

A large ray, possibly a guitarfish, is shown lying on a bed of crushed ice. The ray's body is dark brown and yellowish, with a long, thin tail extending towards the bottom left. Its mouth is slightly open, revealing a pinkish-red interior. The background is a textured, white surface of ice.

THE SHARK AND RAY MEAT NETWORK

A DEEP DIVE INTO A GLOBAL AFFAIR
2021

Editor

Evan Jeffries (Swim2birds)

Communications

Stefania Campogianni (WWF MMI), Magdalena Nieduzak (WWF-Int)

Layout

Bianco Tangerine

Authors

Simone Niedermüller (WWF MMI), Gill Ainsworth (University of Santiago de Compostela), Silvia de Juan (Institute of Marine Sciences ICM (CSIC)), Raul Garcia (WWF Spain), Andrés Ospina-Alvarez (Mediterranean Institute for Advanced Studies IMEDEA (UIB-CSIC)), Pablo Pita (University of Santiago de Compostela), Sebastián Villasante (University of Santiago de Compostela)

Acknowledgements

Serena Adam (WWF-Malaysia), Amierah Amer (WWF-Malaysia), Monica Barone, Andy Cornish (WWF-Int), Marco Costantini (WWF MMI), Chitra Devi (WWF-Malaysia), Giuseppe di Carlo (WWF MMI), Caio Faro (WWF Brazil), Chester Gan (WWF-Singapore), Ioannis Giovos (iSea), Pablo Guerrero (WWF-Ecuador), Théa Jacob (WWF-France), Shaleyla Kelez (WWF-Peru), Patrik Krstinić (WWF-Adria), Giulia Prato (WWF-Italy), Rita Sayoun (WWF-France), Umair Shahid (WWF-Pakistan), Vilisoni Tarabe (WWF-Pacific), Jose Luis Varas (WWF-Spain), Eduardo Videira (WWF-Mozambique), Ranny R. Yuneni (WWF-Indonesia), Heike Zidowitz (WWF-Germany).

Special acknowledgments to contribution of Glenn Sant (TRAFFIC).

Special acknowledgements go to WWF-Spain for funding the scientific part of this report.

For contact details and further information, please visit our website at wwfmmi.org

Cover photo: © Monica Barone / WWF Safesharks

Back cover photo: © Matthieu Lapinski / Ailerons





© Nuno Queirós (APECE) / WWF

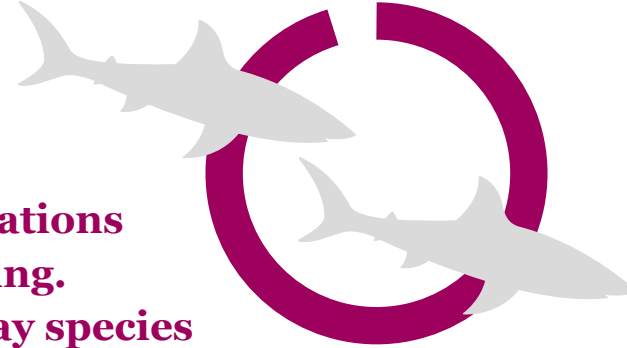
CONTENTS

EXECUTIVE SUMMARY	4
SHARKS AND RAYS IN CRISIS	6
THE OVERALL TRADE VALUE	7
GLOBAL NETWORK ANALYSIS	8
SHARK MEAT TRADE	10
RAY MEAT TRADE	18
THE ROLE OF THE EUROPEAN UNION IN THE SHARK AND RAY TRADE	26
A GLOBAL SELECTION OF DISHES WITH SHARK AND RAY MEAT	28
RECOMMENDATIONS	30

EXECUTIVE SUMMARY

SHARKS AND RAYS ARE IN CRISIS GLOBALLY

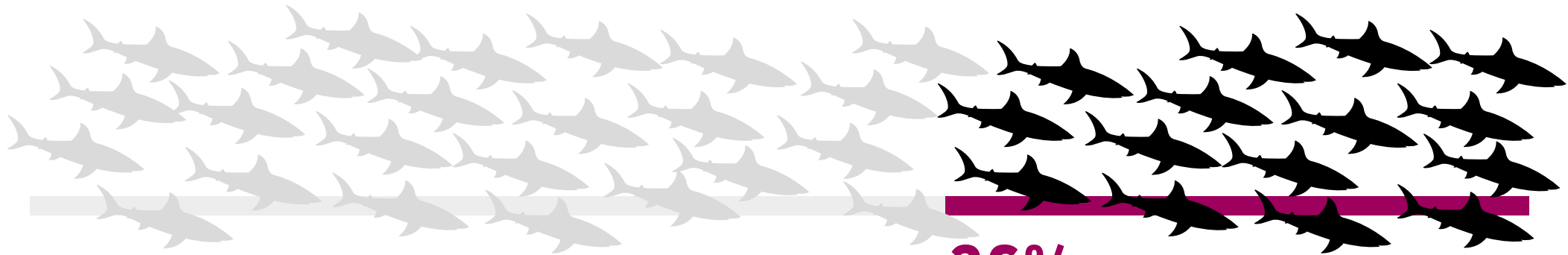
Up to 100 million are killed each year, and some populations have declined by more than 95% as a result of overfishing. Today, 36% of the more than 1,200 known shark and ray species are threatened with extinction.



-95%
OF SOME SHARK
POPULATIONS



© Simone Niedermueller / WWF



36% OF THE MORE THAN 1,200 KNOWN
SHARK AND RAY SPECIES ARE
THREATENED WITH EXTINCTION

The decline of sharks and rays is a contributing factor to the deterioration of our ocean, and symptomatic of much wider marine overexploitation. In order to deal with the situation before it's too late, we need a much better understanding of the opaque and complex global trade of their products.

WWF contracted a team of scientists to develop the first ever analysis of the global shark and ray trade network using graph theory, to give as clear a picture as possible of the key players, relationships and networks properties that drive flows in this niche but highly traded seafood product.

Even though fins are generally much more expensive than meat and the global fin trade has received far more attention to date, global trade in shark and ray meat is actually larger than trade in fins by both volume and by value. The total value of shark and ray trade in the period 2012-2019 exceeds US\$4.1 billion. The value of shark and ray meat combined (US\$2.6 billion) exceeds the value of shark fins (US\$1.5 billion). Prices can range from US\$0.1/kg for meat to more than US\$100/kg for fins. Of the top traders Italy pays on average the highest price for imports of shark meat at US\$4/kg, while Hong Kong pays the highest price for fins at US\$30/kg.

Spain dominated the highly complex global trade in fresh and frozen shark meat, appearing in the top three traders by value, volume, and number of trading partners. In the last decade, the trade routes where the largest volumes of shark meat moved have been from Uruguay to Brazil; from Portugal to Spain; from Spain to Italy, Portugal and Brazil; and from Ecuador to Peru. Nevertheless, the most important trade bridges for shark meat network stability have been between Japan, Portugal, the UK and Spain, Japan and Panama, and China and Japan. The EU has established itself as the main supplier to Southeast and East Asian markets, its own exports and imports accounting for about 22% of the total global shark meat trade.

The global trade network for ray meat is less diversified than for shark meat, with trade between Argentina as an exporter and South Korea as an importer dominating the market. The US and Brazil are also important suppliers to the South Korean market. South Korea's exports to the USA, although not large, are important for the structure of the network; while several of the most important bridging traders for network stability come from within the EU.

This analysis has identified not only major importers and exporters of shark and ray meat but also traders playing an

essential role as intermediaries, providing useful information on how and where best to focus international efforts to reverse the decline of shark and ray populations. It has also exposed a need for far more detailed international trade data.

Leading national players in the global trade must step up as global champions for conservation and sustainable fishing, adopting precautionary measures and science-based management. Extra resources should be devoted to controls and surveillance.

Internationally, far more detailed trade and tariff codes are required, in particular for ray meat. Species-specific reporting must become the norm globally, including for bycatch, so populations can be effectively managed.

Transparency and traceability are needed from point of capture through every stage of the supply chain, to ensure the trade remains legal and manageable, to keep protected species off the market, and to allow consumers to make informed purchases. Where food security does not depend on shark and ray products, consumers should avoid buying or eating such products unless they are from sustainable and traceable sources. Consumers should be aware that currently very few products available in the market meet these requirements.

SHARKS AND RAYS IN CRISIS

Sharks and rays are in crisis globally. Up to 100 million are killed each year in fisheries of all kinds,¹ and some populations have declined by more than 95% as a result of overfishing.²

Overfishing due to a lack of regulation and/or proper management measures for targeted and non-targeted catches is the biggest threat for shark and ray species.³ A lack of proper reporting of catches and landings not only hinders effective fisheries management but also opens the door to illegal activities. The lack of sustainability and traceability of shark and ray products (meat and fins) in international trade obscures the data and further hinders measures urgently needed for fisheries and trade to become sustainable. Trade analysis can therefore provide meaningful information to complement available fisheries data, and shed light on the drivers of overexploitation.⁴

At the time of writing, 36% of the more than 1,200 known shark and ray species are threatened with extinction.⁵ The global community recognized the seriousness of the situation 20 years ago, with the release of the UN FAO International Plan of Action for Sharks (IPOA) based on a resolution from CITES⁶ (Convention on International Trade in Endangered Species of Wild Fauna and Flora). The aim of this voluntary international agreement was to ensure the conservation and management of sharks and rays and their long-term sustainable use. However, 20 years later the plan has made little impact in reversing trends in most shark-fishing actors, and population declines have largely

continued unabated due to the continued increase in trade (Davidson *et al.* 2016). Currently 14 species of shark and 29 species of ray are listed on CITES Appendices I and II, which states that their trade should be forbidden or closely controlled.

Why does this matter? The decline of sharks and rays is a contributing factor to the deterioration of our ocean, and symptomatic of much wider marine overexploitation.⁷ As top predators, these animals have existed for more than 400 million years⁸ and play essential roles in marine ecosystems, from maintaining balanced food webs and habitats, to controlling population sizes, and helping nutrient exchange through the ocean layers. Their role in carbon capture and storage – when they die of natural causes, their carcasses sink to the ocean floor and take their carbon with them – is also increasingly acknowledged as a factor to mitigate climate change.⁹

But to fill their vital and varied ecological niches and contribute to ocean health, shark and ray populations need conservation and management of their fisheries and trade – and in order for that to happen, we need a much better understanding of the opaque and complex global trade of their products.



