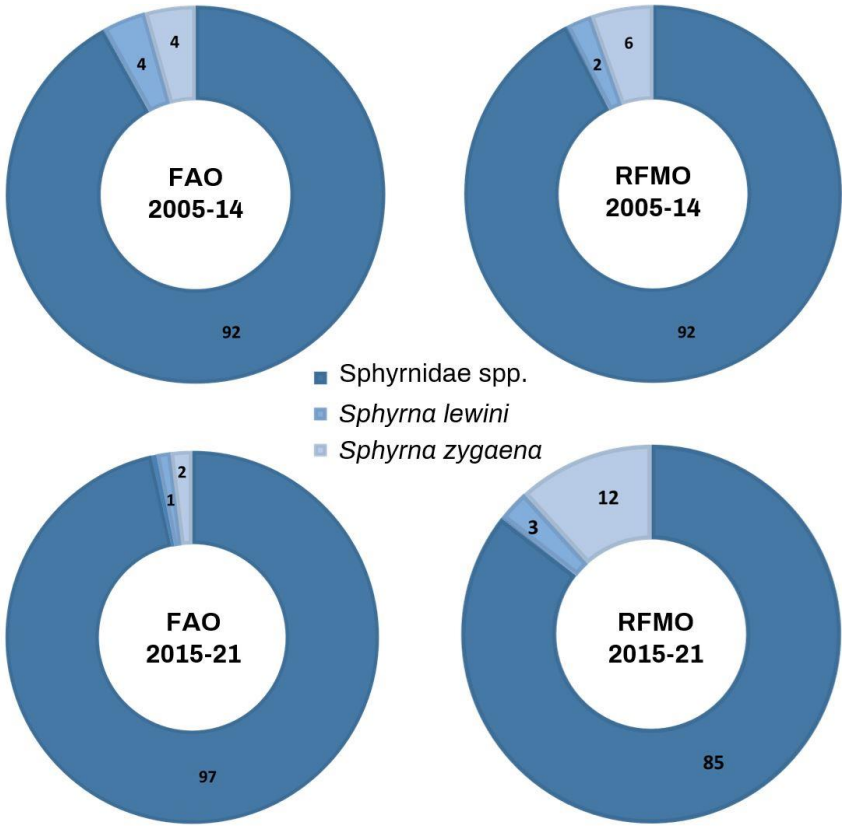

Figure 1. Percent of Sphyrnidae catch reporting by category pre- and post-CITES listing in 2014 to FAO and RFMOs. *Sphyrna mokarran* was reported to species, however, the volumes in all cases were so low that they were less than 0.5% of reported catch.

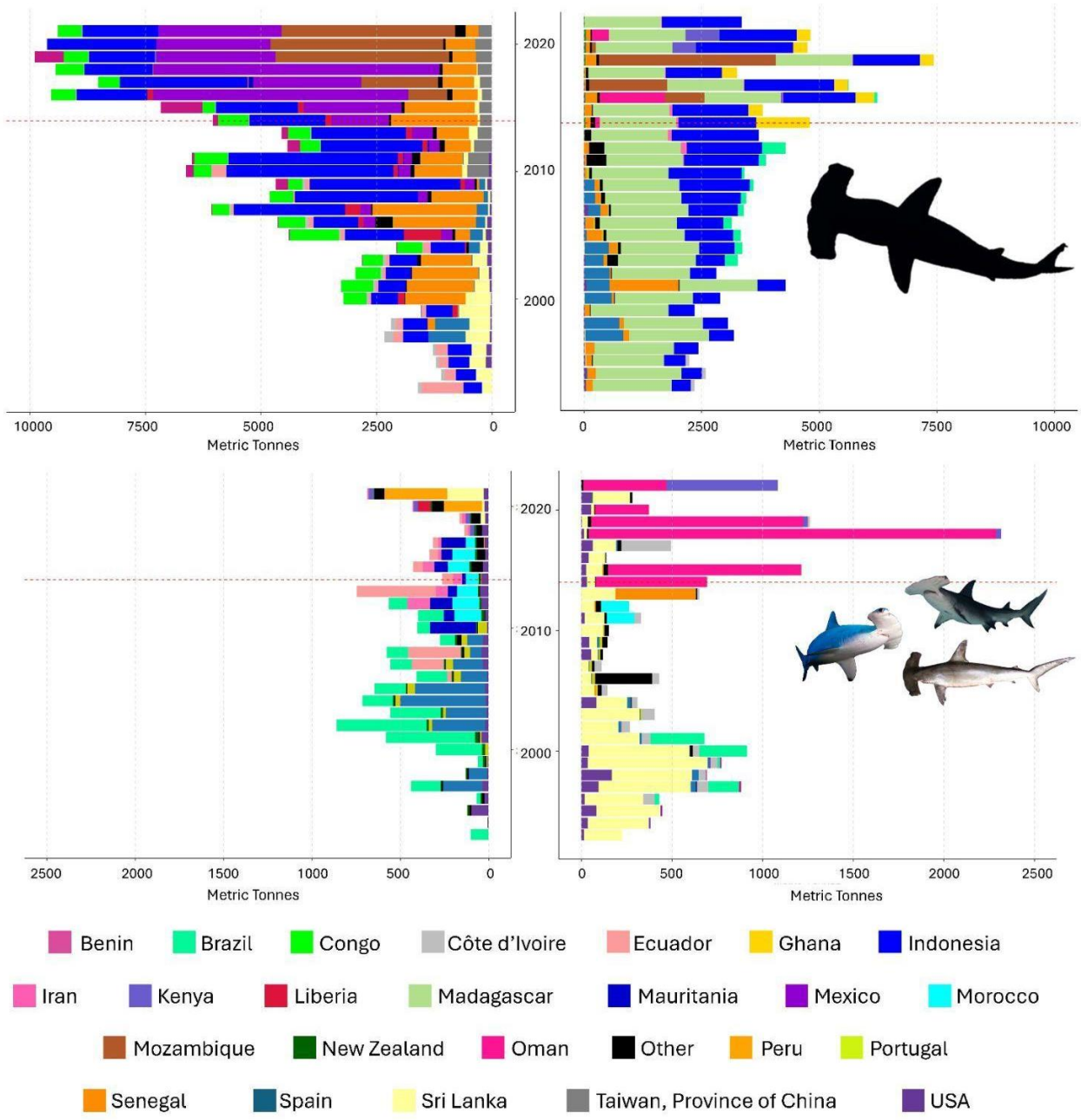

Figure 2. Total Sphyrnidae catch reported as "*Sphyrna* spp." (top) or to a specific species (bottom) by country or province to FAO (left) and RFMOs (right). Year of listing on CITES Appendix II is indicated by a dashed red line. *Images: Jim Abernathy, Masayuki Agawa / Ocean Image Bank.*

Reporting of hammerheads by species to both FAO and RFMOs was further analysed at the species level. *Sphyrna mokarran* contribute the least to the total species-specific reporting to both FAO and RFMOs (**Figure 3**). The United States of America reported small volumes of *Sphyrna mokarran* catch to RFMOs in the late 1990s and since their listing in 2014. However, reporting to FAO only began around the time the species was listed on CITES Appendix II (**Figure 3** - purple).

Sphyrna lewini was reported by Brazil to both FAO and RFMOs, however, the volumes reported do not match. This mismatch could be due to the RFMO dataset only including data from 3 tRMFOs. All reporting by Brazil stopped when the species was listed in the CITES Appendix II and a national ban on hammerhead catch was implemented (**Figure 4** - light green). Both Spain and Mauritania reported *Sphyrna lewini* catch to FAO for 6-8 years. However, despite being a member of all RFMOs, Spain reported very low volumes of *Sphyrna mokarran* and *Sphyrna zygaena* catch to the RFMOs for a few years, but larger volumes were recorded in the FAO database (**Figure 4 & 5** - dark blue). *Sphyrna zygaena* makes up all of the species-specific hammerhead reported to RFMOs by Oman (**Figure 5** - hot pink).

According to the cleaned CITES Trade Database, *Sphyrna mokarran* is exported by 36 Parties for "E", "L", "P", "Q", "S," and "T" purpose codes (**Table 7**). While the majority of the export is reported by the exporting Party, export from nine Parties is only reported by the importing Party (**Supplementary Table 4**). Concerning commercial export, there are 14 Parties with reported export of *Sphyrna mokarran*, with three only being reported by importers. Forty-three countries export *Sphyrna lewini* with eight being reported by importers. These numbers are reduced to 22 and four, when considering only commercial trade, respectively. *Sphyrna lewini* is traded under purpose codes "E", "P", "Q", "S", "T", "Z", and blank (**Table 7**). For *Sphyrna zygaena*, there are 21 countries with reported export in the CITES Trade Database with one being reported by importers (China; **Supplementary Table 4**). *Sphyrna zygaena* is traded under purpose codes "E", "P", "Q", "S", and "T" (**Table 7**). All except one of thirteen exporting Parties have reported commercial export of *Sphyrna zygaena*.

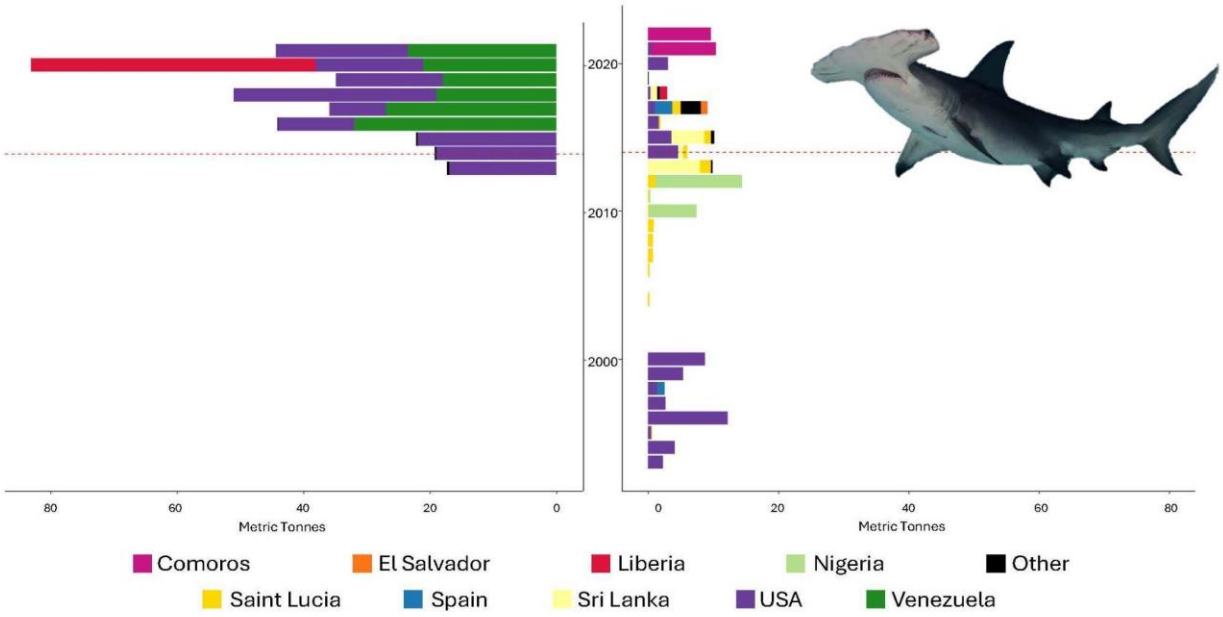

Figure 3. All countries and their reporting volumes of *Sphyrna mokarran* to FAO (left) and RFMOs (right). Year of listing on CITES Appendix II is indicated by a dashed red line. *Image: Jim Abernathy.*

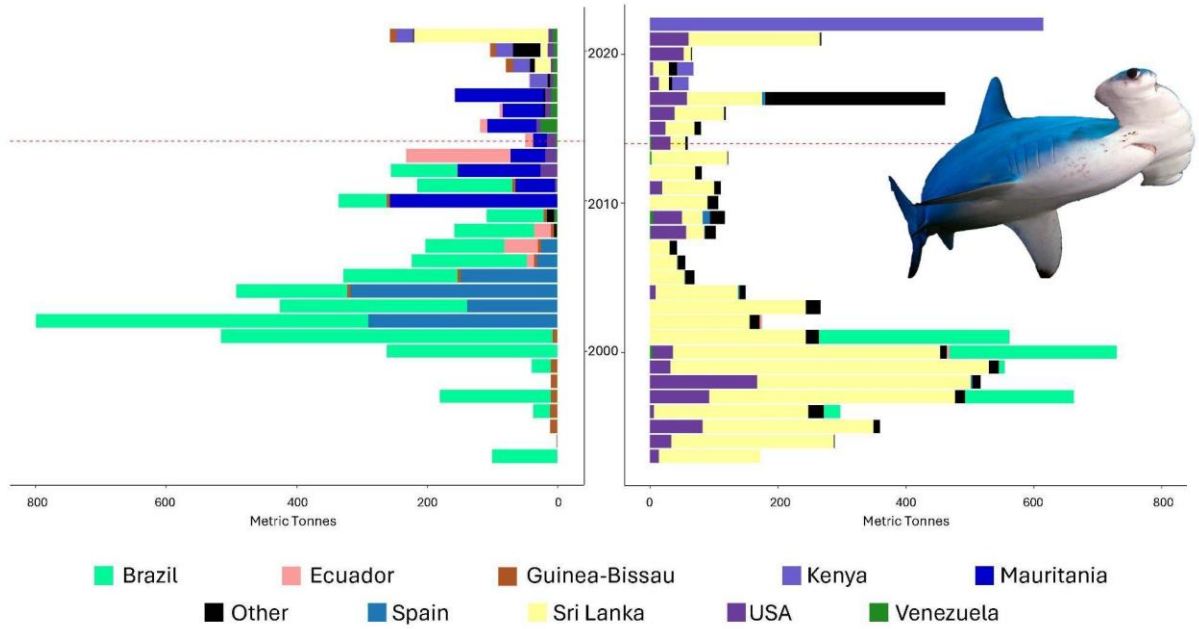

Figure 4. All countries and their reporting volumes of *Sphyrna lewini* to FAO (left) and RFMOs (right). Year of listing on CITES Appendix II is indicated by a dashed red line. *Image: Masayuki Agawa / Ocean Image Bank.*

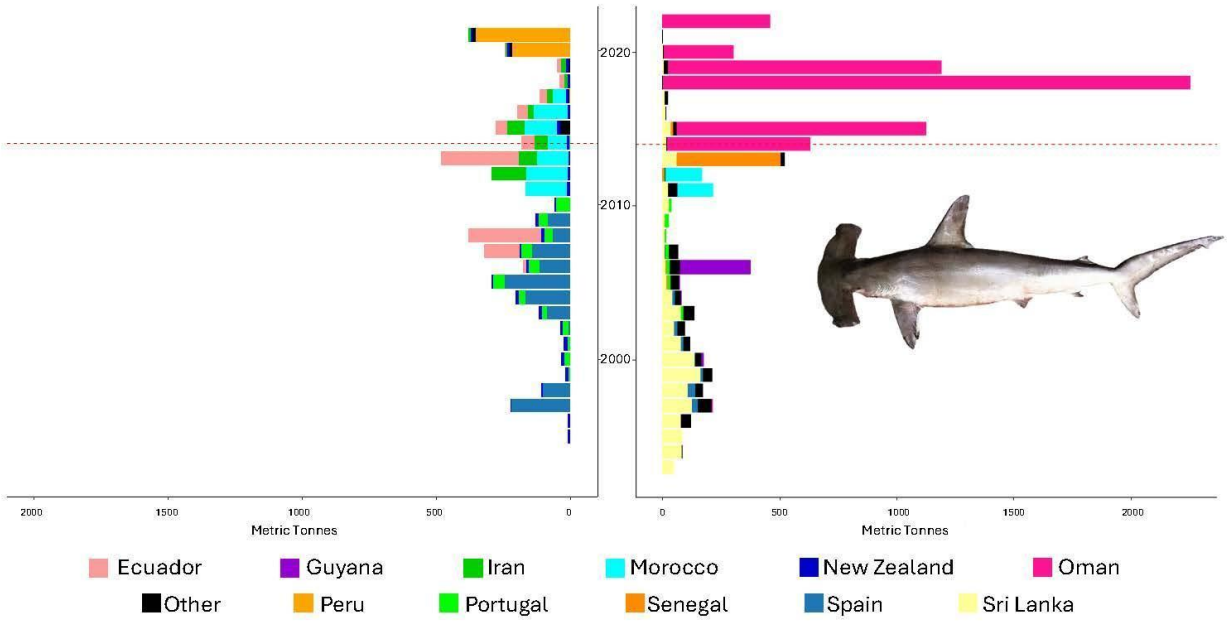

Figure 5. All countries and their reporting volumes of *Sphyrna zygaena* to FAO (left) and RFMOs (right). Year of listing on CITES Appendix II is indicated by a dashed red line. *Image: Australian National Fish Collection, CSIRO.*

Alopiidae

The majority of thresher shark catch was reported to both FAO and RFMOs as a broad category (**Fig. 6**). After listing, reporting to the broad "*Alopias* spp." category increased by 18% to FAO and 3% to RFMOs. In both datasets, reporting to broad category increased after their CITES-listing (**Fig. 6**). Although not all catch reported to RFMOs comes from ABNJ, the high proportion reported to the genus level is unlikely to be caught only within EEZs.