- ¹ Worm *et al.* 2013 <https://doi.org/10.1016/j.marpol.2012.12.034>
- ² Dulvy *et al.* 2014 <https://elifesciences.org/articles/00590>, Tremblay-Boyer *et al.* 2018 <https://www.wcpfc.int/node/42932>
- ³ Dulvy *et al.* 2014 <https://elifesciences.org/articles/00590>
- ⁴ e.g. Dent and Clark 2015 <http://www.fao.org/3/i4795e/i4795e.pdf>. Okes and Sant 2019 <https://www.traffic.org/publications/reports/an-overview-of-major-shark-and-ray-catchers-traders-and-species/>
- ⁵ <https://www.iucnredlist.org/>
- ⁶ <https://cites.org/sites/default/files/document/E-Res-12-06-R18.pdf>
- ⁷ Dulvy *et al.* 2017 <https://www.sciencedirect.com/science/article/pii/S0960982217304827>
- ⁸ Kriwet *et al.* 2008 <https://doi.org/10.1098/rspb.2007.1170>
- ⁹ Mariani *et al.* 2020 <https://advances.sciencemag.org/content/6/44/eabb4848.abstract>

THE OVERALL TRADE VALUE

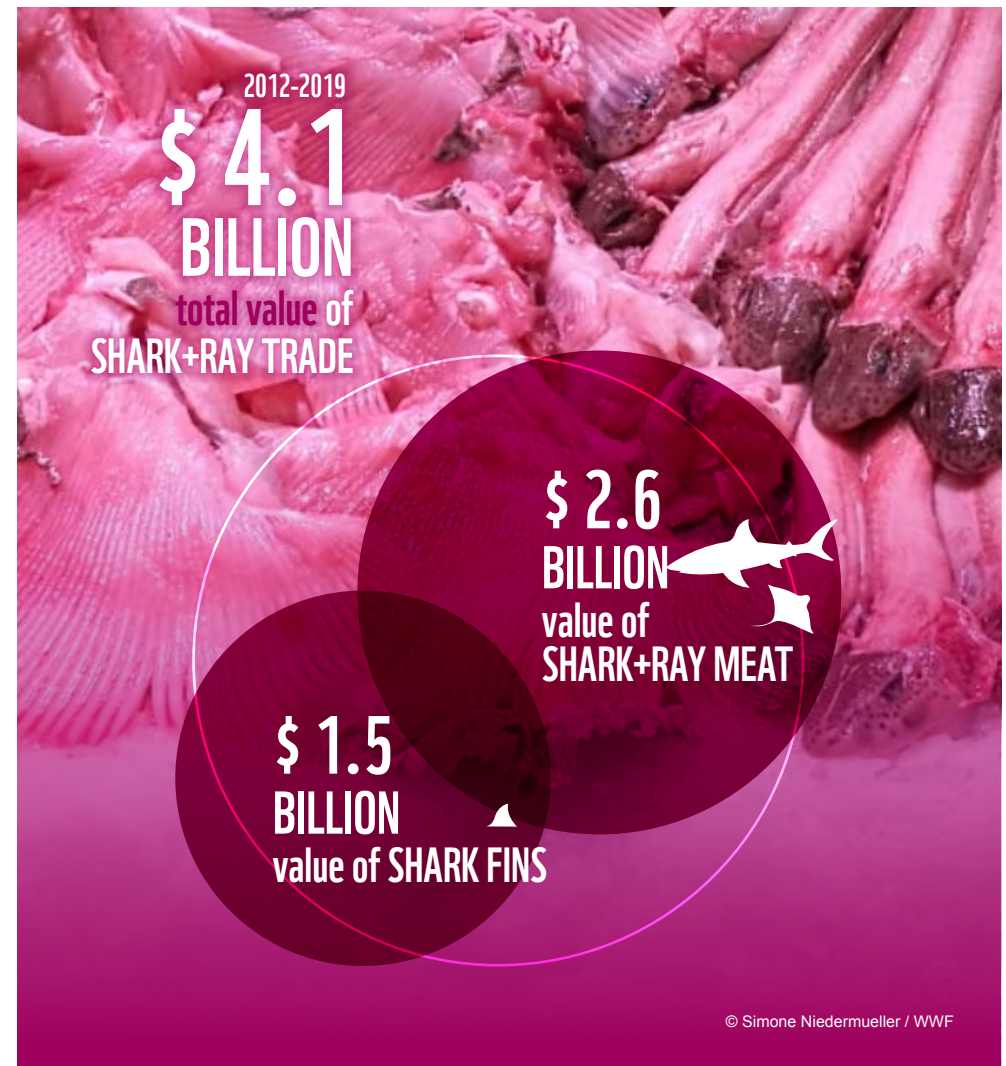
Even though fins are generally much more expensive than meat and the global fin trade has received far more attention to date, global trade in shark and ray meat is actually larger than trade in fins by both volume and by value.

The total value of shark and ray trade in the period 2012-2019 exceeds US\$4.1 billion. The value of shark and ray meat combined (US\$2.6 billion) exceeds the value of shark fins (US\$1.5 billion). Depending on the species and product types being traded, prices can range from US\$0.1/kg for meat to more than US\$100/kg for fins,¹⁰ with the latter reaching some of the highest prices in Asia. Price can vary widely depending on species, product and trader, among other factors that influence price. Of the top traders¹¹ Italy pays on average the highest price for imports of shark meat at US\$4/kg, while Hong Kong pays the highest price for fins at US\$30/kg.

Although shark meat products appear relatively cheap, and they're often fraudulently passed off as more expensive elasmobranch or bony fish species, they in fact contain hidden costs: these animals are worth more alive as key parts of in the ecosystem than dead in a boat, their true value as a carbon sink is only now becoming understood, and their meat often contains high levels of mercury and other toxic substances.

¹⁰ Clark and Dent 2015 <http://www.fao.org/3/i4795e/i4795e.pdf>, Okes and Sant 2019 <https://www.traffic.org/publications/reports/an-overview-of-major-shark-and-ray-catchers-traders-and-species/>, Fowler et al. 2021(BFN)

¹¹ The term “trader” refers to a country, territory or other political entity reporting trade data. For consistency the terms “importer,” and “exporter” have been used in the same way.



GLOBAL NETWORK ANALYSIS

WWF contracted a team of scientists¹² to develop the first analysis of the global shark and ray trade network using graph theory,¹³ to give as clear a picture as possible of the key players, relationships and properties of the networks that drive flows in this highly traded seafood product.

The scientific team used graph theory, the main tool of network science, to extract the meaning of shark and ray trade networks composed of import and export relationships for more than 250 traders. Their analysis is based on official information from the UN Comtrade, using a wide range of commodity codes for shark and ray products. None of these codes give species-specific information due to the lack of disaggregated data by species, but collectively they capture the reported global trade in sharks and rays in its entirety.

Along with looking at the number of trade relations of the network participants, i.e. how many traders each trader exports to and imports from, the flow of imports and exports was examined both in volume and in value. The sum of these imports and exports determines the 'strength'¹⁴ of each trader in the network. But regardless of volume and value, many traders have a high 'betweenness'¹⁵ that identifies them as important trade bridge makers, key players in the global system.

Trading networks, like many real-world networks, have emergent properties that only come to light through analyses that attempt to describe the structure of the network and not just the quantities or values and their flows. The new approach allows us to identify not only major importers and exporters but also traders playing an essential role as trade funnels or facilitators, providing key information on how and where best to focus international efforts to reverse the decline of shark and ray populations. Many of these emerging properties of the global trade network cannot be revealed by more conventional trade analysis.

The main results of the analysis and more details on the methods are available on [→ a free interactive online portal](#),¹⁶ where users can also configure their own searches by choosing one or more commodity codes, time periods and measures of centrality and trade influence.

A full peer-reviewed report will be released later in the scientific literature. In the meantime, some of the key findings about the shark¹⁷ and ray meat¹⁸ trade are detailed below.

- ¹² Sebastián Villasante (1), Silvia de Juan (2), Gill Ainsworth (1), Pablo Pita (1), Andrés Ospina-Alvarez (3) Affiliations:
1. Cross-Research in Environmental Technologies (CRETUS)-Department of Applied Economics, University of Santiago de Compostela, Campus Sur, Santiago de Compostela, A Coruña, Spain.
2. Institute of Marine Sciences ICM (CSIC), Passeig Marítim de la Barceloneta 37, CP 08003, Barcelona, Spain.
3. Mediterranean Institute for Advanced Studies IMEDEA (UIB-CSIC), C/ Miquel Marqués 21, CP 07190 Esporles, Balearic Islands, Spain.

- ¹³ <https://www.britannica.com/topic/graph-theory>

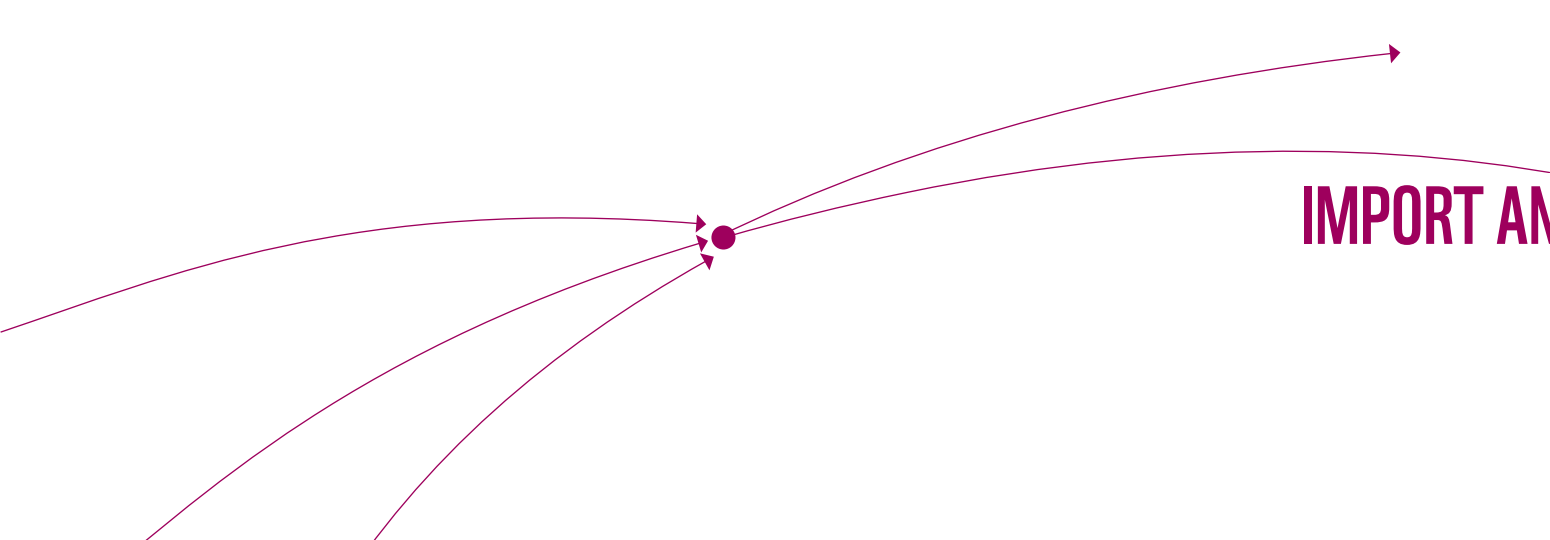
- ¹⁴ Also named weighted degree. It is the number of relations (edges) of the traders(nodes), but also considers the weight of each edge. The degree is the number of other traders with which a trader has trade relationships. Strength indicates if a trader is involved in important (by weight) trades with other traders. Hence the volume or the total value of trade is combined with the number of trade relationships to give a measure for the importance of the trader in the network. Traders with high strength can be acting as keystones since they are connected by imports and exports to many neighbouring traders.

- ¹⁵ Imports and exports are important, but they are not the whole picture. Traders with high betweenness centralities have been called 'bridges' and prevent network fragmentation. A trader that acts as a bridge between two well differentiated groups of traders usually has a high Betweenness.

- ¹⁶ https://aospina.shinyapps.io/SRGTN_WWF/

- ¹⁷ Shark meat UN COMTRADE (<https://comtrade.un.org/>) commodity codes: 030265; 030281; 030447; 030375; 030381; 030456; 030488 and 030496); N.B. 030488 is a combined code and also includes rays; we assume across all codes chimaeras (now called ghost sharks) are included as they have no separate code

- ¹⁸ Ray meats UN COMTRADE commodity codes: 030282; 030448; 030382; 030457 and 030497; N.B. that ray fins are currently not possible to be detected as they might be reported as shark fins (see also Dent & Clarke 2015 FAO report)



IMPORT AND EXPORT RELATIONSHIPS FOR MORE THAN 250 TRADERS

The application of graph theory to global seafood trade →

Graph theory is the mathematical study of a network of interacting elements. This approach provides a quantitative but simplified view of the multiple factors involved in the connection (edges) among elements (nodes) contained in a network. In a network of traders, graph theory provides insights into the trading relationships' properties and identifies critical nodes (traders) with high centrality that are connected to many other traders, or clusters of well-connected traders. In plain words, it goes beyond the mere interchange between network elements, by considering the network as a whole, where a node might play a crucial role independently on the dimension of the individual connections (i.e. transactions in a trading network). These emerging properties are measured through different centrality measures.



In-degree

indicates the number of connections coming into each trader (imports). This metric does not take into account the weight or strength of the edges.



Out-degree

indicates the number of connections going out from each trader (exports). This metric does not take into account the weight or strength of the edges.



Strength

is the number of relations (edges) between the nodes. Strength indicates if a node is involved in many important (by weight) interactions with other nodes. Nodes with high strength can act as keystones, since they are connected to many neighbouring nodes.



Betweenness

is a measure of the influence of a node over the flow of products between every pair of nodes. While the volume of transactions is important, it is not everything. Nodes with high betweenness have been termed 'bottlenecks' or 'bridges', and they prevent the fragmentation of the network.



Eigenvector

is a measure of the influence of a node in a network, as it takes into consideration not only how many connections a node has, but also the centrality of the nodes that it is connected to. High eigenvector indicates those nodes that are well connected to other highly connected nodes.

SHARK MEAT TRADE

Shark meat trade was analysed between 2009-2019 and shows a **highly complex global trade network**. The top exporters and importers as well as trade flows are listed in tables 1 and 2. We analysed the trade links (figure 1) as well as the strength and betweenness to identify key players and important intermediaries and trade bridges (figures 2 and 3). Some of the main findings include:



- The lucrative trade in shark fins is a well-known global issue – however, in economic terms the trade in shark meat is also significant but to date has received far less attention. The link between trade in shark meat and overfishing for threatened shark species needs to be more highly prioritized in public communication campaigns, as well as among those directly involved in shark fisheries.
- Spain dominated world trade in fresh and frozen shark meat from 2009 to 2019, appearing in the top three traders by value (approximately US\$536 million and US\$289 million in exports and imports, respectively), volume (approximately 184,000 t and 149,000 t in exports and imports, respectively) and number of trading partners (85 export links and 65 import links). It is by far the world's largest exporter, and it is also a significant importer: it could play a stronger role in monitoring the flow of shark products, and support the introduction of more refined trade and tariff codes that identify products at a species level to improve traceability.
- Over the last decade, the most important trade bridges¹⁹ for shark meat have been between Japan and Spain (and vice versa), Portugal and Spain, the UK and Spain, Japan and Panama, and China and Japan. These traders have the greatest influence on how shark meat flows around world markets, and should be the primary focus for where to implement future regulatory measures such as better traceability systems and a stricter control of illegal, unregulated and unreported (IUU) fishing activities.
- During the same decade China's influence has diminished, replaced by a few Southeast Asian players (Singapore and Hong Kong), all of which are mainly importers. The EU has established itself as the main supplier to these markets, its own exports and imports accounting for about 22% of the total global shark meat trade – which therefore makes it a key actor.

¹⁹ Imports and exports are important, but they are not the whole picture. Traders with high betweenness centralities have been called 'bridges' and prevent network fragmentation. A trader that acts as a bridge between two well differentiated groups of traders usually has a high betweenness. Because they are so important they can also act as important bottlenecks. They connect many different partners in the network which would 'fall apart' if the trader's trade flow was impaired. On the other hand any regulatory measure implemented in these traders can influence the network significantly.

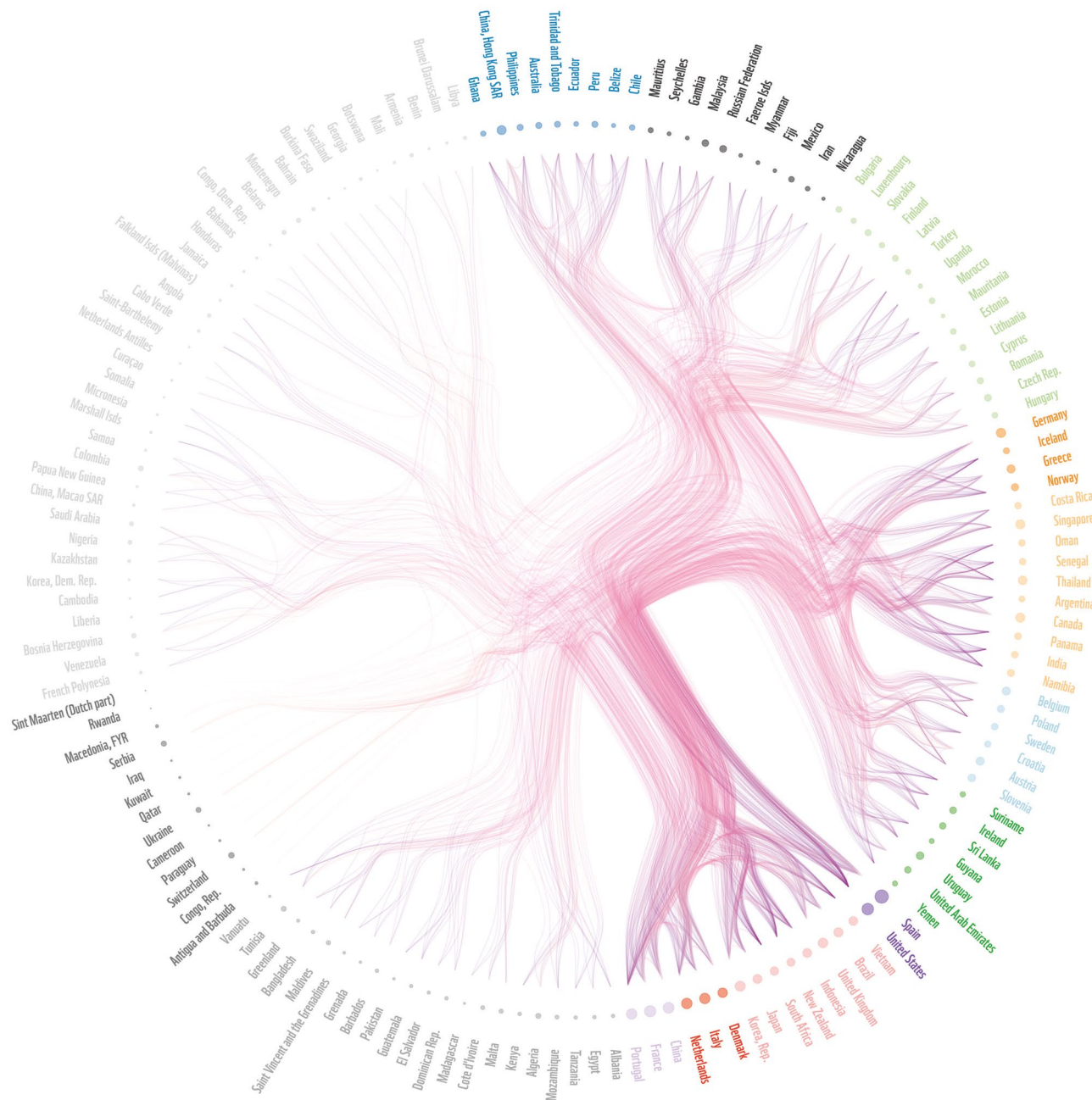


FIGURE 1.