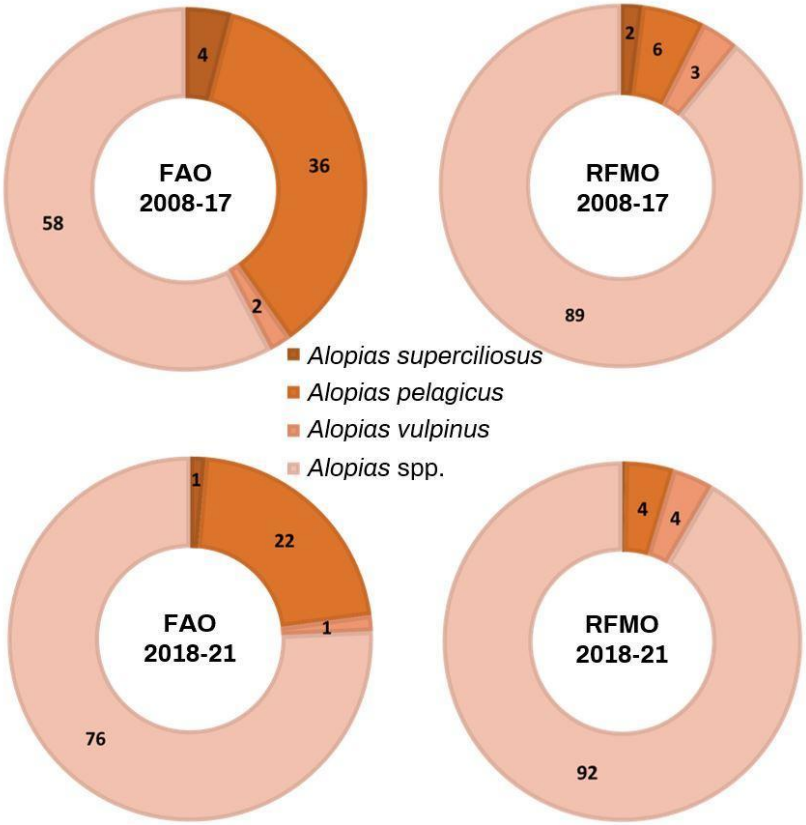

Figure 6. Percent of Alopiidae catch reporting by category pre- and post-CITES listing in 2017 to FAO and RFMOs.

In some countries, catches are reported for only one or two years. This may be due to capacity enhancing efforts to improve catch reporting of certain countries, however, further investigation is needed to confirm this hypothesis. For example, Algeria reports species-specific thresher shark catch in 2021 only. Similarly, Cote d'Ivoire only reports this in 2016 and 2017 (**Figure 7** - light purple and grey bars in bottom right panel).

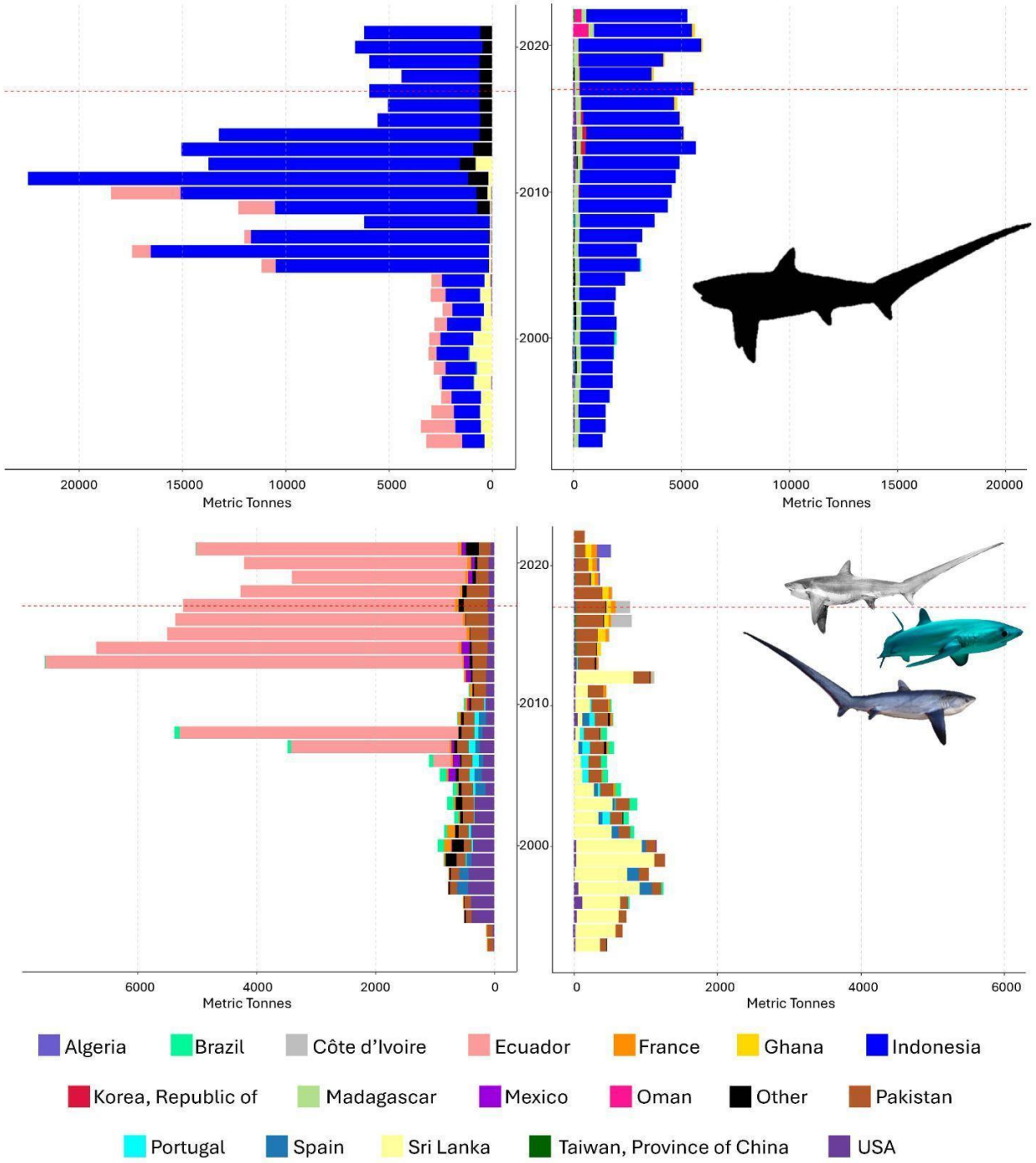

Figure 7. Total catch of Alopiidae reported as "*Alopias* spp." (top) or to a specific species (bottom) by country or province to FAO (left) and RFMOs (right). Year of listing on CITES Appendix II is indicated by a dashed red line. *Images: NOAA Fisheries Apex Predators Investigation, FAO Fish, & Australian National Fish Collection, CSIRO.*

Other patterns to note include Sri Lanka's reporting of *Alopias vulpinus* until 2011 (**Fig. 8 -** light yellow). After 2011, they report a large amount of *Alopias superciliosus* catch and some *Alopias pelagicus* catch (**Figs. 9 & 10 -** light yellow). After 2012, there is no species-specific reported catch from Sri Lanka to the

RFMOs (**Fig. 7 -** light yellow). None of their catch is captured as species-specific in the FAO Catch Statistics (**Fig. 7 -** light yellow). Several countries that report species-specific catch of Alopiidae to RFMOs, are not recorded at all as catching the family in the FAO Catch Statistics.

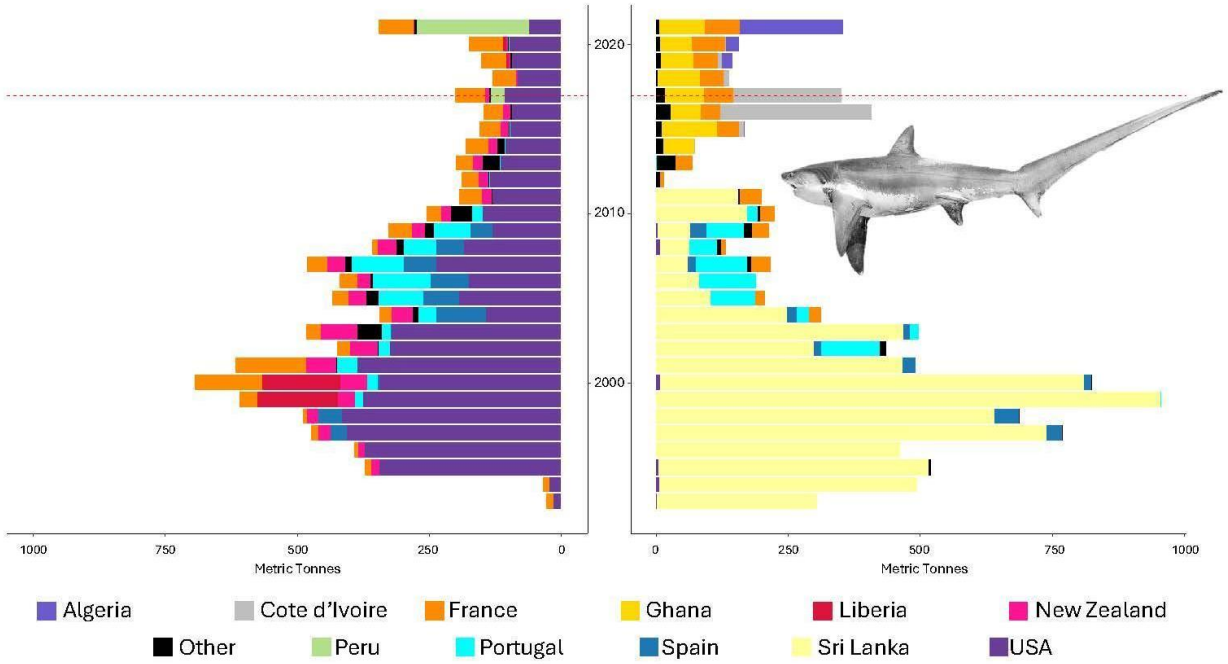

Figure 8. All countries and their reporting volumes of *Alopias vulpinus* to FAO (left) and RFMOs (right). Year of listing on CITES Appendix II is indicated by a dashed red line. *Image: NOAA Fisheries Apex Predators Investigation.*

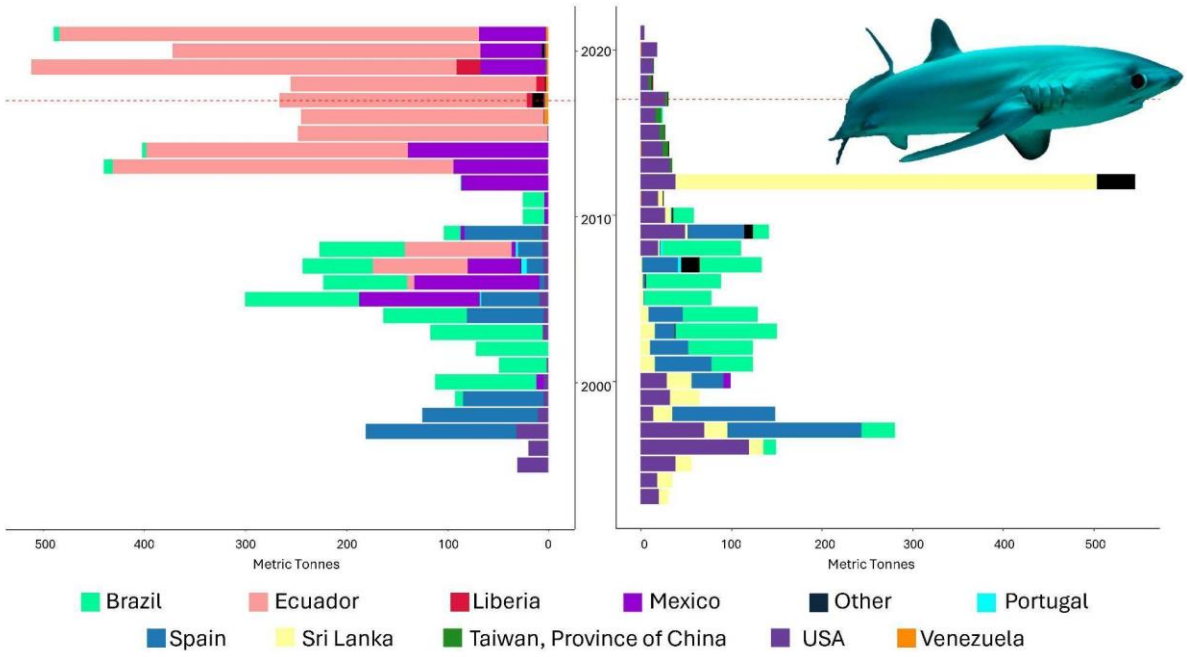

Figure 9. All countries and provinces and their reporting volumes of *Alopias superciliosus* to FAO (left) and RFMOs (right). Year of listing on CITES Appendix II is indicated by a dashed red line. *Image: FAO Fish.*

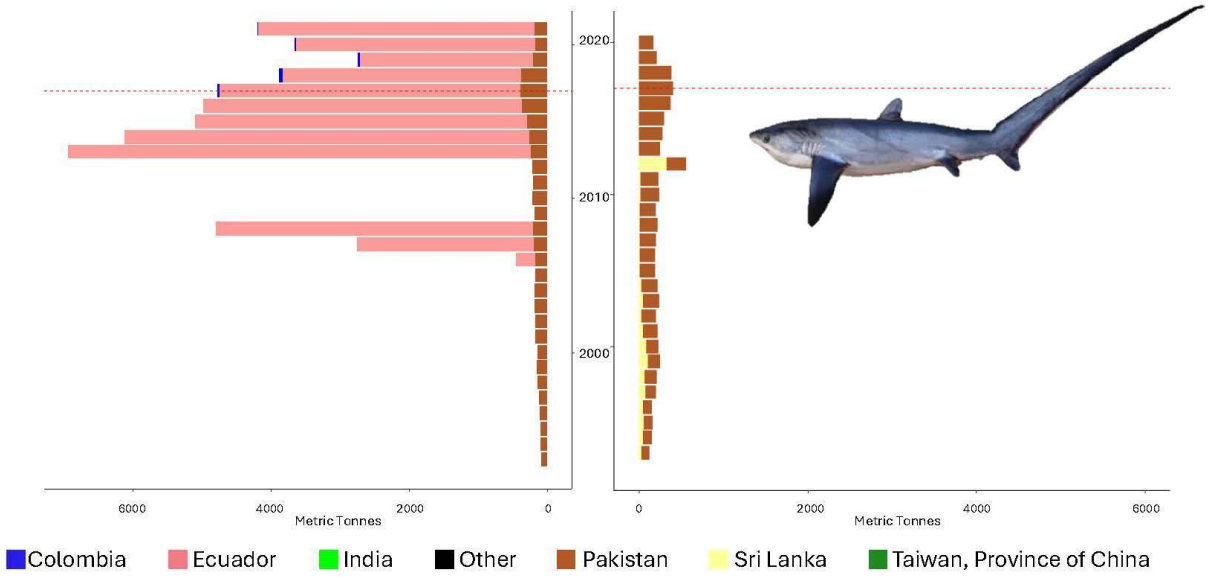

Figure 10. All countries and provinces and their reporting volumes of *Alopias pelagicus* to FAO (left) and RFMOs (right). Year of listing on CITES Appendix II is indicated by a dashed red line. *Image: Australian National Fish Collection, CSIRO.*

Despite differences in the countries reporting catch of *Alopias vulpinus* to RFMOs and FAO, the overall pattern of catches is similar, with a peak in 1999 before a steady decline and sudden increase in 2021 (**Fig. 8**).

According to the CITES Trade Database, *Alopias pelagicus* is exported by 18 Parties, but export from six Parties is only reported by the importing Parties (**Supplementary Table 4**). In terms of commercial trade, of the ten Parties that export *Alopias pelagicus*, two Parties are only reported by importing Parties. Other trade codes used for *A. pelagicus* includes: “E”, “Q”, “S”, “T”, blank (**Table 7**). Sixteen countries export *Alopias superciliosus* with four Parties only being reported by importing Parties. *A. superciliosus* is exported under trade codes “E”, “Q”, “S”, and “T” (**Table 7**). Less than half of those Parties (seven) commercially export *Alopias superciliosus*, and all exporters report at least some of their trade. For *Alopias vulpinus*, there are 21 Parties with reported export and export from seven Parties are only reported by the importing Parties (**Supplementary Table 4**). Of the eleven Parties have reported commercial export of *Alopias vulpinus*, one Party is only reported by importing Parties. Trade codes used for *A. vulpinus* are “E”, “Q”, “S”, and “T” (**Table 7**). Nine countries have reported trade of “*Alopias* spp.” in the CITES Trade Database and export from one Party is only reported by an importing Party. There may, however, be instances where an importing country reports as general “*Alopias* spp.” where the exporting country has reported this to species.

Isurus spp.

The majority of *Isurus* spp. catch was reported to both FAO and RFMOs at the species level, mostly as *Isurus oxyrinchus* (**Fig. 11**). In both the FAO and RFMO datasets, reporting to broad category increased after their CITES-listing by 4 and 9%, respectively. FAO Catch Statistics include a much higher proportion of species-specific catches than appears in the RFMO databases.

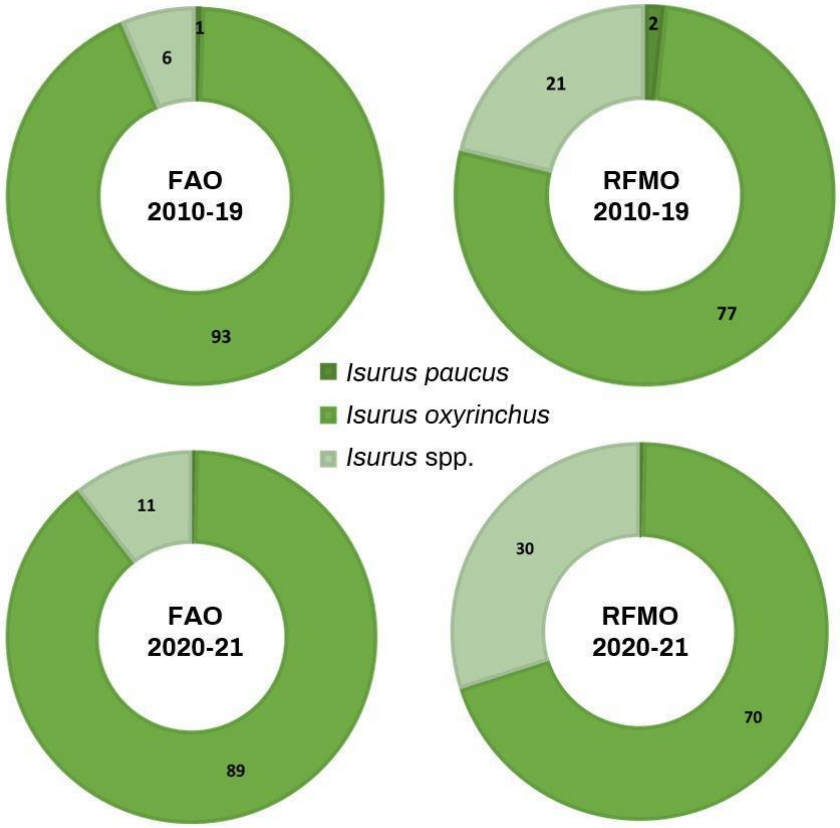

Figure 11. Percent of *Isurus* species (Mako shark) catch reporting by category pre- and post-CITES listing in 2019 to FAO and RFMOs.

Overall, reporting of *Isurus* spp., both general and specific, was much greater in the RFMOs, when compared to FAO, prior to 2000. Since then, countries with species-specific reporting are largely the same in both datasets. However, FAO Catch Statistics of broad *Isurus* reporting, for example, does not include catches from Japan or Taiwan, Province of China, reported to RFMOs (based on RFMO data, approximately 1,000 mt of catches were reported by Japan and Taiwan, Province of China, to RMFOs since 2009). Similarly, catches of *Isurus* spp. by Indonesia were not included in the FAO Catch Statistics until 2011 while reports were submitted to RFMOs [approximately 100 mt of catch reported by the RFMOs since at least the mid-1990s (**Fig. 12**)].

According to the cleaned CITES Trade Database, *Isurus oxyrinchus* is exported by 33 Parties, of which six are only reported by importing Parties (**Supplementary Table 4**). Thirty of the 33 countries have reported commercial export *of Isurus oxyrinchus*, though seven are only reported by the importing Parties. Belize, Portugal and Spain are the only Parties reporting one-state transactions of *Isurus oxyrinchus* specimens from ABNJ, despite this being a species frequently encountered in ABNJ. Eight Parties export *Isurus paucus*, all of which have some export reported in the CITES Trade Database, and seven of which have some commercial export (**Supplementary Table 4**). Two exporting countries have reported trade of the broad grouping "*Isurus* spp." in the CITES Trade Database, one of which reports commercial trade of "*Isurus* spp" (Indonesia). *Isurus oxyrinchus* is traded under purpose codes "E", "H", "P", "S", "T", and blank in the CITES Trade Database (**Table 7**).

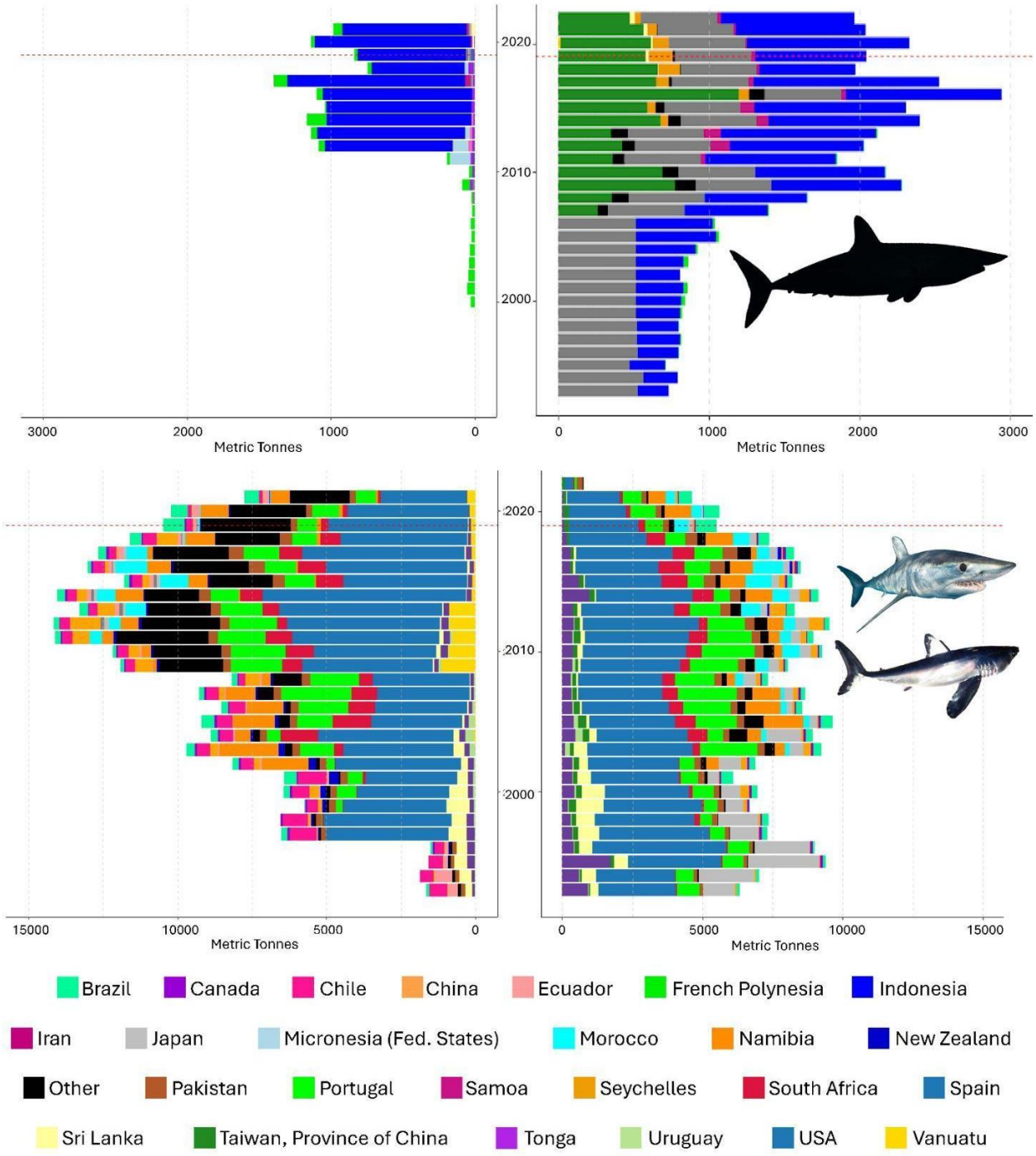

Figure 12. Total *Isurus* catch reported as "*Isurus* spp." (top) or to a specific species (bottom) by country or province to FAO (left) and RFMOs (right). Year of listing on CITES Appendix II is indicated by a dashed red line. *Images: Ron Watkins / Ocean Image Bank & PIRO-NOAA Observer Program.*

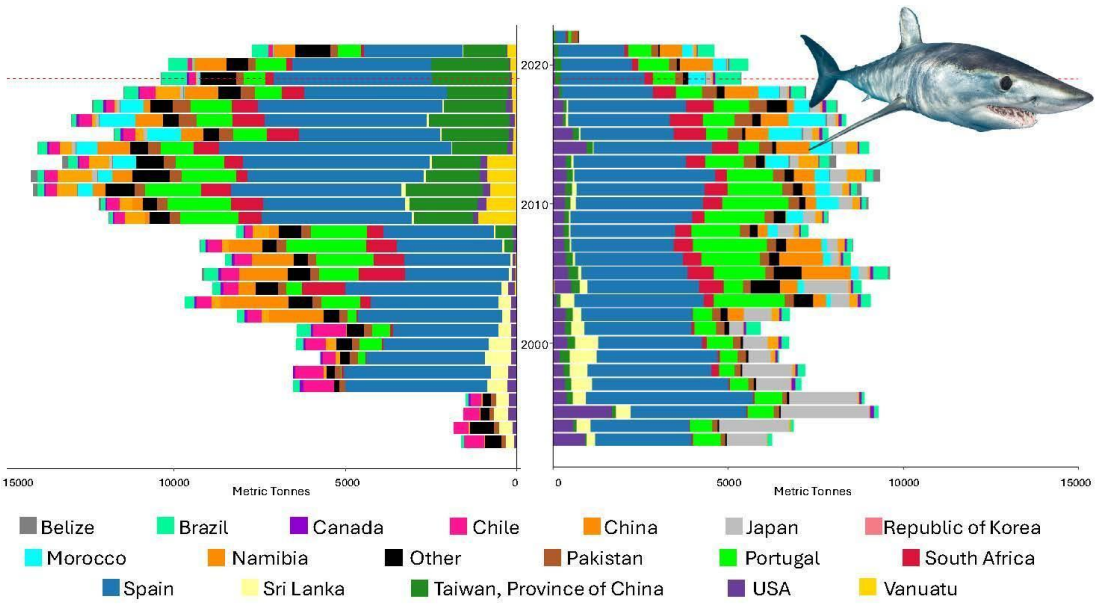

Figure 13. All countries and provinces and their reporting volumes of *Isurus oxyrinchus* to FAO (left) and RFMOs (right). Year of listing on CITES Appendix II is indicated by a dashed red line. *Image: Ron Watkins / Ocean Image Bank.*

Though the large majority (>95%) of species-specific *Isurus* catch is *Isurus oxyrinchus* (**Fig. 13**), the reported catches of *Isurus paucus* to FAO differ substantially from reports of the RFMOs. Prior to 2013, there was negligible catch of *Isurus paucus* included in the FAO Catch Statistics, while catches in the RFMO datasets exceeding 100 mt most years since 1993 (**Fig. 14**). Species-specific catches of *Isurus paucus* reported to RFMOs by Sri Lanka, USA, Namibia, and the United Kingdom are vastly under-represented in the FAO Catch Statistics. These catches do not appear to be captured in the broad, genus-level reporting by the FAO either (**Fig. 12**). *Isurus paucus* is traded with only two purpose codes: “S” and “T” (**Table 7**).

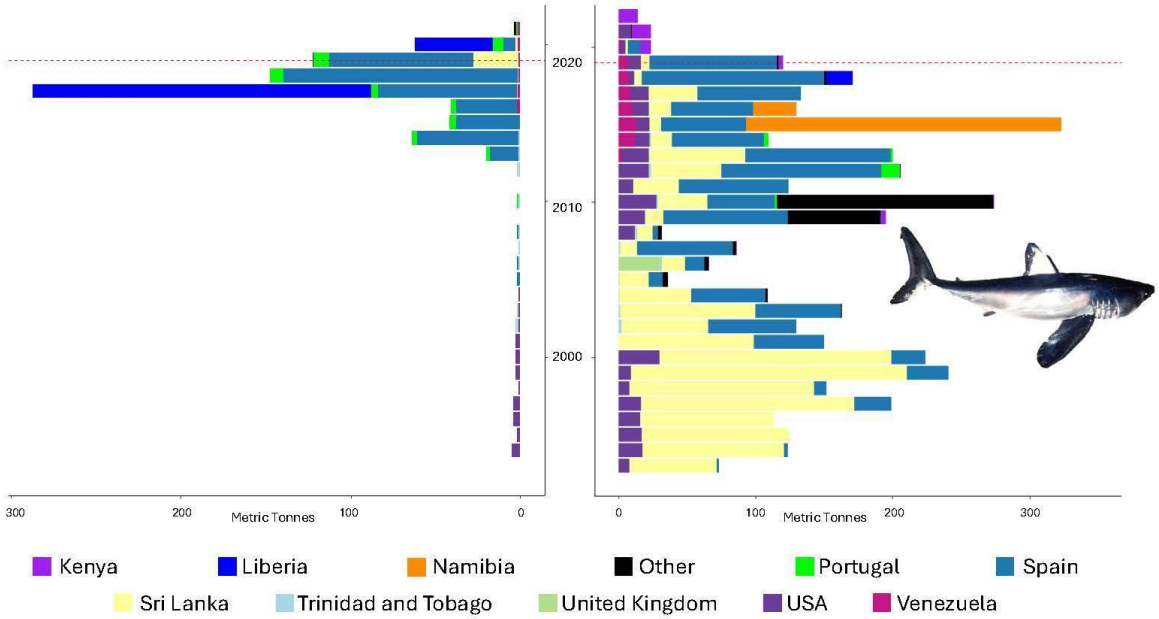

Figure 14. All countries and their reporting volumes of *Isurus paucus* to FAO and RFMOs. Year of listing on CITES Appendix II is indicated by a dashed red line. *Image: PIRO-NOAA Observer Program.*

Mobulidae

The two manta rays (*Mobula alfredi* and *M. birostris*) were listed three years prior to the entire Mobulidae family listing and so the analysis for this study started at the first listing to avoid changes in reporting patterns as mantas could be reported under the general "Mobulidae" catches. If the analysis started when the full family was listed, the report would have already captured different reporting based on the two manta rays.