Trade links between traders of shark meat by volume

Trade links between traders of shark meat by volume (UN Comtrade commodity codes: 030265; 030281; 030447; 030375; 030381; 030456; 030488 and 030496). The top 220 traders of shark meat network as nodes (circles) and their links as lines. The size and colour of the nodes represent the cluster membership and relative importance of the trader in the network, estimated from the number of trade links with other traders (i.e. degree): warm colours represent a high number of trade links (i.e. high degree) and cold and grayscale colours represent a small number of trade links (i.e. low degree). The thickness and colour of the edges represent the sum of trade links for all years between each pair of traders.

TABLE 1.

Ranking of the most important traders in the network of shark meat trade (2009-2019) in volume for top exporters, top importers, and top trade flows.



Export		
TOP EXPORTERS		VOLUME (t)
	Spain	183,884
	Portugal	104,758
	Uruguay	72,839
	Japan	59,117
	USA	49,422
	Namibia	37,492

Import		
TOP IMPORTERS		VOLUME (t)
	Brazil	149,484
	Spain	136,144
	Italy	88,876
	Portugal	60,316
	Uruguay	56,963
	China	34,809

Top flows between traders				
EXPORTER		IMPORTER		VOLUME (t)
	Uruguay		Brazil	71,750
	Portugal		Spain	70,571
	Spain		Italy	49,014
	Spain		Portugal	31,613
	Spain		Brazil	30,441
	Ecuador		Peru	21,176

Number of trade links		
TRADERS	EXPORT LINKS	IMPORT LINKS
 Spain	85	65
 USA	81	34
 France	54	52
 China	53	42
 Portugal	56	33
 Italy	48	40

TABLE 2.

Ranking of the most important traders in the network of shark meat trade (2009-2019) by value for top exporters, top importers, and top trade flows.



Export		
TOP EXPORTERS		VALUE (USD)
	Spain	536,339,368
	Portugal	232,967,950
	USA	192,719,619
	Uruguay	177,983,226
	China	165,072,476
	Singapore	128,347,782

Import		
TOP IMPORTERS		VALUE (USD)
	Italy	344,401,467
	Brazil	327,864,620
	Spain	288,814,173
	Hong Kong SAR	183,680,756
	Portugal	118,860,422
	Japan	115,390,016

Top flows between traders				
EXPORTER		IMPORTER		VALUE (USD)
	Uruguay		Brazil	174,322,699
	Portugal		Spain	157,595,128
	Spain		Italy	149,156,246
	France		Italy	76,829,172
	Spain		Hong Kong SAR	65,660,084
	Spain		Portugal	62,463,253

Number of trade links			
TRADERS		EXPORT LINKS	IMPORT LINKS
	Spain	85	65
	USA	81	35
	France	54	52
	China	53	42
	Portugal	56	33
	Italy	48	40

Shark Global Trade Network

Fresh and Frozen Meat | Normalised Mass (Kg) | 2009 - 2019

Data from <https://comtrade.un.org> | United Nations

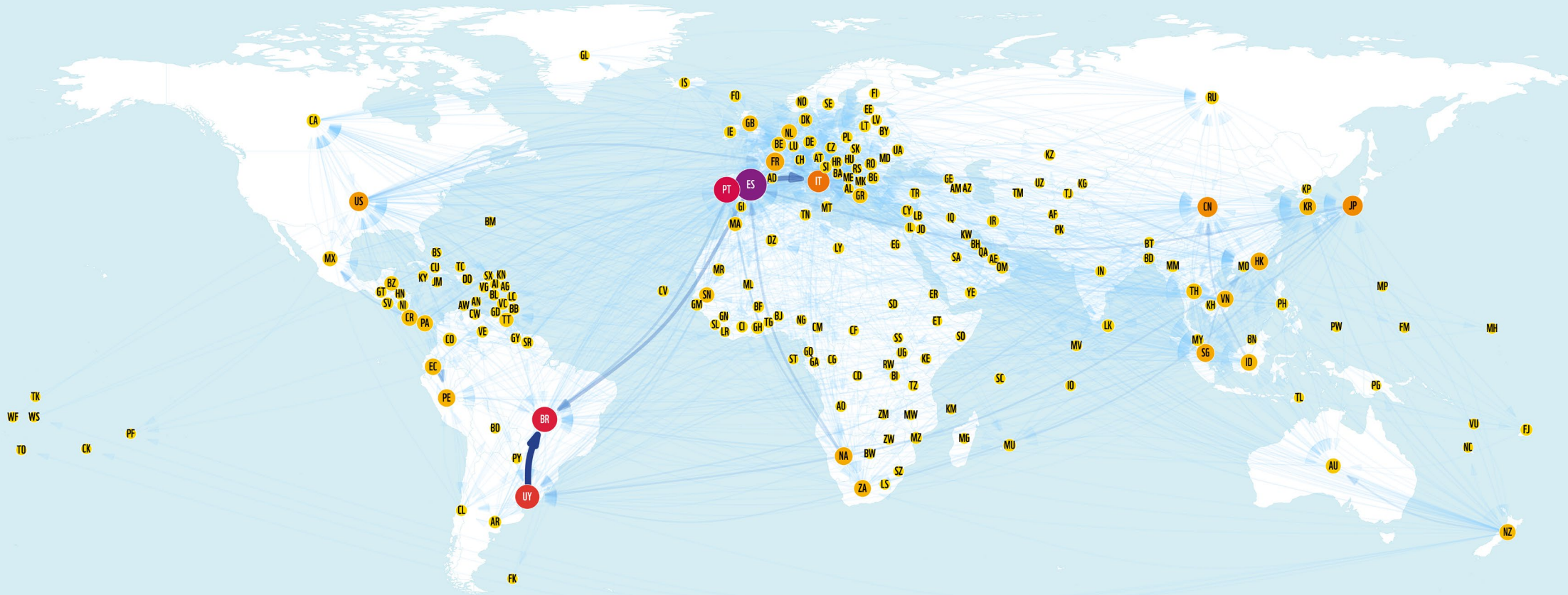


FIGURE 2.



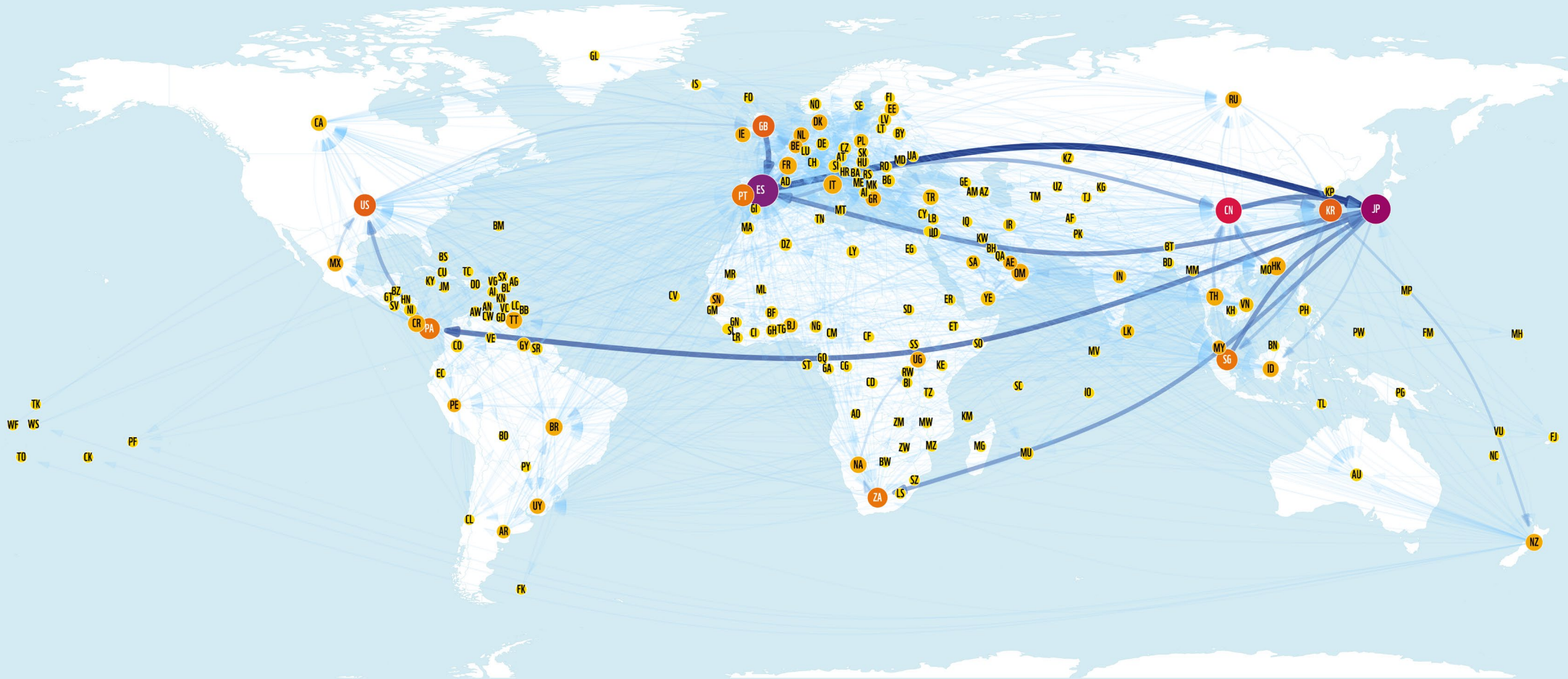
Global trade network for shark meat (2009-2019). The quantities correspond to the normalised amount of mass (kg) traded. Each node represents a trader and each edge represents the relationship between two traders. The size and colour of the node represent the relative importance of the trader in the network in terms of its strength above and betweenness below. The width and intensity of the color of the edge represents the relative importance of the relationship between two traders in terms of their edge strength above and edge betweenness below, with each arrow representing the direction of the trade flow from an exporter to an importer. This graph is based on UN COMTRADE commodity code(s): 030265; 030281; 030447; 030375; 030381; 030456; 030488 and 030496.