The proportion of species-specific reporting improved in the FAO dataset by 16% post-listing. However, in RFMOs, 100% of reporting was species-specific prior to the CITES-listing and that percentage dropped to 67% after their listing.

Prior to the CITES listing, all Mobulid catch reported to RFMOs was species-specific as either *Mobula birostris* or *Mobula mobular* (**Figure 15**). However, post CITES-listing, the proportion of catch reported to genus increased to 33%. Catches of *Mobula mobular* became dominant and less *Mobula birostris* catch was reported, likely due to landing prohibitions for the species. Both pre- and post-CITES listing, the majority of Mobulid catch was reported to FAO to the genus level (83% and 99%, respectively; **Figure 15**). In both time periods, this is significantly higher genus-level reporting than what is reported to RFMOs.

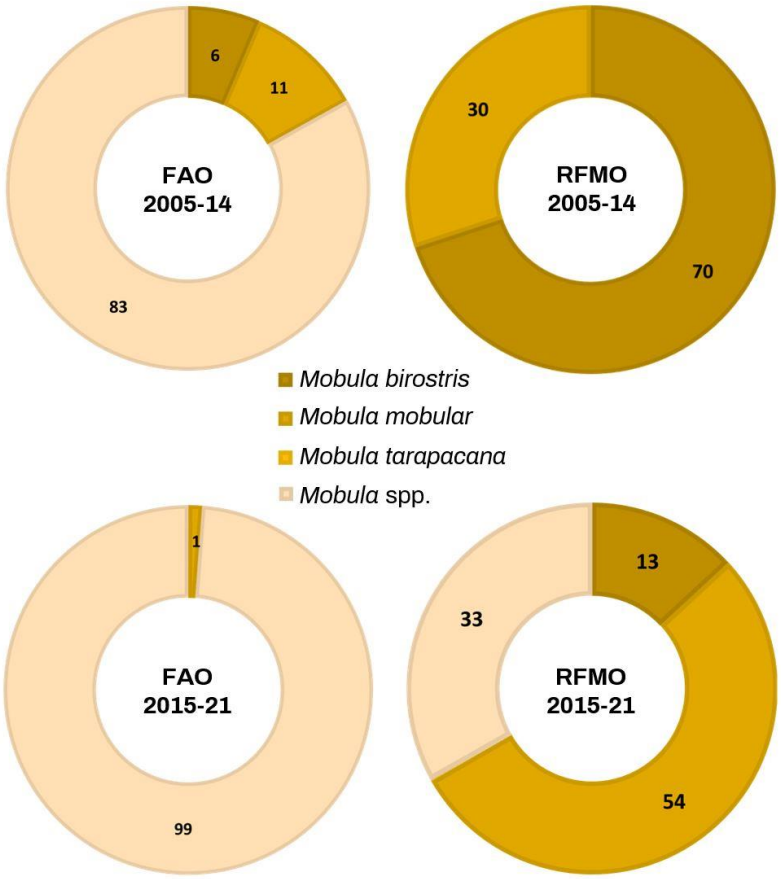

Figure 15. Percent of Mobulid catch reporting by category pre- and post-entry into force of their CITES listing (2014) to FAO and RFMOs. *Mobula thurstoni* was reported to species, however, the volumes in all cases were so low that they were less than 0.5% of reported catch.

Few countries report catch of mantas and devil rays, and only a handful report any substantial catch. The countries with the largest volume of Mobulid catch are Indonesia (only reported to FAO broad category), Kenya (reported to FAO and RFMO as specific species), and Sri Lanka (reported to RFMOs both as specific species and broadly and to FAO as broad categories; **Figure 16**- blue, dark purple, and yellow, respectively).

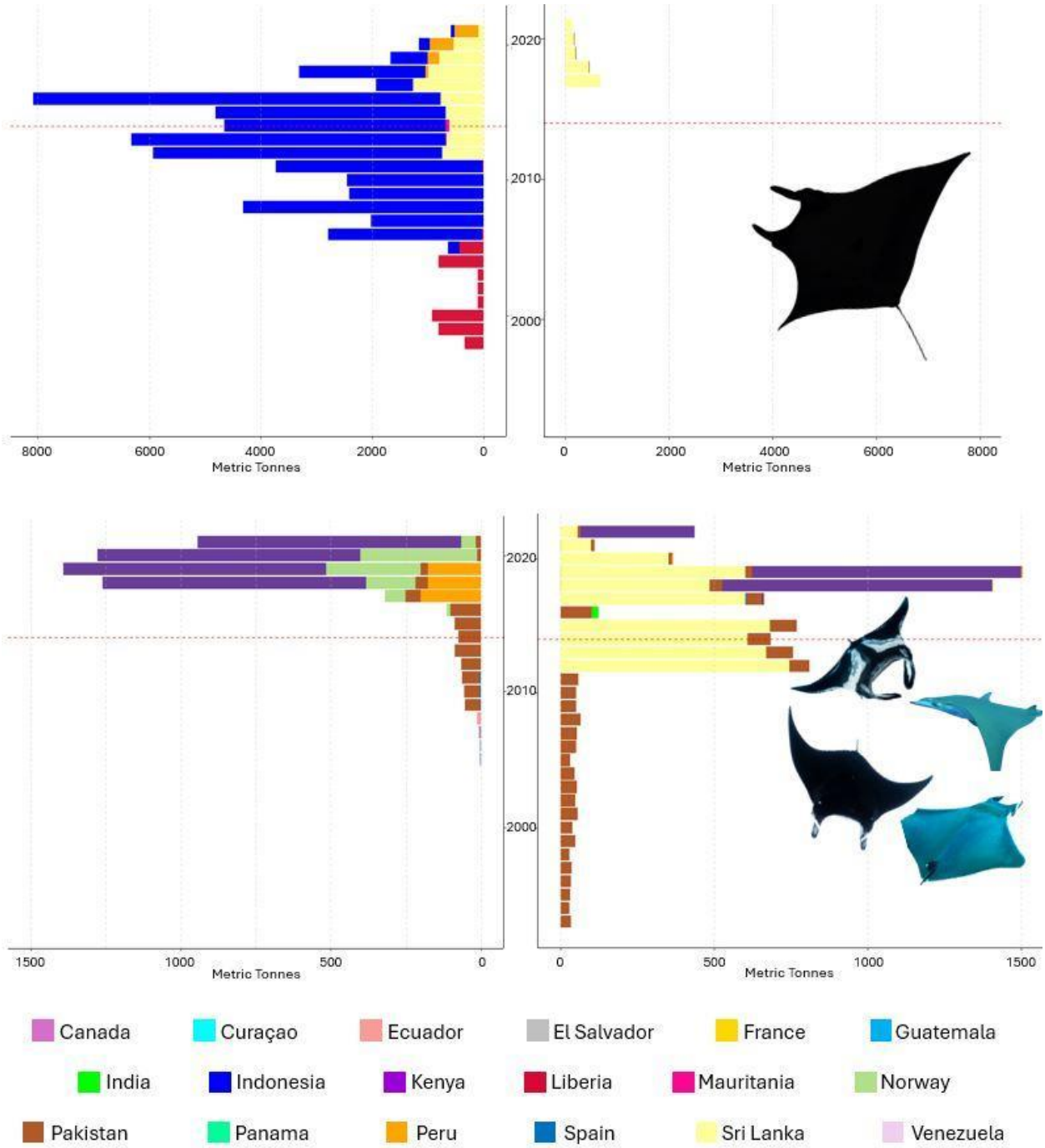

Figure 16. Total Mobulid catch reported as "*Mobula* nei" (top) or to a specific species (bottom) by country to FAO (left) and RFMOs (right). Year of listing on CITES Appendix II is indicated by a dashed red line.

Images: Amanda Cotton / Ocean Image Bank, Jake Wilton / Ocean Image Bank, Tiago Matias, & Rickard Zerpe.

There was only species-specific data within the RFMOs to compare *Mobula birostris* between the RFMOs and FAO catch statistics (**Figure 17**). Kenya is the only country to report catches to both RFMOs and FAO, but only in 2018 and 2019, though there is similar reported catch in the FAO database in 2020 and 2021 (**Figure 17**). This may be due to FAO continuing to report the catch by Kenya though they may not be self-reporting these catches directly to FAO.

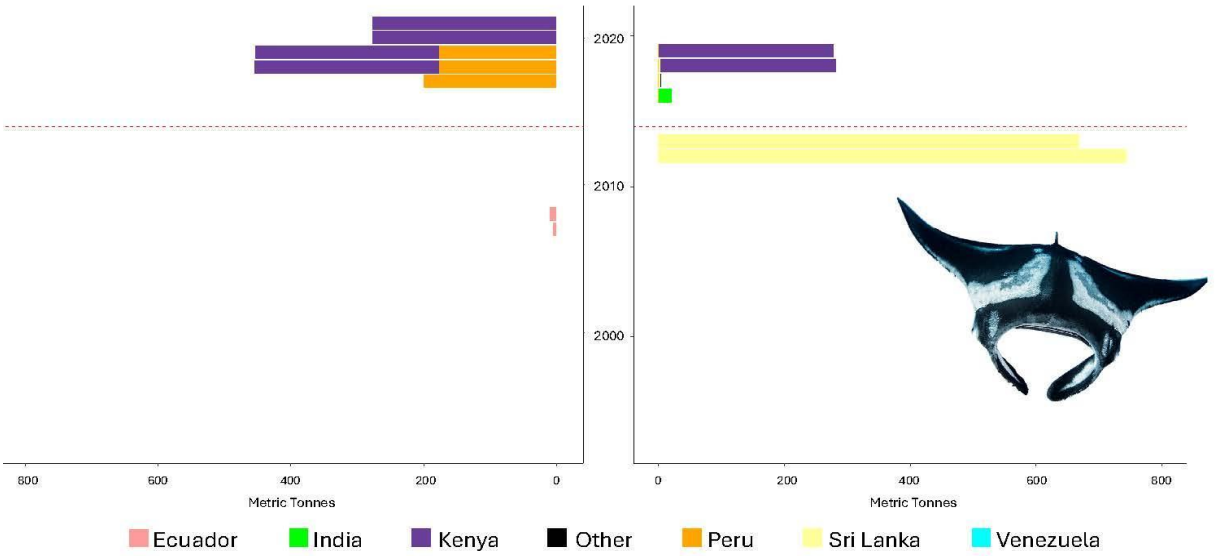

Figure 17. All countries and their reporting volumes of *Mobula birostris* to FAO and RFMOs. Year of listing on CITES Appendix II is indicated by a dashed red line. *Image: Amanda Cotton / Ocean Image Bank.*

As the two Manta Rays (*Mobula alfredi* and *Mobula birostris*) were originally listed on CITES Appendix II under the genus "Manta", trade in the CITES Trade Database is reported as both "*Manta birsotris*" and "*Mobula birostris.*" To simplify this analysis, these were joined and will be discussed as *Mobula* spp.. Similarly, *Mobula japonica*, which is recognized under CITES standard nomenclature as a distinct species is recognised as a synonym of *Mobula mobular* in the scientific community and in RFMO databases, therefore, all cases in the CITES Trade Database were renamed and analysed with *Mobula mobular*. Nine countries have reported export of the broad "Mobulidae" in the CITES Trade Database, with two exporting Parties only reported by the importing Parties (**Supplementary Table 4**). Neither the United Kingdom nor Mexico report export of species-specific Mobulid species, therefore, this lack of reporting may be importers reporting to the CITES Secretariat as a broad category rather than specific species. *Mobula birostris* is traded by the most countries, with reported export from 14 different countries, though four exporting Parties are only reported by the importing Parties. Only two countries (Sri Lanka and USA) commercially export *Mobula birostris*, and both report these exports to the CITES Secretariat. Purpose codes used for *Mobula birostris* transactions include E, S, T, and Z (**Table 7**).

Mobula alfredi and *Mobula mobular* are both exported by eight countries. For *Mobula alfredi*, there is only export from one Party, which is reported by the importing Party. However, all Parties with reported export of *Mobula mobular* report at least some of their export. Three of eight Parties that export *Mobula mobular* have reported commercial exports of *Mobula mobular* (**Supplementary Table 4**). All other *Mobula* species with reported trade in the CITES Trade Database (*M. eregoodoo, M. hypostoma, M. kuhlii, M. munkiana, M. tarapacana,* and *M. thurstoni)* include export from four or fewer countries, all of which are reported by the exporting Parties (**Supplementary Table 4**). Commercially, only three countries have reported export

of any of these species. When looking across all Mobulidae, this family is traded using purpose codes “E”, “P”, “S”, “T”, and “Z” (**Table 7**).

Pristidae spp.

The Sawfish family (Pristidae) is the only group of sharks to be listed on CITES Appendix I. Though their targeting and landing is banned in many countries, there is still ongoing trade of Sawfish. Twenty-nine countries have exported Sawfish or Sawfish products since their listing based on the cleaned CITES Trade Database. These transactions are made using purpose codes “E”, “L”, “P”, “Q”, “S”, “T”, “Z”, and ‘blank’ (**Table 7**). For many Parties with reported export, Sawfish are non-native, meaning the trade is either from captive populations or is re-exported. Trade recorded in the CITES Trade Database are predominantly sourced from the wild or are pre-Convention specimens. However, some Sawfish trade comes from export of specimens that were confiscated.

According to the cleaned CITES Trade Database, export of non-specific sawfish (Pristidae spp.) exists from nineteen countries, including four exporting Parties that are only reported by the importing Party (**Supplementary Table 4**). These non-specific trades are reported for purpose codes “E”, “L”, “P”, “Q”, “S”, and “T” (**Table 7**). *Pristis microdon* (recognized as a species under the CITES standard nomenclature), *Pristis perrotti* (synonymized with *P. microdon* at CoP17) and *Pristis pristis* were combined under *Pristis pristis* in this study (**Table 1**) to standardize across the different databases. *Pristis pristis* is exported from twelve countries from the CITES Trade Database for purpose codes “E”, “P”, “Q”, “S”, “T”, and “Z”, with export from three Parties only reported by importers (**Table 7**). *Pristis pectinata* has reported export from eleven countries, with exports from four Parties only being reported by importers. *Anoxypristis cuspidata* is recorded to be exported by seven Parties, of which export from three Parties are only reported by importers (**Supplementary Table 4**). All export of *Pristis zijsron* (three Parties) are reported by exporters. *Pristis clavate* is exported by two Parties as per importer reported data (**Supplementary Table 4**).