Shark Global Trade Network

Fresh and Frozen Meat | Normalised Mass (kg) | 2009 - 2019

Data from <https://comtrade.un.org> | United Nations

normalised betweenness 0.00 0.25 0.50 0.75 1.00 | 0.00 0.25 0.50 0.75 1.00 normalised edge betweenness



Shark Global Trade Network

Fresh and Frozen Meat | Normalised USD | 2009 - 2019

Data from <https://comtrade.un.org> | United Nations

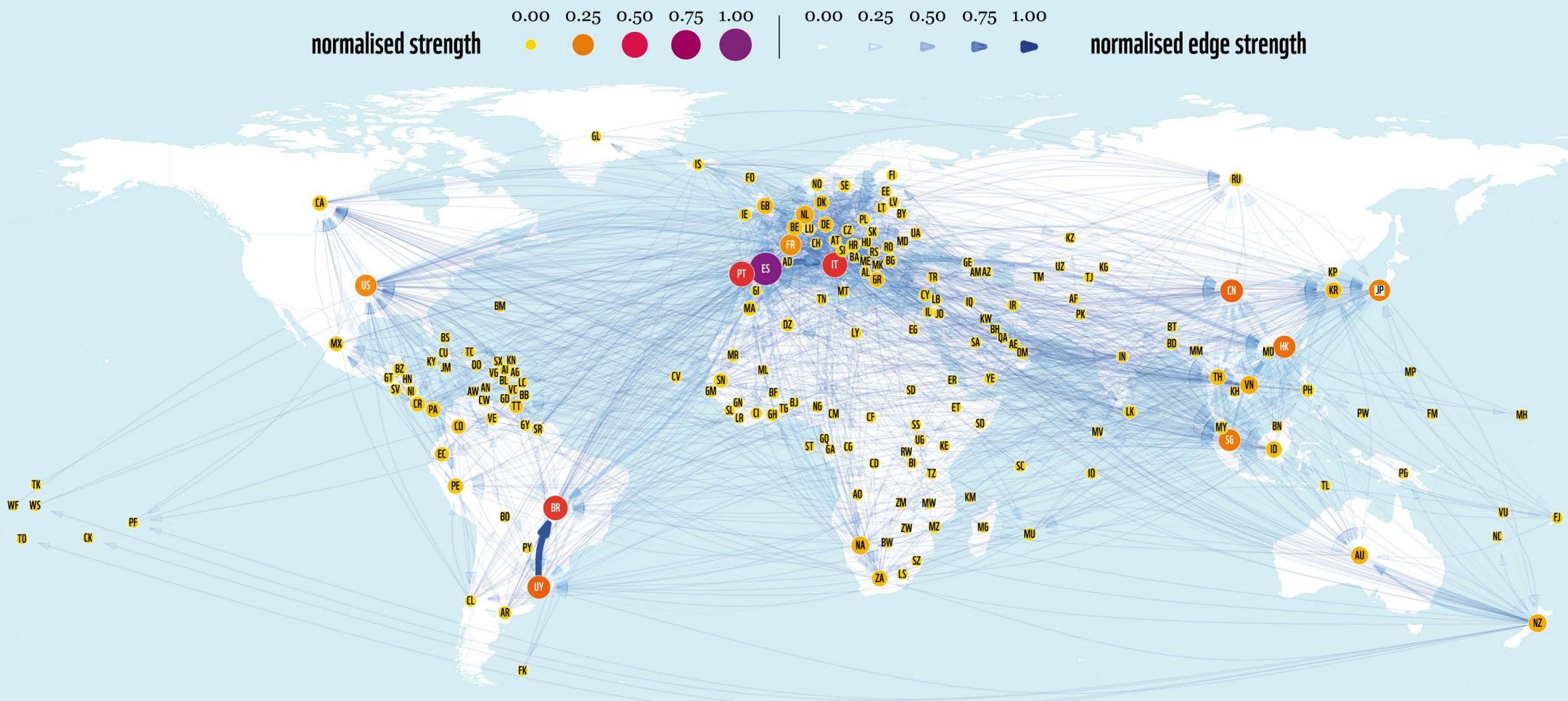


FIGURE 3.



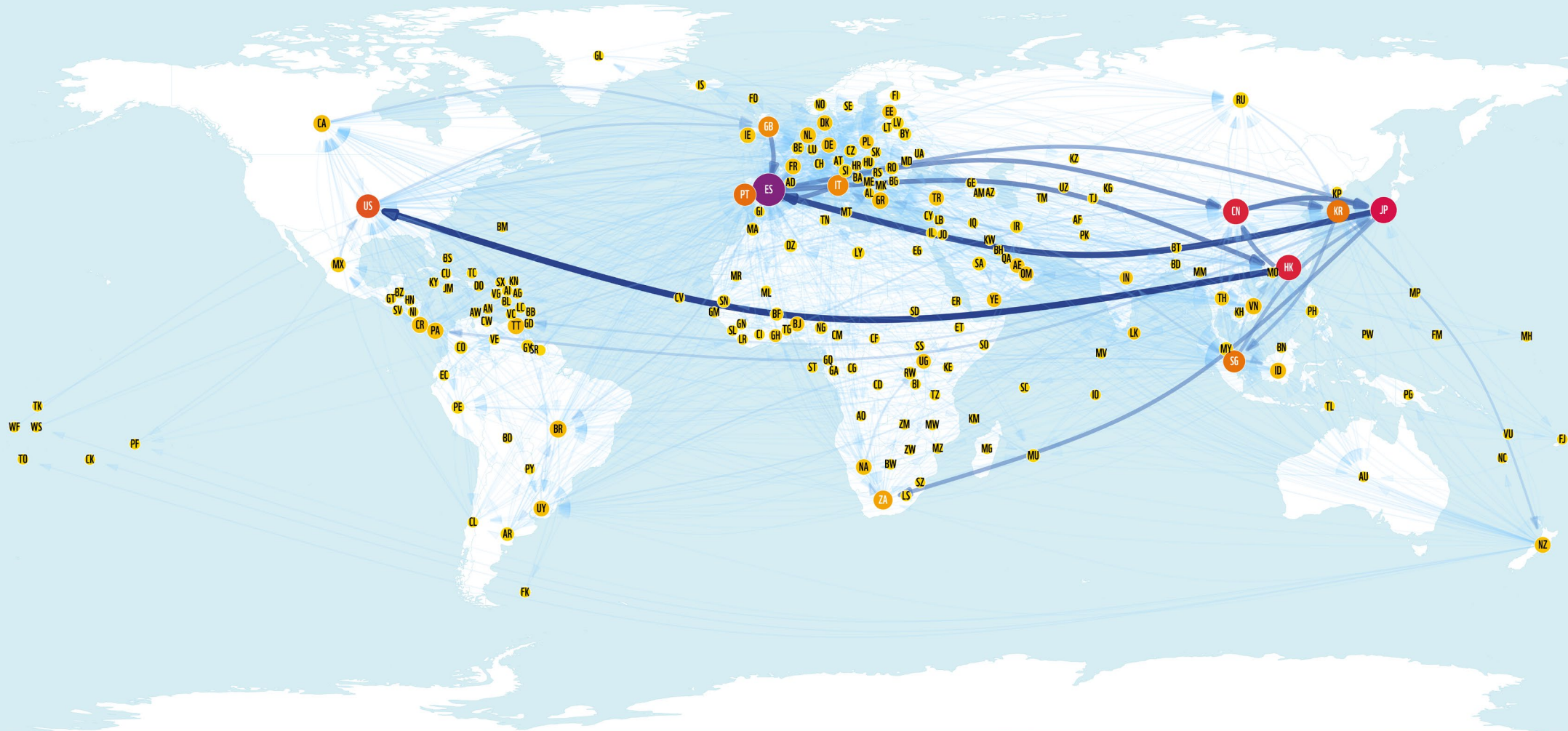
Global trade network for shark meat between 2009-2019. The quantities correspond to the normalised amount of value (US\$) traded. Each node represents a trader and each edge represents the relationship between two traders. The size and colour of the node represent the relative importance of the trader in the trade network in terms of its strength above and betweenness below. The width and intensity of the colour of the edge represents the relative importance of the relationship between two traders in terms of their edge strength above and edge betweenness below. These graphs are based on UN Comtrade commodity code(s): 030265; 030281; 030447; 030375; 030381; 030456; 030488 and 030496.

Shark Global Trade Network

Fresh and Frozen Meat | Normalised USD | 2009 - 2019

Data from <https://comtrade.un.org> | United Nations

normalised betweenness 0.00 0.25 0.50 0.75 1.00 0.00 0.25 0.50 0.75 1.00 normalised edge betweenness



RAY MEAT TRADE

Ray²⁰ meat trade was analysed between 2012-2019²¹ and shows a less complex global trade network. The top exporters and importers as well as trade flows are listed in table 3 and 4. We analysed the trade links (figure 4) as well as the strength and betweenness to identify key players and important intermediaries and trade bridges (figure 5 and 6). Some of the main findings include:



- The global trade network for ray meat follows different directions and features different actors to those underpinning the shark meat trade. This network should therefore be treated separately from the shark meat network, with attention being focused on its unique characteristics.
- The ray meat trade is less diversified, with trade between Argentina as an exporter and South Korea as an importer dominating the market in both monetary and volume terms over the last decade. The USA and Brazil are also important suppliers to the South Korean market. Attention should be focused on these (and other important) trade connections with South Korea as any impacts (e.g. implementation of regulations, trade sanctions etc.) could potentially reverberate across the entire global trade network.
- South Korea's exports to the USA, although not large in volume or value, are important for the structure of the network. The USA is the first non-Asian trader to which South Korea exports processed ray products. This intercontinental bridge is key to the stability of the network and thus presents an important focal point for future ray conservation and management activities. Furthermore, this emerging property is not identifiable by conventional analysis, which demonstrates the importance of the graph theoretical method to understanding the role of bridges in complex trade networks.
- Perhaps surprisingly, while most of the high-volume movement of ray meat products involves traders outside the EU, several of the most important bridging traders in the network (those with a high 'betweenness' score) come from within the EU: the top three are France, Spain and the Netherlands. Elsewhere the USA, Indonesia, Canada and New Zealand are also prominent. Any efforts to regulate or manage the ray meat trade need to include a focus on these key traders, since measures they put in place would have the greatest impact on the network as a whole.

²⁰ For simplicity "rays" in the following includes rays and skates

²¹ The categories for rays only exist since 2012 in Comtrade data

TABLE 3.

Ranking of the most important traders in the network of ray meat trade (2012-2019) by volume for top exporters, top importers, and top trade flows.



Export		
TOP EXPORTERS		VOLUME (t)
	Argentina	81,601
	Sierra Leone	55,818
	USA	41,524
	Indonesia	18,049
	Spain	16,188
	Japan	9,752

Import		
TOP IMPORTERS		VOLUME (t)
	Korea	141,655
	Ghana	55,788
	France	26,131
	Malaysia	18,231
	China	15,600
	Portugal	9,471

Top flows between traders				
EXPORTER		IMPORTER		VOLUME (t)
	Argentina		Korea	67,065
	Sierra Leone		Ghana	55,787
	USA		Korea	19,904
	USA		France	11,170
	Indonesia		Malaysia	10,084
	Brazil		Korea	9,252

Number of trade links		
TRADERS	EXPORT LINKS	IMPORT LINKS
 France	58	35
 USA	66	18
 Netherlands	43	33
 Spain	39	35
 Korea	29	43
 Germany	39	24

TABLE 4.

Ranking of the most important traders in the network of ray meat trade (2012-2019) by value for top exporters, top importers, and top trade flows (US\$).



Export	
TOP EXPORTERS	VALUE (USD)
 Argentina	221,230,213
 USA	144,779,396
 Spain	53,640,864
 Japan	43,234,144
 China	41,428,758
 Indonesia	34,872,536

Top flows between traders		
EXPORTER	IMPORTER	VALUE (USD)
 Argentina	 Korea	195,064,464
 USA	 Korea	68,412,749
 USA	 France	44,874,924
 Japan	 Korea	41,897,976
 Spain	 Portugal	31,688,484
 Brazil	 Korea	29,634,366

Import	
TOP IMPORTERS	VALUE (USD)
 Korea	449,614,966
 France	97,772,005
 Malaysia	38,220,861
 Portugal	33,146,065
 Japan	31,654,899
 Belgium	21,584,838

Number of trade links		
TRADERS	EXPORT LINKS	IMPORT LINKS
 France	58	36
 USA	65	18
 Netherlands	43	33
 Spain	39	35
 Korea	29	43
 Germany	39	25

Rays Global Trade Network

All elaborations | Normalised Mass (kg) | 2012 - 2019

Data from <https://comtrade.un.org> | United Nations

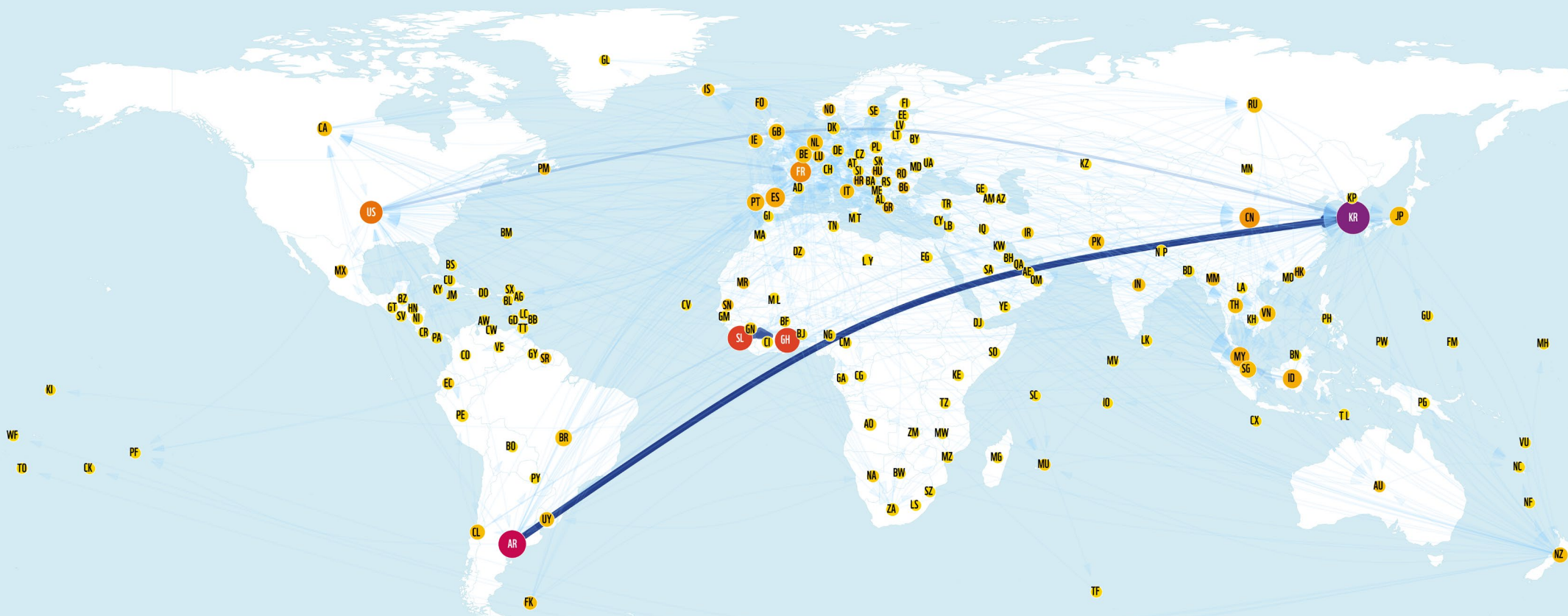


FIGURE 5.



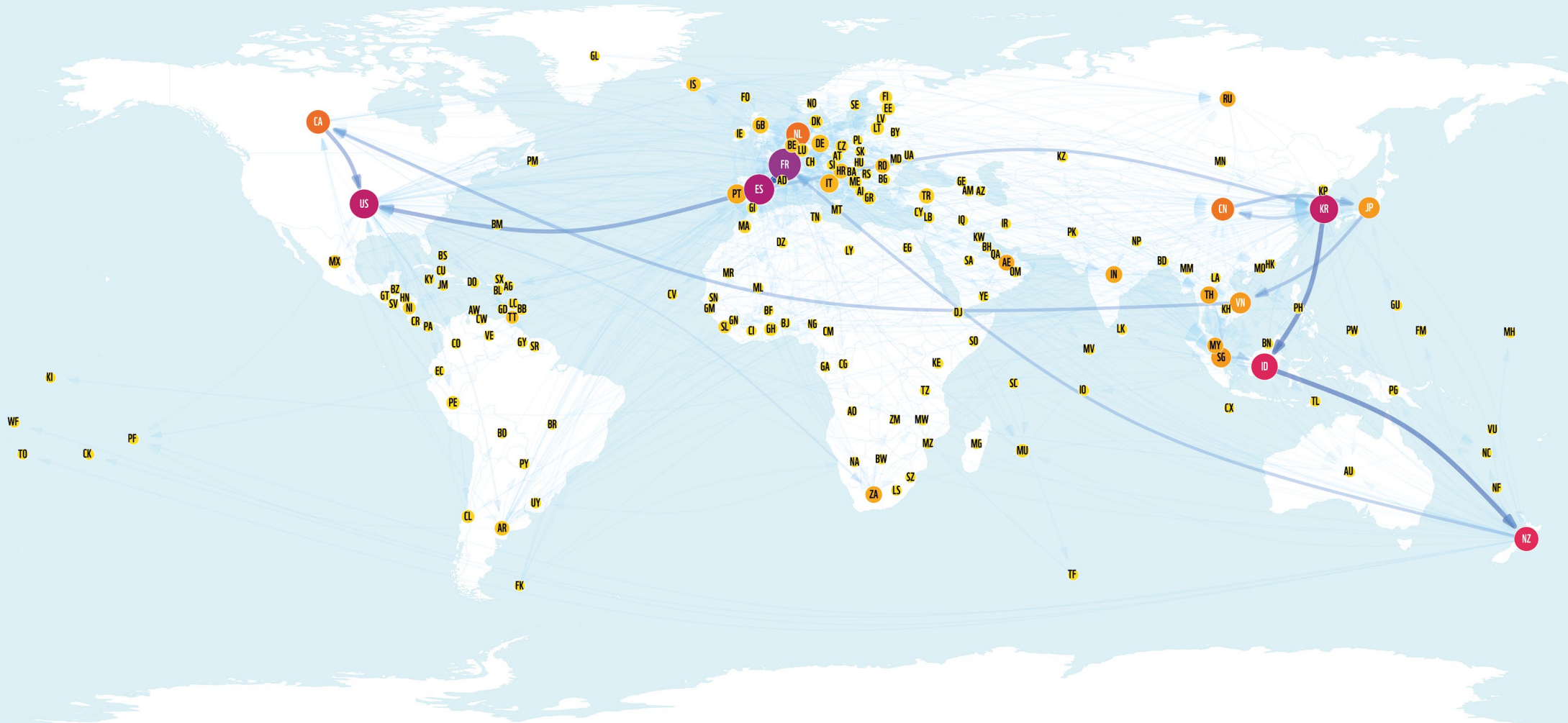
Global trade network for ray and skate meat between 1 January 2012 and 31 December 2019. The quantities correspond to the normalised amount of mass (kg) traded. Each node represents a trader and each edge represents the relationship between two traders. The size and colour of the node represent the relative importance of the trader in the network in terms of its strength above and betweenness below. The width and intensity of the color of the edge represents the relative importance of the relationship between two traders in terms of their edge strength above and edge betweenness below, with each arrow representing the direction of the trade flow from an exporter to an importer. This graph is based on UN COMTRADE commodity code(s): 030282; 030448; 030382; 030457 and 030497.