Cetorhinus maximus

Cetorhinus maximus is one of the first two species of shark to be listed on CITES Appendix II with an effective listing date of February 13, 2003. *Cetorhinus maximus* was listed on CITES following the population collapse due to overexploitation in targeted fisheries around the world (Rigby *et al*. 2021). For example, in the Northeast Atlantic, catch peaked in the mid-1960s and mid-1970s at around 5,000 tonnes annually (ICES, 2018). Since then bans on targeting *Cetorhinus maximus* have meant declines in landings to <0.1 tonnes since 2013 (ICES, 2018). Much lower levels of catch were reported after the peak, with reported catches almost non-existent since the CITES-listing in 2003 (**Fig. 18**). Small volumes of catch are still reported to RFMOs to date, however, after 2012, no catch of *Cetorhinus maximus* has been included in the FAO Catch Statistics.

Fourteen Parties have reported export of *Cetorhinus maximus* in the CITES Trade Database with all Parties reporting at least some export to the CITES Secretariat (**Supplementary Table 4**). These transactions have been made using purpose codes “E”, “P”, “Q”, “S”, “T”, and “Z” (**Table 7**). Commercially, only seven Parties have any reported export of *Cetorhinus maximus*, however, two Parties do not report this as commercial trade. Both Parties report exports of *Cetorhinus maximus* using other purpose codes. This indicates that they are either not reporting all exports or that the importing Parties are using different purpose codes when importing the shipments.

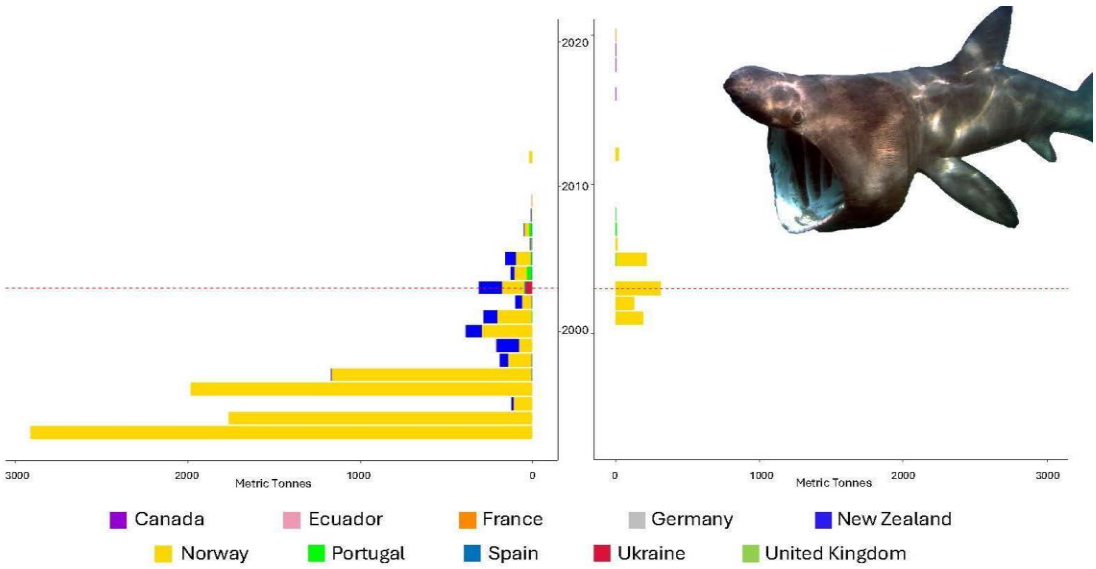

Figure 18. Total catch of *Cetorhinus maximus* reported by country to FAO (left) and RFMOs (right). Year of listing on CITES Appendix II is indicated by a dashed red line. *Image: Green Fire Productions.*

Carcharodon carcharias

Carcharodon carcharias was one of the first elasmobranch species to be afforded both national and international protections. A total of eight countries report catch of *Carcharodon carcharias* to RFMOs, however, only five include reported catch to FAO (**Figure 19**). Despite the *USA* reporting catch to RFMOs from the mid-1990s to mid-2010s, there is minimal reporting during the same period to FAO (**Fig. 19 -** dark purple). Though *Carcharodon carcharias* remains a targeted species in swimmer protection programs in Australia and South Africa with noted mortalities (Dudley and Simpfendorfer, 2006; Bruce, 2008; Roff et al 2018), no catch has been included from either country in the FAO Catch Statistics nor the RFMO database. Despite not being used for commercial use after capture in these programs, these fishing mortalities should still be included in reports of fisheries catches and fishing mortality.

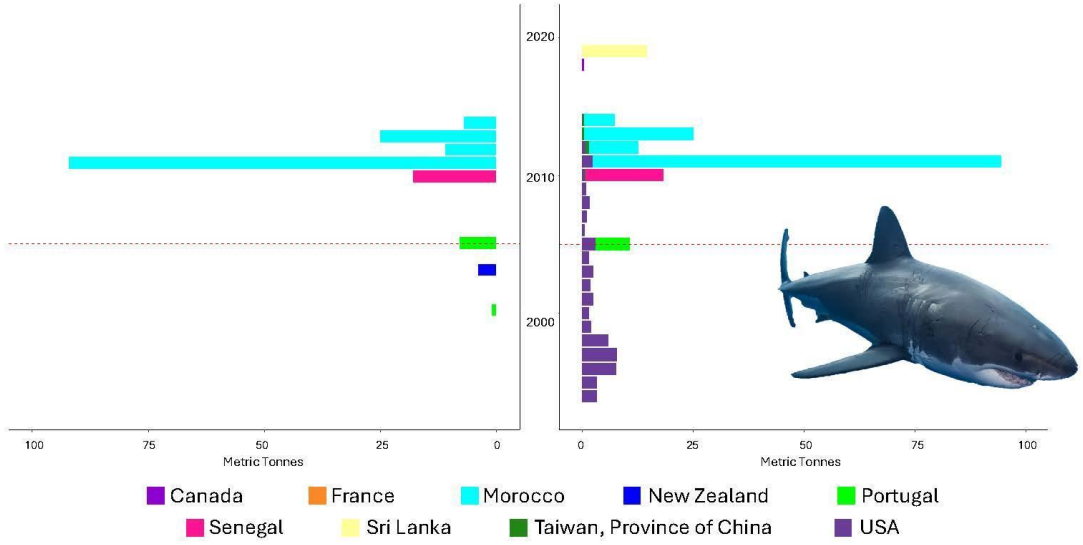

Figure 19. Total catch of *Carcharodon carcharias* reported by country and province to FAO (left) and RFMOs (right). Year of listing on CITES Appendix II is indicated by a dashed red line. *Image: Andy Cassagrande / Ocean Image Bank.*

In the CITES Trade Database, there is reported export of *Carcharodon carcharias* from 33 Parties, with six exporters only being reported by importers (**Supplementary Table 4**). *Carcharodon carcharias* is traded under purpose codes “E”, “P”, “Q”, “S”, “T”, “Z”, and ‘blank’ (**Table 7**). In terms of commercial trade, 16 Parties have reported export in the CITES Trade Database. Of these, almost half (n = 7, 44%) of the exports are only reported by importers. These Parties include three that do report at least some export of *Carcharodon carcharias*, but not for commercial purposes (**Supplementary Table 4**).

Rhincodon typus

Rhincodon typus was one of the first two species of shark to be listed on CITES Appendix II with an effective listing date of February 13, 2003. Only three countries report any catch of *Rhincodon typus* to either FAO or RFMOs - Marshall Islands, France, and Sri Lanka (**Figure 20**). The low reports of *Rhincodon typus* catches may be due to lack of landings, as at least 45 countries have national measures for the species (Pierce and Norman, 2016). Despite only three countries reporting catching *Rhincodon typus*, there are 19 Parties with reported export in the CITES Trade Database. These trades use purpose codes “E”, “P”, “Q”, “S”, “T”, and “Z” (**Table 7**). None of the Parties with reported export include the three that report catch to FAO or RFMOs. Of the Parties with reported export, two are only reported by importers (**Supplementary Table 4**). Only three Parties have reported commercial trade of *Rhincodon typus* in the CITES Trade Database and one reports commercial export, one reports non-commercial export, and one is only reported by the importer (**Supplementary Table 4**). The large discrepancies between reported landings and trade in the CITES Trade Database may stem from scientific samples being taken from live specimens, where a small biopsy is taken, and the entire individual is not landed.

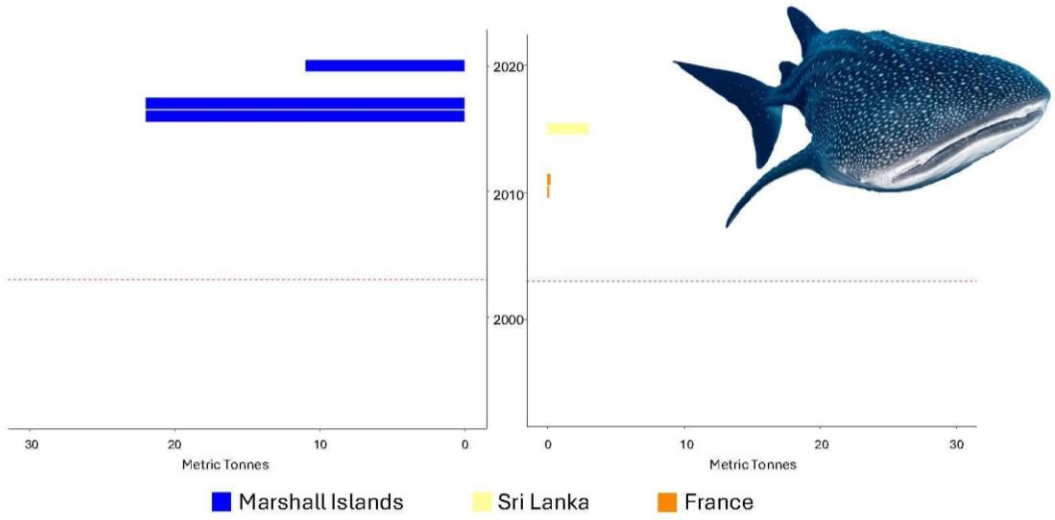

Figure 20. Total catch of *Rhincodon typus* reported by country to FAO (left) and RFMOs (right). Year of listing on CITES Appendix II is indicated by a dashed red line. *Image: Connor Holland / Ocean Image Bank.*

Lamna nasus

The majority of *Lamna nasus* catches reported in the FAO Catch Statistics and RFMO Databases are by the same countries. However, prior to 2000, catch reported to RFMOs was greater than that from the FAO Catch Statistics (**Fig. 21**).

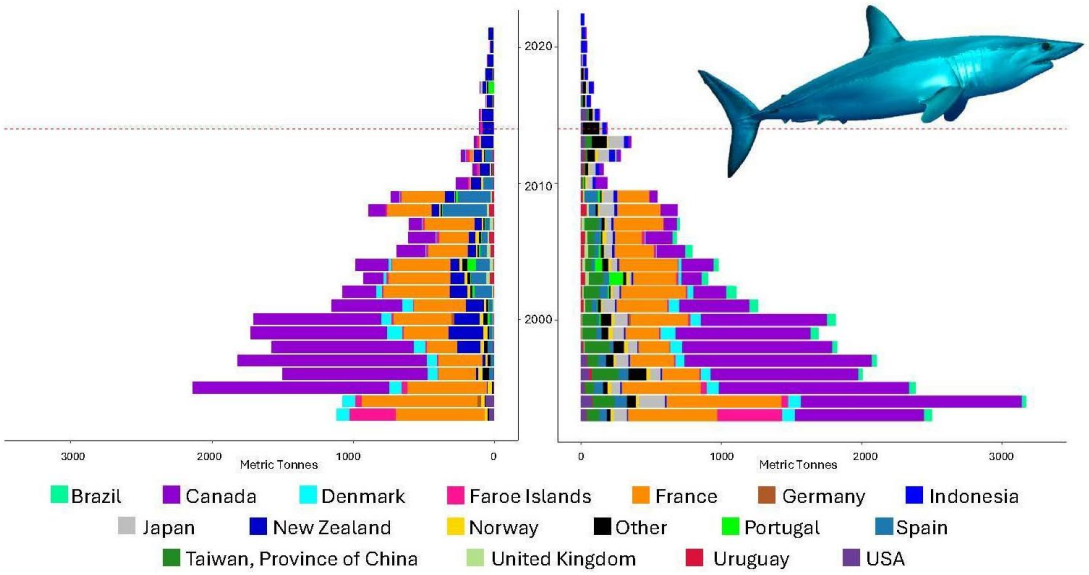

Figure 21. Total catch of *Lamna nasus* reported by country and province to FAO (left) and RFMOs (right). Year of listing on CITES Appendix II is indicated by a dashed red line. *Image: Patrick Doll.*

Lamna nasus is the only shark with species-specific trade information in the FAO trade database. The majority of export and import in the FAO trade database is between European Union (EU) countries and Spain, Ireland, Portugal, and Finland (**Figure 22**). Much of this trade is not reported in the CITES Trade Database. However, due to being traded within the EU, it is not required to be reported to the CITES Secretariat. In the cleaned CITES Trade Database, 25 Parties have reported export of *Lamna nasus* and almost half (n = 11; 44%) of the exports are only reported by importers (**Supplementary Table 4**). Nine of these countries have reported commercial export of *Lamna nasus*, two (Faroe Islands and Japan) are only reported by importers. The Faroe Islands is a non-Party, therefore, not obligated to report. Additionally, Japan has a reservation on *Lamna nasus*, therefore, they are not required to report export of this species. *Lamna nasus* is traded using purpose codes “E”, “Q”, “S”, and “T” (**Table 7**).

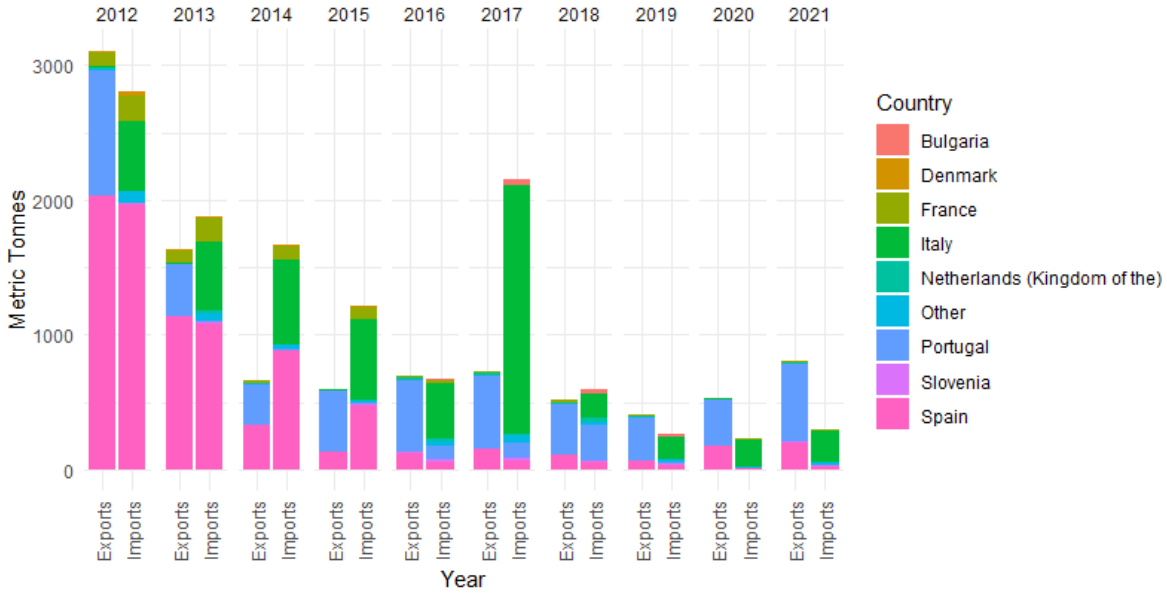

Figure 22. Export and Import of *Lamna nasus* in the FAO database by country. All countries contributing less than 5% cumulatively to export and import were combined to “Other.”