Rays Global Trade Network

All elaborations | Normalised Mass (kg) | 2012 - 2019

Data from <https://comtrade.un.org> | United Nations

normalised betweenness 0.00 0.25 0.50 0.75 1.00 | 0.00 0.25 0.50 0.75 1.00 normalised edge betweenness



Rays Global Trade Network

All elaborations | Normalised USD | 2012 - 2019

Data from <https://comtrade.un.org> | United Nations

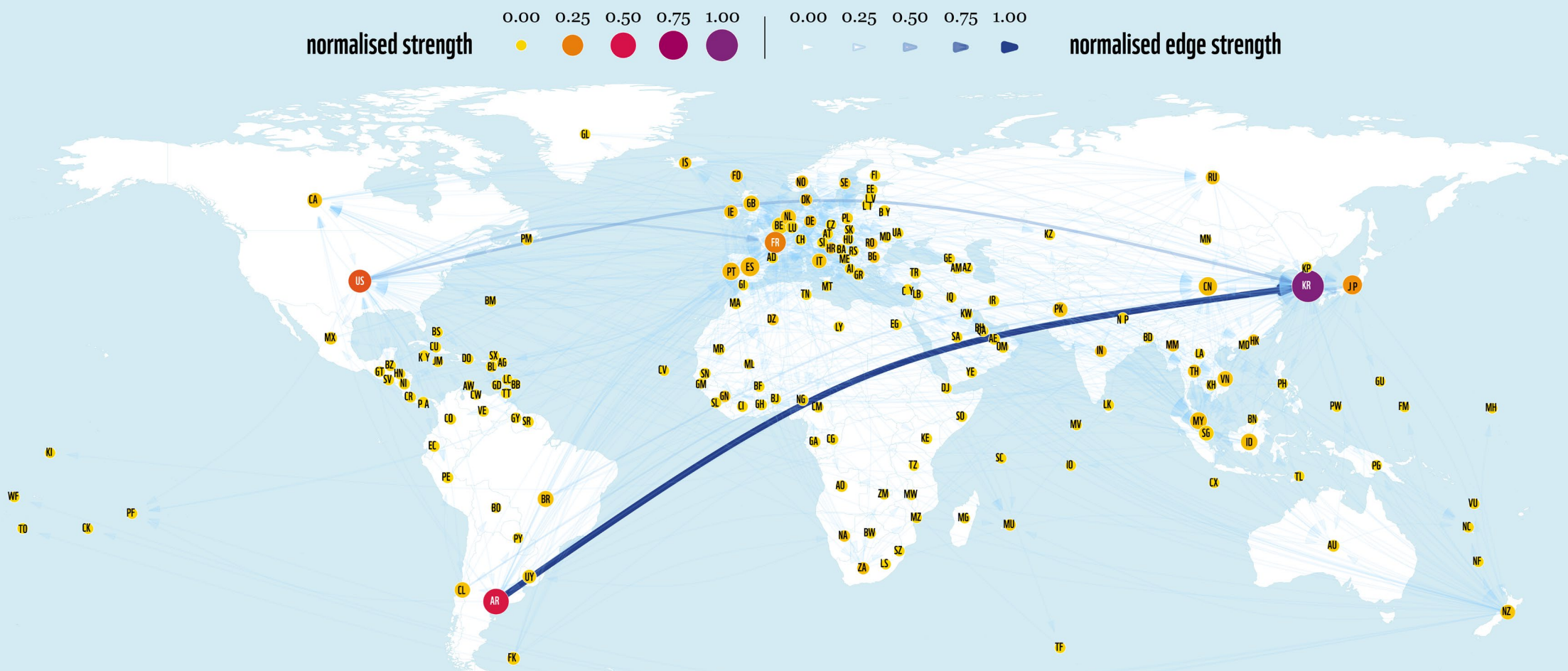


FIGURE 6.



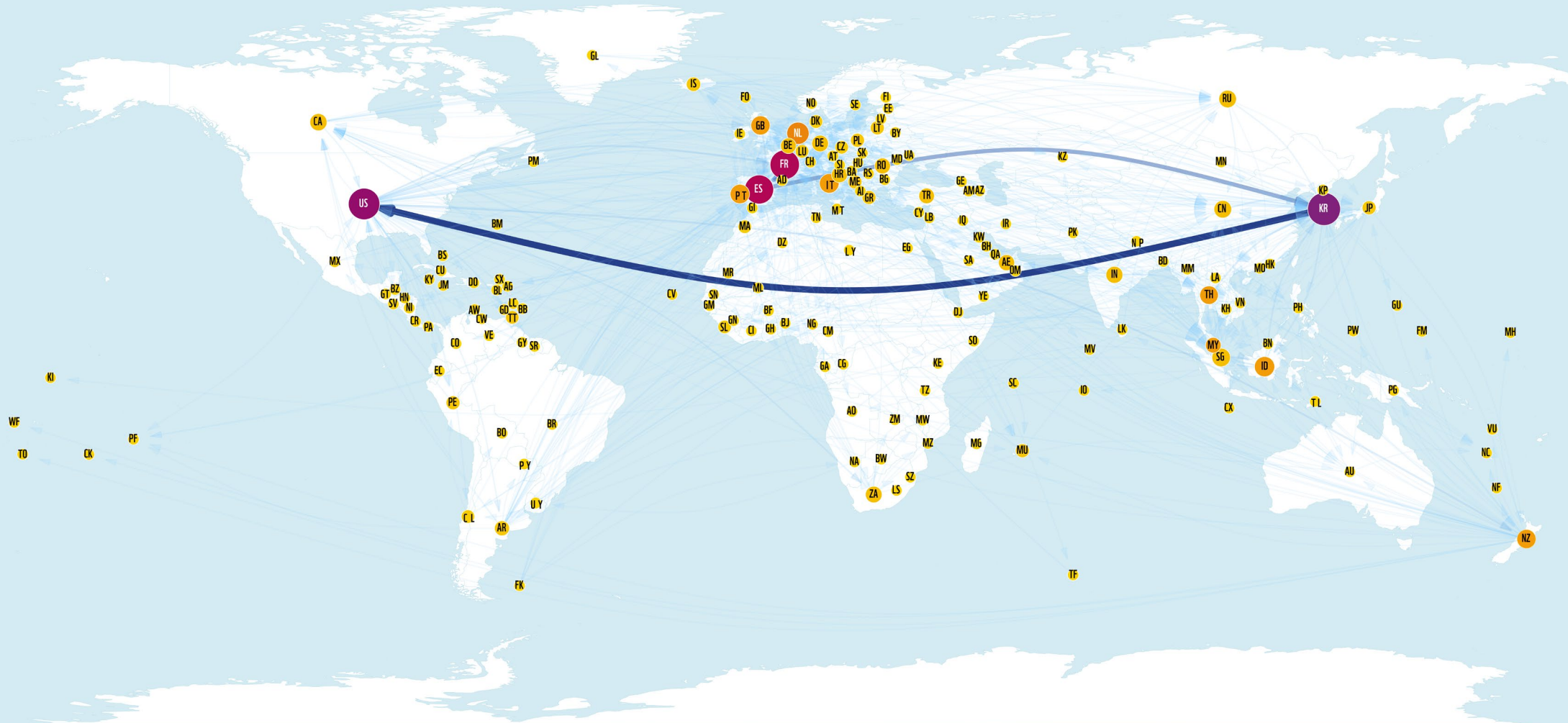
Global trade network for ray and skate meat between 1 January 2012 and 31 December 2019. The quantities correspond to the normalised amount of value (US\$) traded. Each node represents a trader and each edge represents the relationship between two traders. The size and colour of the node represent the relative importance of the trader in the network in terms of its strength above and betweenness below. The width and intensity of the colour of the edge represents the relative importance of the relationship between two traders in terms of their edge strength above and edge betweenness below, with each arrow representing the direction of the trade flow from an exporter to an importer. This graph is based on UN COMTRADE commodity code(s): 030282; 030448; 030382; 030457 and 030497.

Rays Global Trade Network

All elaborations | Normalised USD | 2012 - 2019

Data from <https://comtrade.un.org> | United Nations

normalised betweenness 0.00 0.25 0.50 0.75 1.00 | 0.00 0.25 0.50 0.75 1.00 normalised edge betweenness





Although shark meat products **APPEAR RELATIVELY CHEAP**,
and they're often fraudulently passed off
as more expensive
elasmobranch or bony fish species,
THEY IN FACT CONTAIN HIDDEN COSTS.



The role of the European Union in the shark and ray trade

The EU plays a significant role in the global trade of shark and ray products. EU Member States not only include some of the most important traders in volume and value terms, but they also act as important trade bridges between key parts of the global network. This means that these traders could have a major impact on prices and the flow of traded volume.

The EU's imports account for 17.3% of total transactions in the global network since 2000. It is a key player with important market regulatory tools such as the EU control regulation²² and the EU IUU regulation²³ with the potential to improve traceability of sharks and rays, and prevent and deter IUU fishing of sharks and rays. However, to date EU shark fisheries have no comprehensive management framework either at European or Regional Fisheries Management Organization (RFMO) level, and the European Action Plan for Sharks is outdated and lacks SMART targets.²⁴

One area in which EU legislation has had some success in conservation terms has been the introduction of the 'Fins Naturally Attached' regulation²⁵ in 2013, which prohibits vessels in EU waters, as well as EU vessels outside EU waters, from removing valuable shark and ray fins at sea and then discarding the carcasses (or the fatally injured animals while still alive) to leave room in the hold for more lucrative species such as tuna or billfish.

Other states would do well to follow the EU's lead on 'finning'. The practice of finning not only has ethical objections made against it, it's also contributing to dramatic declines in shark and ray populations largely driven by overfishing. Even so, the EU continues to be a major source of legally obtained fins, and by fuelling the global market it contributes to the worsening of the overall situation.