Carcharhinus longimanus

Prior to 2008, there were only two countries with species-specific catches of *Carcharhinus longimanus* in the FAO Catch Statistics (Brazil and Sri Lanka). Both of these countries have similar reported landings to the RFMOs (**Fig. 23**). Species-specific catch reporting of *Carcharhinus longimanus* was required by the IATTC in 1993, which may explain the larger number of countries with reported catch in the RFMO Database before 2008. Additionally, WCPFC, ICCAT, and IOTC all require species-specific reporting for *Carcharhinus longimanus*, which began in 2008, 2011, and 2013, respectively (**Appendix I**). All four of these RFMOs have prohibited the retention of *Carcharhinus longimanus*, the earliest mandated in 2011 and latest in 2014, the same year as the CITES-listing. These prohibitions explain the low numbers of catch reported in the RFMO Database after the listing, with the exception of Comoros in 2016 (**Fig. 23**). Conversely, in the FAO Catch Statistics, catches post-CITES-listing have remained relatively high, with the majority of catch occurring in four countries and territories (China, Fiji, French Polynesia, and Iran).

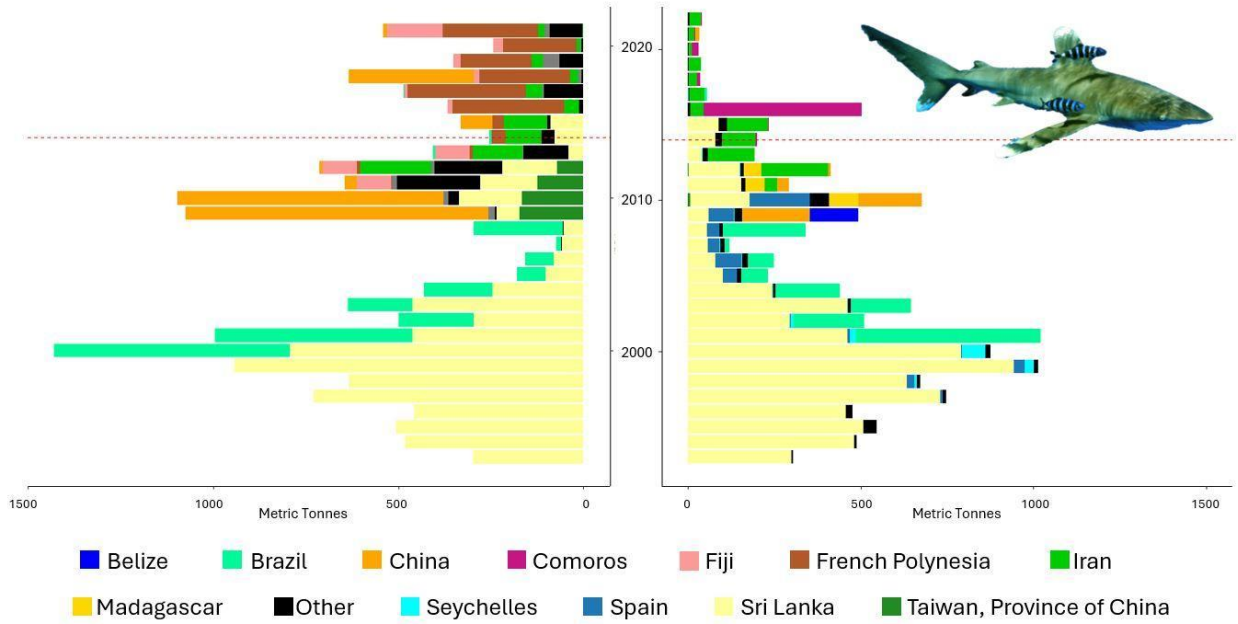

Figure 23. Total catch of *Carcharhinus longimanus* reported by country and provinces to FAO (left) and RFMOs (right). Year of listing on CITES Appendix II is indicated by a dashed red line. *Image: Cvf-ps.*

In the cleaned CITES Trade Database, 34 Parties have reported export of *Carcharhinus longimanus* and over one third of these (n = 12; 35%)are only reported by importers (**Supplementary Table 4**). Trade of *Carcharhinus longimanus* is reported using purpose codes “E”, “L”, “Q”, “S”, and “T” (**Table 7**). Despite being an important species in the global fin trade (Clarke et al., 2006), only 16 Parties have reported commercial export of *Carcharhinus longimanus*. Of these, export from three Parties are only reported by importers (**Supplementary Table 4**). This species has high capture rates in ABNJ (Bonfil et al., 2008), and there has been continued catch reported in both the FAO and RFMO databases since the CITES-listing (**Fig. 23**). Therefore, reporting of take of the species from ABNJ in the CITES Trade Database would be expected. However, there is no records in the CITES Trade Database of the species being taken from ABNJ.

Carcharhinus falciformis

As a pelagic species, the similar countries and pattern of *Carcharhinus falciformis* catches in the FAO and RFMO Databases was expected (**Fig. 24**). Prior to 2012, Sri Lanka comprised the majority of reported catches to both FAO and RFMO. Notably, between 2009 and 2017, Belize reported catches to RFMOs, none of which was included in the FAO Catch Statistics. RFMO catches of *Carcharhinus falciformis* have steadily decreased since 2010, coinciding with the first year of prohibited retention in ICCAT. Subsequently, both WCPFC and IATTC have prohibited the retention of *Carcharhinus falciformis* in 2014 and 2016, respectively. After CITES-listing in 2017, catches in the RFMOs continued to decline and some countries (i.e., Belize) have not reported any catch since. However, in the FAO Catch Statistics, Costa Rica's catches increased just prior to the CITES-listing and remained higher than pre-2010 levels after the listing (**Fig. 24**). Positively, post-CITES-listing, a large number of additional countries appear in the FAO Catch Statistics with catches of *Carcharhinus falciformis*. This is possibly due to improved species-specific reporting, as this data is required for export permits.

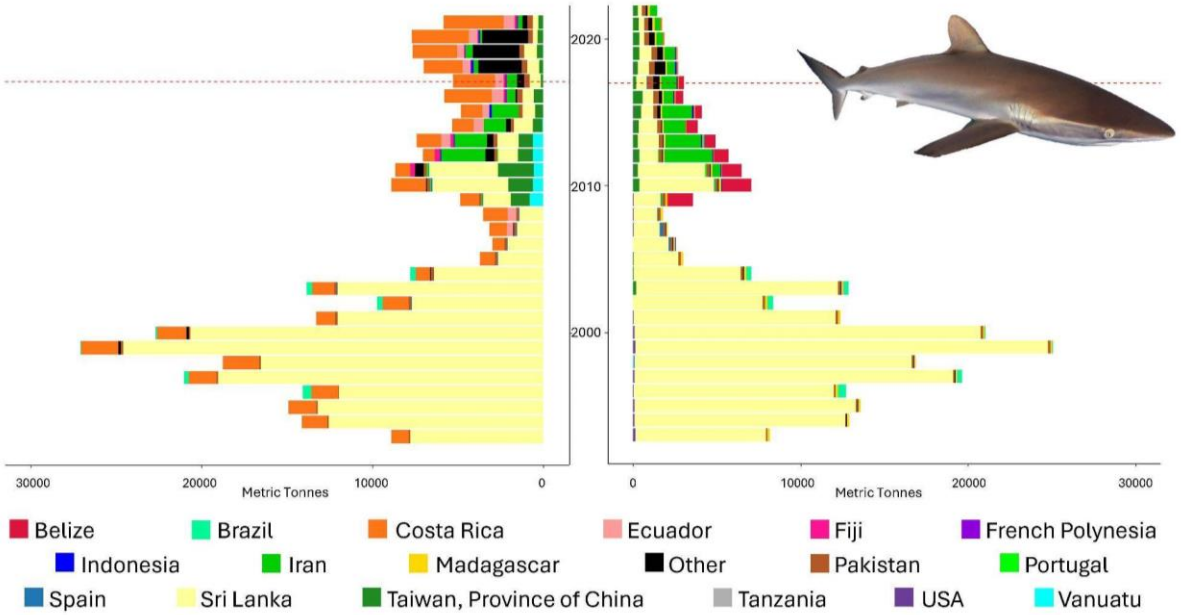

Figure 24. Total catch of *Carcharhinus falciformis* reported by country and province to FAO (left) and RFMOs (right). Year of listing on CITES Appendix II is indicated by a dashed red line. *Image: Sean Chinn / Ocean Image Bank.*

In the cleaned CITES Trade Database, there are 38 Parties with reported export of *Carcharhinus falciformis*, and almost one-third (n = 10; 26%) are only reported by importers (**Supplementary Table 4**). These transactions are reported using purpose codes "E", "P", "Q", "S", "T", and 'blank' (**Table 7**). Despite being the second most commonly encountered species in fin trimmings from Hong Kong SAR of China, comprising over 10% of trimmings (Cardeñosa et al., 2022), less than two-thirds of the Parties reporting trade, have any reported commercial export in the CITES Trade Database (n = 23; 61% of exporting Parties). Of the Parties with commercial export, five are only reported by importers. China and the United States both report non-commercial export of *Carcharhinus falciformis* (**Supplementary Table 4**).

4.2 International Trade

Purpose Codes (CITES Trade Database)

Purpose codes are used in the CITES Trade Database to indicate the intended use of the shipment. The purpose codes used for all transactions of the species included in this study were summed to examine patterns between species. As both exporters and importers may report transactions, there may be some duplication in the reported sums, however, as exporters and importers may report transactions differently, this is unlikely to affect relative sums. Though transactions do not indicate volumes for each purpose, they do provide insights into effort and uses.

Eight of the twelve purpose codes are used to trade CITES listed sharks and rays. The purpose codes not used are “B” (breeding), “G” (botanic garden), “M” (medical), and “N” (reintroduction). The most commonly used purpose code is “T” (commercial), accounting for 83% of the 9,806 reported transactions (**Table 7**). The “H” (hunting trophy) purpose code was only used in a single transaction of *Isurus oxyrinchus*. Purpose codes “L” (law enforcement) and “Z” (zoo) were also used in fewer than 35 transactions each (**Table 7**). There are also several species with transactions where the purpose code field was left blank, totalling 122 transactions (**Table 7**).

There are several species where the relative number of transactions are good indicators of the predominant use. For example, the charismatic species with many national protections, like *Rhincodon typus, Mobula birostris,* and *Carcharodon carcharias*, all have the most transactions under the S (scientific) purpose code with 74.3%, 52.6%, and 43.6% of transactions, respectively (**Table 7**). This is expected due to the large number of researchers working on these species globally. However, other species that are targeted for their meat and fins, like *Isurus oxyrinchus*, *Carcharhinus falciformis,* and the Sphyrnidae species, are predominantly traded under the T (commercial) purpose code with 99.4%, 92.5%, and 86.0% (collectively) of transactions, respectively (**Table 7**). Comparing these groups, the species used for commercial purposes had higher percentages of transactions for that purpose than the species mainly used for scientific purposes. Similarly, all species in the commercial group had 6% or less of their transactions be for scientific purposes, however, the scientific group had 3.0-24.4% of transactions listed as commercial purposes. Other species, like *Lamna nasus* had a similar number of transactions under multiple purpose codes (**Table 7**).

Table 7. Rows in the CITES Trade Database for each species / group traded under the different 'purpose codes.' Rows indicate transactions, not volume traded and may include duplications where the exporter and importer have both reported the trade.

Species / Trade Code	E - education	H - hunting trophy	L - law enforce-ment	P - personal	Q - circus/ exhibition	S - scientific	T - commercial	Z - zoo	Blank	TOTAL
Sphyrna mokarran	18		4	4	44	27	298			395
Sphyrna lewini	28			2	39	72	760	4	1	906
Sphyrna zygaena	1			5	1	20	581			608
Sphyrna spp. / Sphyrnidae				1		3	50			54
Alopias vulpinus	3				22	4	101			130
Alopias superciliosus	1				21	8	405			435
Alopias pelagicus	1				22	6	716		33	778
Isurus oxyrinchus	4	1		4		5	2431		1	2446
Isurus paucus						3	128			131
Mobula birostris	16					41	19	2		78
ALL Mobulidae	21			192		127	513	10		863
Pristidae spp. / Pristis spp.	8		3	19	12	1	15		2	60
Pristis pristis	7			2	5	16	12	8		50
Anoxypristis cuspidata	2			2		9				13
Pristis zijsron				4	4	1	3	3		15
Pristis clavata						5				5

ALL Pristidae	21		3	28	25	39	34	11	2	163
Cetorhinus maximus	4			2	11	17	43	2		79
Carcharodon carcharias	40			38	51	144	52	1	4	330
Rhincodon typus	9			1	9	75	3	4		101
Lamna nasus	6				45	31	44			126
Carcharhinus longimanus	25		4		41	19	169			258
Carcharhinus falciformis	17			1	25	21	1780		81	1925
TOTAL	215	1	11	278	356	662	8127	34	122	9806

4.3 Trade Volumes

Species-specific data was only available in the CITES Trade Database, which included smaller volumes than the total shark trade (not disaggregated to species) reported in the other datasets. Trade of *Lamna nasus* is reported to species level by the FAO. However, only 28 countries are included as exporters in the FAO dataset and 36 countries are included in the CITES database. In order to identify any discrepancies in trade reporting, reported fin exports to Hong Kong SAR of China from the Comtrade dataset were compared to reported fin imports in the Hong Kong SAR of China dataset from 2012-2022. Though the total tonnage reported in each dataset across the eleven years was similar, there are clear discrepancies within years and countries (**Figure 25**).

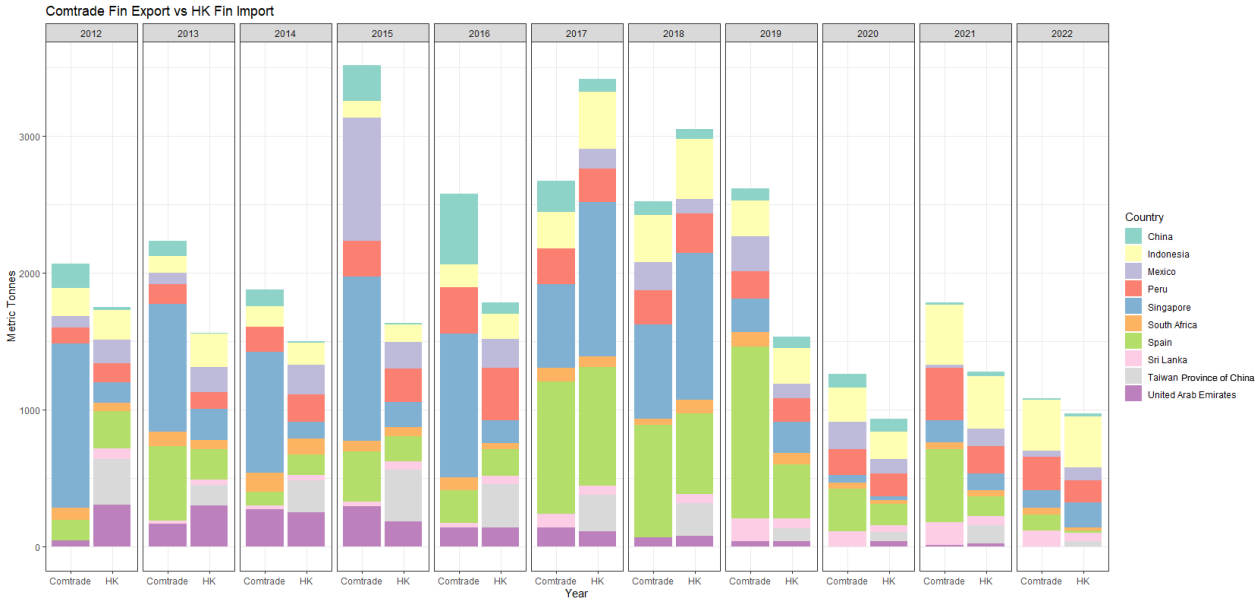

Figure 25. Reported export volume (metric tonnes) of shark fins, by country/province, exported to Hong Kong SAR of China, in Comtrade (left) and imported to and reported by Hong Kong SAR of China (right).

4.4 Why are there mismatches in data?

FAO and RFMO Mismatches

FAO catch statistics are meant to include all catches, including what is caught in international waters. Thus, if there is no reporting of catch of certain species by a country to FAO but the data is available in RFMO catch statistics, FAO may use the data reported to the RFMO to fill in missing data or under certain circumstances use the data reported to the RFMOs instead of those reported by the countries to improve the accuracy of catch statistics (pers. comms. FAO Fisheries Statistics Division, December 2023). However, examples of discrepancies between reporting to RFMOs and FAO were found in the data.

For example, in 2006, Guyana reported 301 metric tonnes of *Sphyrna zygaena* landing to ICCAT. However, in the FAO database, this catch is recorded as 301 mt of “Hammerhead sharks, etc. nei” and not the species-specific resolution available from ICCAT. Given FAO endeavours to maintain a global dataset, estimation of catch is a necessary instrument to minimise gaps in the confluence of an overall fisheries

picture. However, there are challenges when assessing the catch of CITES-listed species where estimation occurs at high taxonomic levels.

Approximately two-thirds of shark catch in the FAO Catch Statistics Database is recorded as "Chondrichthyes," "Elasmobranchii," or "Selachimorpha" (Sherman *et al.* 2023). It is reasonable to assume that an unknown proportion of this undifferentiated catch contains CITES-listed species, however, there is no way to accurately estimate the proportion and species-composition of this catch. When accompanied with the lack of species-specificity in international trade codes (Comtrade), there may be undocumented fisheries resource use in contravention of the CITES agreement. This data deficiency in turn leads to profound challenges in estimating the scale of economics associated with shark trade, and needs to be addressed to allow for quantitative assessment of the success of CITES-listing as a conservation measure for sharks. Additionally, when countries do not report their catch to FAO, or under-report values, the Catch Statistics team may override reports using historic catches and/or RFMO catches. This inconsistency in data collection makes further comparisons with other datasets difficult as the catch statistics are not uniformly collected.

CITES Trade Database Mismatches

Though international trade of CITES-listed species is required to be reported to the Secretariat through annual reports by the exporting country, importing countries often report this trade as well. The implications of this reporting mean: (1) there is evidence of countries not reporting exports and (2) there are differences in aspects of a trade (e.g., purpose codes, volumes, species, etc.) when reported by exporters and importers. They may also sometimes be temporary, owing to delays in annual reporting. These differences can include mismatch in the reported volume traded, the importing or exporting country, purpose codes and the year of the trade. For the year of the trade, these mismatches are easily explained by differences in timing of shipments being sent and received (e.g., a shipment sent in December may not arrive until January or February of the following year). Other differences, like volumes, may be simply explained by rounding differences (e.g., a shipment reported as 22.7 and 23 kg by the different Parties). Other volume differences may be extreme, differing by thousands of kgs (e.g., a shipment in 2021 of *Isurus oxyrinchus* reported under the same permit number by exporting Party as 25,980 kg and by the importing Party as 17,479 kg, a difference of 8,501 kg). Some of the differences in volumes may be explained by the necessity to obtain an export permit prior to packing the shipment and the actual weight of the export may be less than anticipated, but the volume on the export permit being reported in the CITES Trade Database.

In some cases, mismatches may occur when a shipment has been reported to have been exported to one Party, but a different Party has reported receiving the shipment. This may have been due to a change in buyer as the shipment was en route. Alternatively, this may have been a shortcut taken where one country was an intermediary and re-export permits were not obtained to forward the shipments to the final destination. Without further investigation, this is mere speculation. Instances like this, however, may impact the analyses of the CITES Trade Database, as duplicates were removed only when the shipments were reported for the same permit, species, importer, and exporter. Therefore, if there are additional examples of different importers/exporters of the same shipment, these were duplicated in our analyses, thus our results of the total trade reported to the CITES Trade Database are likely higher than the true value reported.

Further complications exist in the CITES Trade Database, as Hong Kong SAR of China and Taiwan, Province of China, are both listed as exporters and importers, separate to China. This is the only example in the CITES Trade Database where a dependent territory or jurisdiction of a CITES Party reports exports and/or imports separately from the Party.

Hong Kong SAR of China and Taiwan, Province of China, have reported exports of 12 and 13 CITES-listed species, respectively, though the exporter only reports two of these species (**Supplementary Table 4**).

China reported export of 15 species, but one species was only reported by an importing Party. Consequently, it is difficult to determine the total trade of CITES-listed species between China and other Parties. Therefore, reports in the CITES Trade Database by China, Hong Kong SAR of China and Taiwan, Province of China, were consolidated for the analysis of this study. It is important to note that there may be some duplication in the consolidation of these shipment reports.

Of the 90 countries with at least one export of CITES-listed sharks or rays reported in the CITES Trade Database, twelve have not reported any of their export (**Supplementary Table 4**). Only one of the twelve countries is not a CITES Contracting Party (Faroe Islands), and therefore, not required to report any export. The others have exported between one and eight different CITES-listed species, according to reported imports, though the number may be higher due to lack of import reporting requirements.

In addition to the twelve countries with no reported export of any species, an additional 31 countries do not report export of at least one species where import is reported by another country (**Supplementary Table 4**). About half (n = 47, 52%) of the countries with reported export in the CITES Trade Database have no records where an importer reported a species that was never reported by the exporter. This does not mean that these 47 countries report all their export, only that no countries report import of species not already reported by the exporter themselves. For example, if country A reported export of *Pristis pristis* to country B, but countries C and D also reported import of *Pristis pristis* from country A, this was not accounted for. These in-depth analyses would require improved documentation of the weights of shipments in order to properly quantify the reported and unreported trade.

FAO, RFMO, and CITES Trade Database Mismatches

Identification of possible areas where there are “missing sharks” in the catch and trade databases was determined by looking at the trade reported to CITES and the catches reported to both the RFMOs and FAO.

Since the time of listing on CITES, the volume of trade reported in the CITES Trade Database outnumber the reported catch to either RFMOs and FAOs for 15 of the 29 species/genera (**Table 8**). These numbers do not include all trade reported to CITES, only trade with a weight associated with it. Similarly, catch only includes three RFMOs so is not a complete picture of the catch. However, these results indicate there is likely a large amount of catch occurring that is not being reported to either RFMOs or FAO. Additionally, the weights reported to the CITES Trade Database are reported as the product weight, not live weight as FAO data represents, meaning what appears to be a discrepancy between the two could in fact simply be the comparison of different types of data. The processing of whole animals into their different products and varying forms, including dried, fresh etc. means there will be expected differences between catch and trade volumes. Also for many CITES listed species the traded component internationally will usually only be that of a higher value such as dried fin, with the meat consumed domestically where it is landed. Hence, the catch volumes of species with only a small component of their traded volume entering international trade (such as dried fin) will have a much lower proportion of CITES reported trade compared with catch reporting than species where most of the body (for meat) enters international trade. The values in Table 7 include all catch and trade post-listing to avoid complications from catching in one year and trading the following year(s). Trades in the CITES Trade Database listed as pre-Convention catch were not considered in this analysis to avoid complicating results.

For some species, the catch reported to either FAO or RFMOs is much greater than that reported in the CITES Trade Database (i.e. *Carcharhinus falciformis*). It is possible that this catch is not being traded internationally, but used locally. However, it is highly unlikely to be the case for the entire catch not reported as international trade. In particular, *Carcharhinus falciformis* is a pelagic species frequently caught in ABNJ, not just EEZs, therefore, a greater proportion of this catch should be included in the CITES Trade Database. .

Table 8. Cumulative catch and trade of all CITES-listed species from their first year of effective listing. CITES/RFMO and CITES/FAO indicate the proportion of catch reported to RFMOs and FAO respectively, in relation to the trade of each species reported as commercial trade to the CITES Secretariat. Dark shaded cells indicate species and databases where the trade reported to CITES is higher than the reported catch of the species. Lightly shaded cells indicate species and databases where there is reported trade but no reported catch to the respective database. *Note: This table includes data from the 3 tRFMOs as access to WCPFC and CCSBT catch records were not granted.

Species	RFMO (mt)	FAO (mt)	CITES (mt)	CITES/RFMO	CITES/FAO
Alopias pelagicus	1,488.2	19,238.2	1,764.4	1.19	0.09
Alopias spp.	30,583.7	29,081.4	17.7	0.001	0.001
Alopias superciliosus	82.8	1,894.4	132.1	1.59	0.07
Alopias vulpinus	0	1,003.9	86.6	100*	0.09
Carcharhinus falciformis	13,462.3	33,538.2	3,965.1	0.29	0.12
Carcharhinus longimanus	1,174.3	3,211.9	41.9	0.04	0.01
Carcharodon carcharias	365.9	161.0	3.8	0.01	0.02
Cetorhinus maximus	632.4	714.2	10.5	0.02	0.01
Isurus oxyrinchus	10,956.0	17,867.7	11,974.4	1.09	0.67
Isurus paucus	61.5	66.2	18.8	0.31	0.28
Isurus spp.	6,341.0	2,120.8	0	0	0
Lamna nasus	707.0	583.2	50.5	0.07	0.09
Mobula birostris	0	1,663.7	2.4	100*	0.001
Mobula mobular	1,462.5	982.3	34.8	0.024	0.001
Mobula spp.	10,074.8	34,738.5	26.1	0.003	0.001
Mobula tarapacana	3.7	0	27.2	7.37	NA
Mobula thurstoni	0.7	0	0	NA	NA
Pristidae spp.	0	8,749.1	0	0	0

Pristis pristis	0	0.02	0	0	0
Rhincodon typus	3.4	55.0	0.009	0.003	0.0001
Sphyrna lewini	1,799.6	899.6	178.6	0.10	0.20
Sphyrna mokarran	53.5	334.9	47.4	0.89	0.14
Sphyrna zygaena	6,018.6	1,492.3	168.6	0.03	0.11
Sphyrnidae spp.	44,095.1	73,516.5	4.9	0.0001	6.7E-5

Of the 67 countries that report catch of any CITES-listed sharks and rays to FAO, 35 have reported trade in the CITES Trade Database. Five of these countries that report any species-specific catch to FAO have higher volumes of international trade recorded in the CITES Trade Database than they have reported catching to FAO since the listing of these species (**Table 9**). This may be that they are reporting catch to FAO as a more generic elasmobranch category, or it is being mis-reported in catches to a species that is not listed. Of the 61 countries that report catch of any CITES-listed sharks and rays to RFMOs, 34 have reported trade in the CITES Trade Database. Sixteen of these countries have higher volumes of international trade recorded in the CITES Trade Database than they have reported catching to RFMO (**Table 9**). These differences may be due to large amounts of catch of CITES-listed species within the EEZ of these countries that may not be included in reports to RFMOs due to exemption from reporting requirements for certain fleets, but would be included in the catch reported to FAO. Therefore, the higher volumes of trade in the CITES Trade Database compared to what is reported to FAO is more concerning for determining where these "missing sharks" are. Cumulatively, 27.1% of catch of CITES-listed species reported to FAO are reported as traded internationally in the CITES Trade Database (669,967 mt recorded in the CITES Trade Database, 2,475,960 mt reported to FAO since the listing dates of all CITES-listed species).

Table 9. Cumulative catch and trade by country of all CITES-listed species from their first year of effective listing. CITES/RFMO and CITES/FAO indicate the proportion of catch reported to the 3 tRFMOs and FAO respectively, in relation to the trade of each species reported in the CITES Trade Database. Countries are listed in descending order of reported CITES export. Dark shaded cells indicate countries and databases where the trade reported to CITES is higher than the reported catch of the species. Lightly shaded cells indicate countries and databases where there is reported trade but no reported catch to the respective database. These were also assigned a value of 100 as dividing by zero is not possible. Only countries with >5 mt of export recorded in the CITES Trade Database are included, full table available in GitHub.

Country	RFMO (mt)	FAO (mt)	CITES Export (mt)	CITES/RFMO	CITES/FAO
Spain	4,280.7	6,962.7	5,109.4	1.19	0.73
Costa Rica	535.2	14,172.2	2,919.8	5.46	0.21
China	4,290.8	10,577.9	2,107.5	0.49	0.20
Namibia	1,586.3	1,586.6	1,892.8	1.19	1.19
Ecuador	0	22,612.8	1,740.5	100	0.08

Japan	133.2	40.7	651.5	4.89	16.01
Peru	0	3,076.9	605.9	100	0.20
Portugal	1,681.9	1,674.1	559.0	0.33	0.33
Sri Lanka	13,843.5	14,975.4	548.4	0.04	0.04
South Africa	337.9	281.5	527.8	1.56	1.87
Vanuatu	19.8	463.4	283.9	14.33	0.61
Oman	8,759.0	0	217.1	0.02	100
Mexico	65.9	25,334.5	216.4	3.28	0.01
El Salvador	54.1	0	203.0	3.76	100
Indonesia	45,253.6	70,268.7	133.8	0.003	0.002
Senegal	1,038.0	7,036.2	111.5	0.11	0.02
Seychelles	519.0	171.7	102.4	0.20	0.60
Yemen	0	0	101.2	100	100
Morocco	817.1	547.8	97.1	0.12	0.18
Singapore	0	0	94.0	100	100
Trinidad and Tobago	282.0	322.0	64.0	0.23	0.20
Guatemala	24.3	0	56.5	2.33	100
Korea, Republic of	298.7	0	41.6	0.14	100
Nicaragua	0	0	33.6	100	100
Belize	308.4	7.6	31.9	0.10	4.20
Kenya	3,348.0	3,741.9	28.6	0.01	0.01
Panama	118.2	0	23.8	0.20	100
United Kingdom of Great Britain and Northern Ireland	37.3	46.3	16.6	0.44	0.36
Norway	612.3	1,364.9	12.6	0.02	0.01
India	69.3	0	7.4	0.11	100

Angola	0	0	6.9	100	100
Australia	2.8	4.2	5.4	1.93	1.29

When considering which countries may include "missing sharks," 27 countries were identified that report catch of CITES-listed species to RFMOs but report no international trade to the CITES Secretariat (**Table 10**). Additionally, according to the FAO Catch Statistics, there are 17 countries with over 100 metric tonnes of catch of CITES-listed species that report no international trade (**Table 11**). However, caution is required when looking at FAO reports, as catch within national waters that is consumed locally is not required to be reported to CITES.

Table 10. Countries reporting catch of CITES-listed species after respective listings to the 3 tRFMOs with no international trade reported in the CITES Trade Database.

Country	Catch Reported to RFMOs (mt)
Madagascar	18,192.6
Mozambique	6,347.7
Ghana	4,445.4
Pakistan	3,982.0
Iran, Islamic Republic of	3,865.1
Portugal	1,681.9
Namibia	1,586.3
Comoros	751.2
Guyana	330.4
Cote d'Ivoire	330.3
France	245.6
Italy	184.8
Venezuela	81.6
Liberia	64.7
Grenada	61.0
Netherlands, Kingdom of the	46.0
Barbados	21.5
Germany	12.4
Maldives	10.2
Mauritius	7.1
Malaysia	6.9
Sao Tome and Principe	5.0
Saint Lucia	4.1
Equatorial Guinea	2.6
Russian Federation	0.4
Tanzania, United Republic of	0.3
Denmark	0.3

Dominica	0.1

Table 11. Countries with catch of CITES-listed species after their listing in the FAO Catch Statistics, with no international trade reported in the CITES Trade Database. Countries in **bold** are not CITES Parties.