²² EU Regulation 1224/2009

²³ EU Regulation 1005/2008

²⁴ <https://stecf.jrc.ec.europa.eu/documents/43805/2570959/STECF+19-17+-+Shark+Finning.pdf/0356b56d-78b1-4a98-bf78-9772eef3bbbf>

²⁵ Regulation (EU) No 605/2013

SHARK AND RAY ON THE MENU

A GLOBAL SELECTION OF DISHES WITH SHARK AND RAY MEAT

Germany & Austria

- **Schillerlocken** (smoked belly flaps of Spiny dogfish/Spurdog *Squalus acanthias*):
Eaten as a snack in a bread roll (Fischbrötchen) or for cold dinner for at least a century in northern Germany. Can be bought at fishmongers, at fish bread roll stands at fairs or at touristy harbour places
- **Hai-Steak** formerly marketed as **Kalbsfisch** (veal-fish):
Fillets of porbeagle (*Lamna nasus*) eaten with potatoes, salad, and sauce. Vanished largely due to prohibition of Porbeagle catches in NE Atlantic waters in 2010

Portugal

- **Raia alhada:**
ray *Raja* sp. wings cooked with garlic
- **Caldeirada de pata roxa:**
stewed nursehound *Scyliorhinus stellaris* and potatoes in sauce

France

- **Aile de raie au beurre noir:**
ray wings cooked in black butter

Spain

- **Cazón adobado:** a traditional dish made with marinated and battered tope shark (*Galeorhinus galeus*)

Peru

- **Tortilla de raya** (ray omelette):
traditional dish from northern Peru, specially Lambayeque region, consumed by locals and tourists
- **Chinguirito:**
a traditional ceviche-style dish from northern Peru prepared with cured and dried meat from a species of ray called pacific guitarfish (*Rhinobatos planiceps*)

DISHES WITH SHARK AND RAY MEAT

Porridge



Stew



Grilled steak



Fish and chips



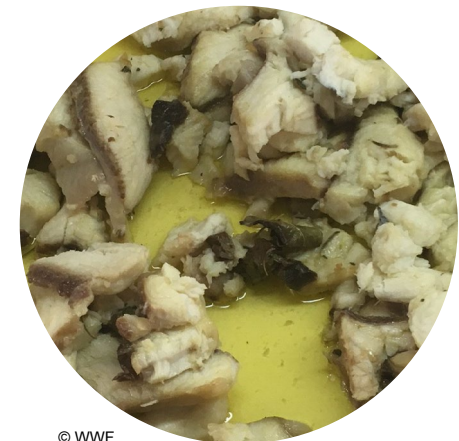
Ceviche



Skewers



Omelette



© WWF



© Semo Mapai / WWF-Mozambique



© H. Zidowitz / WWF



© Monica Barone / WWF Safesharks



Singapore

- **Barbequed Sambal Stingray:**
a prominent product tourists will encounter if they visit Singapore. Almost every food centre has a stall serving this and Singapore import rays in large volumes to feed this demand



Malaysia

- **Sinagol:**
a traditional Bajau dish in Sabah, commonly uses small sharks (juvenile) cooked with turmeric and other spices. Sometimes, the dishes are also cooked with shark liver, which is more an authentic recipe rather than with the shark fillet alone
- **Gulai Ikan Yu Perejang** (Perejang shark curry):
curry-like dish that uses wedgefishes, observed to be a growing demand dish particularly in the Eastcoast of West Malaysia
- **Cui zha sha yu pian** (crispy fried shark fillet) and **Sha yu zhou** (shark porridge):
both dishes are quite popular delicacies, usually served in restaurants near coastal areas



Australia

- **Shark fish and chips:**
meat from tope shark (also called “school shark”, *Galeorhinus galeus*) is sold in Australian fish and chips shops as “flake”



Indonesia

- **Fish Satay:**
a popular and relatively affordable dish in East Java that often included shark meat, in some cases thresher shark (*Alopias* spp.) as revealed by DNA analysis
- **Sliced shark meat:**
often used as substitute for snapper. Prepared mostly deep fried with sweet and sour sauce. Popular at weddings or other events
- **Salted fish:**
often done with meat of shark or ray. The meat is soaked in salt and then dried. Often used as gift or handout



Ecuador

- **Ceviche de tollo** (shark ceviche, smooth-hound ceviche):
a type of ceviche most commonly prepared from “tollos” - smooth-hound sharks from the genus *Mustelus*



Mozambique

- **Shark meat samosas** (Chamuças de tubarão)
- **Raia frita:**
Fried ray meat with garlic and coconut milk (or lemon)
- **Tocossado de tubarão:**
Shark stew



Consumers should **AVOID BUYING OR EATING ANY SHARK OR RAY PRODUCTS** unless they are from sustainable and traceable sources: currently very few products available in the market meet these requirements



RECOMMENDATIONS

This analysis of the global shark and ray trade network has revealed a highly complex network of international actors. It has identified not only major importers and exporters of shark and ray meat and fins but also traders playing an essential role as trade funnels or facilitators, providing useful information on how and where best to focus international efforts to reverse the decline of shark and ray populations. Many of these emerging properties of the global trade network have not been revealed to date. Building on the findings, we make several recommendations for how different trade actors should support the conservation and management of shark and ray fisheries and associated trade.

STATES AND TERRITORIES

- The leading players in the global trade of sharks and rays must step up as **global champions** for conservation and sustainable fishing, accelerating fishery management and recovery plans at national level and in RFMOs. This is a pragmatic commercial consideration as well as an ecological one: without precautionary measures and science-based management, shark and ray populations will not remain viable as economic and ecological resources. The number of species for which sustainable fishing is still possible is dwindling over time.
- They should put in place **legislation** to harmonize landing, market and trade categories, and to drastically improve traceability systems.
- They should **follow regulations** to which they're signed up. In the EU for example, regulations on seafood labelling²⁶ – which specify species, gear and origin – should be fully implemented so consumers can make informed choices about their purchases.
- Regional and National **Plans of Action** for Sharks should be formulated where they do not exist, and updated every four years in line with the FAO's IPOA for Sharks. These Plans should include detailed consideration of market issues, and include strict regulation of shark and ray products intended for trade.
- They should fully support and facilitate **collaboration between fisheries and environmental bodies** to ensure the implementation of Shark Plans of Action, and the implementation of relevant agreements and conventions such as the Port State Measures Agreement,²⁷ the Convention on Migratory Species,²⁸ and CITES at regional and national level.
- Traders **should ensure sufficient resources for controls, monitoring and surveillance** of shark and ray fisheries and markets. This includes capacity building for fishers and control authorities regarding species identification and understanding existing legislation.
- **Trade and tariff codes** need to be refined and made far more detailed. Species-specific reporting needs to be improved globally, including for bycatch: accurate reporting of catches at species level is as important for trade data as it is for sustainable management, not to mention to avoid illegal landings. Commodity coding systems could also be modified to include product categories from threatened species, as a gesture of support for improved management.
- Trade and tariff codes for **ray meat** in particular need urgent attention, and should be improved to differentiate between ray products, including fins and gill plates, and ray species. The trade in ray fins and rostra – often of highly threatened species – is significant but is poorly understood and often overlooked, making effective monitoring of the trade almost impossible. Capacity-building in species identification for fishers and port and control authorities would improve landing and trade data.
- The widespread categorization of sharks and rays as **'bycatch'** is highly problematic, and needs to be resolved. Today, many deliberately caught sharks and rays are recorded under the general code 'bycatch' when landed with primary target species like tuna, lowering expectations that sharks and rays require the same kind of management measures that would

be expected in targeted fisheries (which they do). This also makes species-specific data far harder to gather, and contributes to population declines. Our figures show, for example, that while in Argentina directed fisheries for rays are prohibited, its ray trade flow with South Korea is the largest in the world. France, meanwhile, exports rays from mostly Atlantic fisheries to 58 other traders but proper fisheries management is hindered by the absence of species-specific EU Total Allowable Catches (TACs) of rays. All fisheries taking significant numbers or species of sharks and rays need management that clearly separates incidental catches from secondary target catches that are regularly landed, marketed and traded: this would reduce the risk of the latter remaining unmanaged, and overfishing occurring.

²⁶ EU Regulation 2013/1379

²⁷ The Agreement on Port State Measures (PSMA) is the first binding international agreement to specifically target IUU fishing. Its objective is to prevent, deter and eliminate IUU fishing by preventing vessels engaged in IUU fishing from using ports and landing their catches. www.fao.org/port-state-measures/en/

²⁸ The Convention on Migratory Species is the global convention aimed at the conservation of migratory species, their habitats and migration routes <https://www.cms.int>

TRADE AND SUPPLY CHAIN ACTORS

- **Transparency and traceability** are critical to ensure that the trade in sharks and rays remains legal and manageable, and to keep protected species out of the market. Best practice guidance from CITES and other bodies should be followed, while new tools such as TRAFFIC recently released SharkTrace²⁹ can be used to tag sharks and rays at point of capture and then to trace them throughout the supply chain.

²⁹ www.traffic.org/SharkTrace

CONSUMERS

- When buying fish in restaurants, markets or grocery stores, ask where the fish comes from and how it was caught, and what kind of species it really is. Shark and ray is often sold under vernacular names that disguise the species: skate fillets are sold as ‘pollo de mar’ (sea chicken) in Argentina; while South Africa sells shark meat (shortfin mako shark) labeled as “ocean fillets” or “skomoro”, shark meat is sold as “saumonette” in France, “Palombo” in Italy, or “rock salmon” in the UK. Do not buy or eat seafood without a clear answer. Restaurants, fishmongers and retailers often claim to have a sourcing policy, so perseverance in asking the question will bring more transparency. Local sustainable seafood guides often provide information to help identify the common names of shark and ray species, what cuts of meat may look like and whether products from these species are sustainable or not.
- Where food security does not depend on shark and ray products: consumers should avoid buying or eating any shark or ray products unless they are from sustainable and traceable sources. Be aware that currently very few products available in the market meet these requirements.

**TRANSPARENCY AND TRACEABILITY ARE NEEDED
FROM POINT OF CAPTURE THROUGH EVERY STAGE
OF THE SUPPLY CHAIN, TO ENSURE THE TRADE
REMAINS LEGAL AND MANAGEABLE, TO KEEP
PROTECTED SPECIES OFF THE MARKET,
AND TO ALLOW CONSUMERS TO MAKE
INFORMED PURCHASES**



Working to sustain the natural
world for the benefit of people
and wildlife.

together possible™ wwfmmi.org

© 2021

WWF MMI, Via Po 25/c, 00161, Rome - Italy

WWF® and World Wide Fund for Nature® trademarks and ©1986 Panda Symbol are owned by WWF-World Wide Fund For Nature (formerly World Wildlife Fund). All rights reserved.

For contact details and further information, please visit our international website at wwf.mmi.org