Country	FAO Catch Statistics catch (mt)
Mozambique	13,758.1
Tanzania, United Republic of	6,771.1
Benin	5,067.0
Congo	4,141.0
Pakistan	3,716.0
Iran, Islamic Republic of	2,704.1
France	2,308.5
Liberia	862.0
Fiji	841.4
Micronesia, Federated States of	665.0
Palau	595.2
Mauritania	470.0
Togo	314.0
Marshall Islands	307.0
Kiribati	258.2
Venezuela, Bolivarian Republic of	244.7
Cote d'Ivoire	138.4

Further looking into the CITES Trade Database, there are 28 combinations of a country and species where reported catch to RFMOs is lower than the reported trade to the CITES Secretariat (**Table 12a**). However, there are also four combinations where the reported international trade is higher than the total catch reported to FAO (**Table 12b**).

Table 12. Cumulative catch and trade of species by country for CITES-listed species from their first year of effective listing. CITES/RFMO or CITES/FAO indicate the proportion of catch reported to the 3 tRFMOs or FAO, in relation to the trade of each species reported to the CITES Secretariat. Species are listed in descending order of reported CITES export with countries in alphabetical order for combinations where international trade exceeds catch reported to (a) the 3 tRFMOs and (b) FAO.

a) Country	Species	RFMO (mt)	CITES Export (mt)	CITES/RFMO
Costa Rica	*Carcharhinus falciformis*	523.2	2,870.6	5.49
El Salvador	*Carcharhinus falciformis*	48.8	177.6	3.64

Guatemala	*Carcharhinus falciformis*	21.5	54.3	2.52
Mexico	*Carcharhinus falciformis*	37.9	72.7	1.92
Indonesia	*Carcharhinus falciformis*	123.0	125.8	1.02
Vanuatu	*Isurus oxyrinchus*	8.2	283.9	34.81
Trinidad and Tobago	*Isurus oxyrinchus*	2.1	64.0	29.91
Japan	*Isurus oxyrinchus*	78.1	604.0	7.73
South Africa	*Isurus oxyrinchus*	337.9	527.8	1.56
Mexico	*Isurus oxyrinchus*	4.4	6.4	1.48
Sri Lanka	*Isurus oxyrinchus*	11.9	14.0	1.18
Sri Lanka	*Isurus paucus*	1.5	6.4	4.26
Spain	*Lamna nasus*	0.02	0.59	29.99
China	*Sphyrna lewini*	0.5	17.0	31.95
Korea, Republic of	*Sphyrna lewini*	0.08	2.38	29.76
El Salvador	*Sphyrna lewini*	1.7	14.1	8.19
Costa Rica	*Sphyrna zygaena*	1.7	1.8	1.07
El Salvador	Sphyrnidae *spp.*	0.07	0.92	14.11
b) Country	**Species**	**FAO (mt)**	**CITES Export (mt)**	**CITES/FAO**
Indonesia	*Carcharhinus falciformis*	114.0	125.8	1.10
Japan	*Isurus oxyrinchus*	14.5	604.0	41.66
Trinidad and Tobago	*Isurus oxyrinchus*	2.1	64.0	29.92
Morocco	*Isurus oxyrinchus*	43.8	97.1	2.22
South Africa	*Isurus oxyrinchus*	278.2	527.8	1.90
Sri Lanka	*Isurus oxyrinchus*	11.9	14.0	1.17
Sri Lanka	*Isurus paucus*	1.5	6.4	4.26
Japan	*Lamna nasus*	26.2	47.4	1.81

Anomalous Data Points

Fisheries Data

A recurring phenomenon encountered when observing the catch statistics of both FAO and the RFMO's is the presence of anomalous years wherein a flag state reports a significant volume of a CITES-listed species in one year, but with relatively low or no catch reported in the years before or after that one year of reporting. Examples of this within the RFMO datasets include Senegal reporting 400+ metric tonnes of *Sphyrna zygaena* catch in 2013 (the year prior to CITES effective listing date) and less than 10 metric tonnes in all subsequent years. India reported in excess of 20 metric tonnes of *Mobula birostris* in 2016 (the year prior to the effective data of CITES family-level Mobulidae listing), and less than a single metric tonne in any of

the years before or after. Sri Lanka reported in excess of 600 metric tonnes of *Mobula birostris* in 2012 and 2013 (the two years prior to CITES effective listing date), and less than 60 metric tonnes annually in all other years before and after. Sri Lanka similarly recorded over 450 metric tonnes of *Alopias superciliosus* in 2012, and less than 20 metric tonnes annually in all other years before and after. Namibia reported 230 metric tonnes of *Isurus paucus* to ICCAT in 2015, 32 metric tonnes in 2016 and none in the years before or after (with no corresponding catch reported to FAO at the species-level). Comoros reported in excess of 450 metric tonnes of *Carcharhinus longimanus* to IOTC in 2016, less than 20 metric tonnes in any single year before or after, and less than 50 cumulative metric tonnes of any elasmobranch to FAO in the same year. Belize reported more than 130 metric tonnes of *Carcharhinus longimanus* to IATTC in 2009, and none in any year before or after to either IATTC, ICCAT, IOTC or FAO. In the same year, the cumulative total of any reporting category in FAO that could potentially include *Carcharhinus longimanus* (i.e. "elasmobranch nei") was just 7 metric tonnes.

Within FAO data, similar patterns are evident. Liberia reported 24 metric tonnes of *Alopias superciliosus* in 2019, less than 10 metric tonnes annually in the two years prior, and none in the two years post. They similarly reported 45 metric tonnes of *Sphyrna mokarran* in 2020, and none in the years before or after. Sri Lanka reported more than 25 metric tonnes of *Isurus paucus* to FAO in 2019, and cumulatively less than two metric tonnes in all years before or after (despite reporting hundreds of metric tonnes to RFMO's).

Whilst data disposition is lacking in many of these examples (landings/catch/discards) and may enhance understanding of these unusual years, there exist examples in which this is clearer. In 2017, Côte d'Ivoire reported 273 metric tonnes of landed *Sphyrna lewini* catch to ICCAT, and in the same year to FAO the entire Hammerhead shark catch was reported as just 8 metric tonnes.

As one example of significant reported catch volumes and relatively little associated trade appearing within the CITES Trade Database, Oman has reported a total catch volume of 5,951 metric tonnes of *Sphyrna zygaena* between their effective listing date in 2014 and 2022. However, in the same time period 3.76 metric tonnes of *Sphyrna zygaena* fins were reported by Oman and included the CITES Trade Database – all of which was reported in 2021 and 2022.

CITES Trade Database

Other data that should be further investigated are the possible under-reporting of exports. For example, there are transactions reported by importing countries for 12 different species being exported by Bangladesh in the CITES Trade Database, however, trade of only 7 species is reported by Bangladesh in its annual reports (**Supplementary Table 4**). Similarly, there are exports originating from Mauritania for nine different species, but only three of these (three listed Sphyrnidae species) are reported by Mauritania in their annual reports (**Supplementary Table 4**). Other countries do not report any export to the CITES Secretariat, despite other countries reporting receiving imports of listed species.).

In the CITES Trade Database there are 22 countries which report export themselves for 50% or fewer species than they are reported to have exported (i.e., for 50% or more species, trade is only reported by the importing country; **Supplementary Table 4**).

Several countries have reported catches of CITES listed species, but no reporting of trade to the CITES Secretariat after their listings (**Tables 10** and **11**). Therefore, further clarification is needed on the catch and international trade of countries with high volume catches of CITES-listed species but with no corresponding export.

Specimens taken from ABNJ

Results from the study suggest there might be a misunderstanding by CITES Parties regarding their obligations in reporting CITES-listed species caught in ABNJ.

In the CITES Trade Database, Belize, Spain, Republic of Korea, Portugal, and the USA report one-state transactions of specimens taken from ABNJ. For two-state transactions of specimens taken from ABNJ, Belize, Singapore and Spain are the only Parties that report transactions. Thus, there are five countries who report taking specimens of CITES-listed shark species from ABNJ, despite the dozens of countries reporting catch to RFMOs. Many of these countries not reporting catch from ABNJ, do report international trade of several CITES-listed species in the CITES Trade Database. It can be inferred from the RFMO data that a large number of Parties may be taking CITES-listed specimens from ABNJ but not reporting the transaction in their annual reports, highlighting the possibility of misunderstanding of reporting requirements.

4.5 Limitations of the Data

Among the challenges in using global trade databases such as Comtrade and FAO – as well as domestic bureaus such as Hong Kong SAR of China's Census and Statistics Department – is the lack of species-specificity in trade codes as they relate to elasmobranch commodities. Thus, whilst these datasets do provide insights into the overall global elasmobranch economy, in their current form they offer limited use in monitoring CITES compliance.

One of the major limitations of the data when attempting to identify where there are mismatches is the lack of comparable reporting. Differences in reporting exist between databases in terms of species-specificity of the reporting and quantification of reporting (e.g., as weights, as numbers of individuals, as boxes, etc.). It is impossible to accurately compare catch of 10 individuals to a weighted value of catch as the weight of a single individual can differ in magnitude depending on its size when caught. For example, a juvenile *Sphyrna lewini* with fork length (FL) of ~75 cm weighs less than 5 kg, whereas an adult with fork length of ~240 cm weighs over 160 kg (Kohler et al., 1996). Even more extreme, juvenile *Isurus oxyrinchus* ~60 cm FL weigh less than 5 kg and fully grown adults ~330 cm FL can weigh up to 540 kg, a two magnitude increase in weight (Kohler et al., 1996). Thus, the catch of 10 juveniles and 10 adults can differ by over 5,000 kg.

In addition to differences in how catches of species are documented, the reporting entities are different between organisations. Catch reported to FAO is often split such that dependent territories report their own catch, however, in the CITES Trade Database, the trade for the Party and its dependent territories are reported together. As these territories are often spread throughout the world and quite distant from their State's administrative capital, it is difficult to ascertain the location of the catch, original location of the export (where applicable), and may lead to double counting of catch if it is reported by both the territory and State. For example, there is catch by Curaçao (a territory of Netherlands) of CITES-listed sharks and rays in the FAO Catch Database and is also a Contracting Party of ICCAT. It is unclear if the catch reported to FAO or to ICCAT would be double counted and also reported by the Netherlands. Similarly, it is unclear what trade, reported in the CITES Trade Database as being exported by the Netherlands, comes from Curaçao.

This becomes a potentially large area for mismatch, or simply missing catch and trade information, when the territory or province does not report catch or trade, when the State does not report on their behalf, or when both the state and territory report separately, including to separate entities (i.e., FAO and RFMO). For example, this is the case for Taiwan, Province of China, which catches and exports large quantities of CITES-listed species that are not included in China's reporting to FAO, RFMOs, and CITES, except when reported by importers.

4.6 Issues to Consider

CITES listings of shark and ray species are increasingly including coastal shark and ray species in addition to pelagic species. These listings could create situations where vessels fishing within the EEZs of other nations under bilateral fishing agreements do not report their catch as import when landing said catch in their country. In such a scenario, these vessels would fish in distant waters and land CITES-listed species in their country thus without import permits or reporting the international movement of the catch to the CITES Secretariat. Clarity on reporting requirements in such scenarios would be important in order to account for all catches CITES-listed species.

Additionally, difficulties arose comparing traded volumes and landed weights of species. As trade frequently occurs as a final product, the volume of trade is not indicative of the total landed weight of sharks. Therefore, in all cases where trade volumes are near or greater than reported catch and landing volumes, there is likely to be unreported catch.

5. CHALLENGES

Among the challenges encountered when attempting to appraise the total global catch of CITES listed species is the discrepancy between reporting practices to RFMO's and FAO. Broad catch categories are present in both databases, but without uniformity between their nomenclature, and often with little insight into the species that might be contained within them. An additional complexity is the lack of accounting for which countries are reporting CITES-listed species under these umbrella categories, whether that is consistent across databases, and whether this lack of data resolution exists at the reporter level, or whether aggregation is occurring downstream. In some instances, this can be explained by the absence of species-specific catch categories in either the RFMO's or FAO, particularly evident in the Pristidae family. This notwithstanding, there is evidence of some countries reporting catch to species level in one database, but not all.

6. RECOMMENDATIONS

Based on the findings of this study, the following draft recommendations are submitted for consideration by the Animals Committee:

1. strongly encourage Parties to report all shark and ray trade in weight and not in number of specimens as indicated in the *Guidelines for the preparation and submission of CITES annual reports*;
2. invite Parties to adopt traceability systems along the supply chains of CITES-listed species, noting the definition of traceability[3], which has been agreed by the Parties to CITES and further guidance.
3. invite the Secretariat to follow-up on mismatches (differences in transactions reported by exporter/importer countries under the same permit; weights; species; etc.) in the CITES Trade Database and correct the mismatch, where possible;
4. invite the Secretariat to follow-up with countries that appear to not be reporting exports of sharks and rays (i.e., trade only reported by importing countries) to determine the reason for underreporting and provide necessary support to encourage reporting;

[3] The working definition of CITES traceability is: traceability is the ability to access information on specimens and events in a CITES species supply chain. This information should be carried, on a case-by-case basis, from as close to the point of harvest as practicable and needed to the point at which the information facilitates the verification of legal acquisition and non-detriment findings and helps prevent laundering of illegal products.

5. invite the Secretariat to examine the trade in source code “C” specimens of shark and rays that are unlikely to be captive-bred based on the biology of the specimens;
6. invite the Secretariat to propose clear guidance on the reporting of specimens taken from ABNJ; and
7. remind Parties of the obligation to submit annual reports to the CITES Secretariat, which includes introduction from the sea and export of sharks and rays and to report at the species lev

7. OBSERVATIONS AND POSSIBLE SOLUTIONS

In order to better compare databases and identify inaccuracies, collaboration between international organisations on how data is collected could solve some mismatch questions. In particular, the following would support standardization of databases across organizations:

- All catch be reported and separated to retained and discarded (including fate)
- Require all catch reporting be done by weight, not number
- Require species-specific reporting of catches at a minimum for all CITES-listed species
- The adoption of traceability along the supply chains of CITES listed species, noting the definition which has been adopted by the Parties to CITES and further guidance.

In regards to data acquisition by national fisheries and RFMOs, the following would aid in the identification and resolution of the mismatch in trade data of CITES-listed species:

- disaggregation of catch reports to landings and discards to determine both the total catch volume and the landed volume.
- Catch reportingby weight (not as number of individuals) to determine the amount of biomass removed. Catch of even 10 individuals may differ by hundreds of kg if those individuals are juveniles or fully mature adults.
- Reporting of catch of CITES-listed species at the species-level, not broad categories.
- In cases where reporting to broad categories is completed, providing more description and include as few species as possible. For example, the IOTC includes a “coastal sharks” reporting category that may include catches of dozens of species varying in taxonomy from shallow-water stingrays to large tiger sharks. These broad groupings are not useful for analysing ecosystem impacts as they include multiple morphologies, sizes, trophic levels, and species found in different habitat types.
- Disaggregate catches by jurisdiction (i.e. national waters, High Seas, other country EEZs) to better understand where biomass removal is occurring.
- Use an internationally recognised standard system (i.e. ISO alpha 2 codes for countries or FAO codes for species) rather than creating additional coding systems that do not align with other datasets.

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9. SUPPLEMENTARY FILES AND DATA

List of Spreadsheets:

Supplementary Table 1. List of RFMO regulations relevant to CITES-listed sharks and rays, organised by species.

Supplementary Table 2. Shipments reported to the CITES Secretariat by importers and exporters where the quantities differ by greater than 5 kg, in decreasing order.

Supplementary Table 3. List of discrepancies in shipments of Elasmobranchii species in the CITES Trade Database considered in the study.

Supplementary Table 4. Parties with trade of CITES-listed Elasmobranchii species in the CITES Trade Database considered in the study.