THE GLOBAL VIEW OF TRANSSHIPMENT: REVISED PRELIMINARY FINDINGS

August 2017

Executive Summary

Transshipment at sea, the offloading of catch from a fishing vessel to a refrigerated cargo vessel far from port, obscures the actual source of the catch and is a significant pathway for illegally caught fish to enter the legitimate seafood market. Occurring out of sight and over the horizon, the practice enables other nefarious activity, ranging from smuggling to human trafficking. Increasing the transparency of transshipment could improve fisheries management and reduce human rights abuses.

To address this gap in transparency, SkyTruth and Global Fishing Watch analyzed over 21 billion positional Automatic Identification System (AIS) messages from ocean-going vessels between 2012 and July 2017, and we identified and tracked 641 vessels with refrigerated cargo holds ("reefers") capable of transshipping at sea and transporting fish. We mapped 71,468 instances where these vessels loitered at sea long enough to receive a transshipment, events that we call "potential rendezvous," and 5,783 instances where we see a fishing vessel near a loitering transshipment vessel long enough to engage in transshipment. We call those "likely rendezvous." We considered only events that occurred at sea, ignoring transshipments at port, which are generally less of a management challenge. Our key findings include:

A rendezvous at sea: Hai Feng 648 refrigerated cargo vessel at the Argentine EEZ boundary with the fishing vessel Lu Rong Yuan Yu 898. November 30th, 2016. Satellite image provided by DigitalGlobe.

1. AIS can be used to monitor transshipment behavior. Because almost all transshipment vessels are equipped with AIS and keep their devices turned on most of the time, we can create a map showing where and when these vessels exhibit behavior consistent with transshipment. Also, for a portion of these events, the fishing vessels meeting with transshipment vessels use AIS as well, and we can identify both vessels. The result is a **first-ever global footprint of transshipments at sea**. AIS also allows us to

track which ports these transshipment vessels visit following likely and potential rendezvous, adding another layer of transparency.

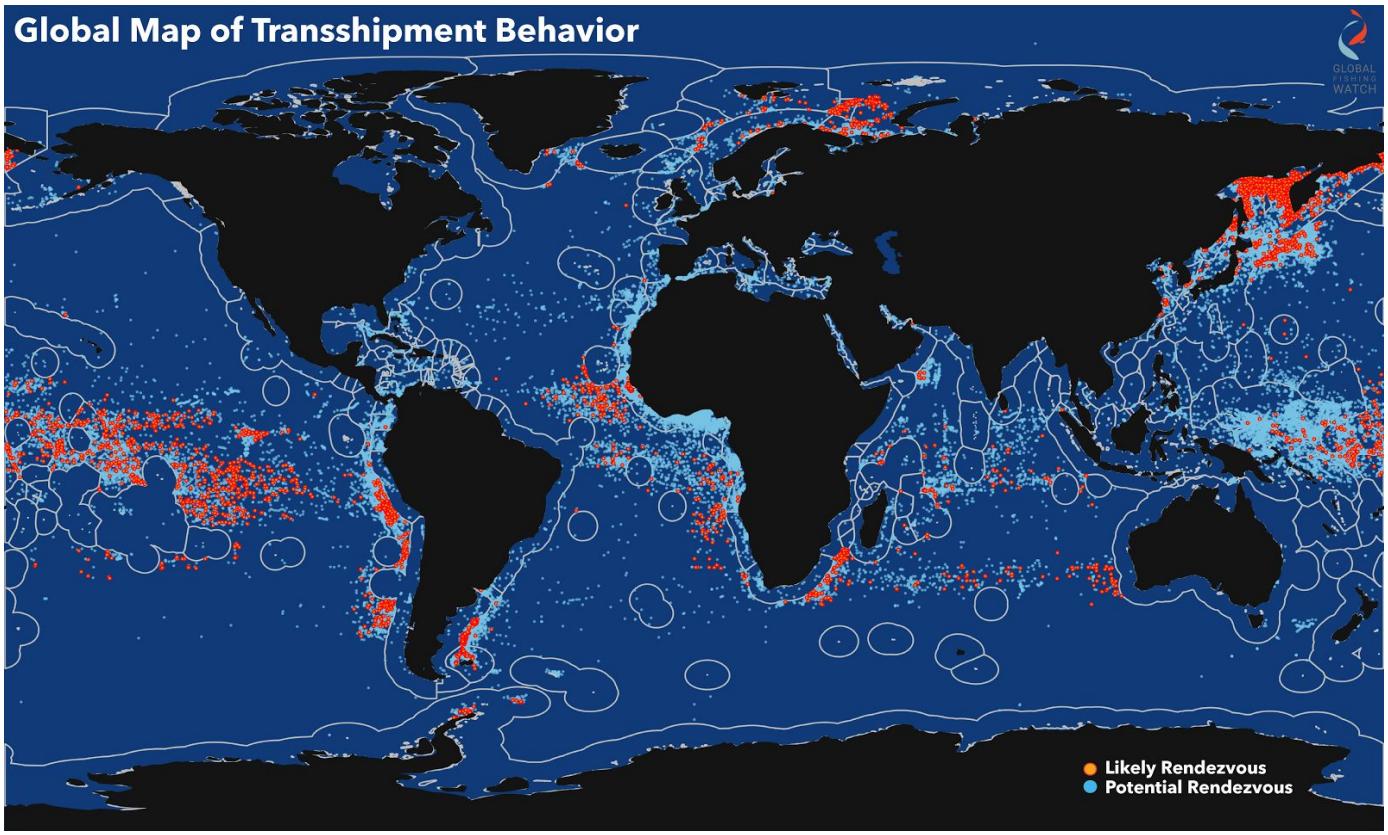
2. Transshipment behaviors are associated with patterns of illegal, unreported, or unregulated fishing (IUU). In many countries with comparatively high levels of fisheries management, such as in North America and Europe, we see relatively little transshipment behavior. In general, we find that transshipment is more common in regions with a high proportion of IUU fishing, and we find interesting patterns of rendezvous clustering along the Exclusive Economic Zone (EEZ) boundaries of some countries. These correlations do not provide definitive proof of specific illegal behavior, but they raise important questions to be addressed by further investigation.

21 B AIS Positions Analyzed

117 M Reefer Positions Analyzed

71 K Potential Rendezvous (Occurrences of loitering transshipment vessels)

5.7 K Likely Rendezvous (Potential encounters between transshipment vessel & fishing vessel)



Global map of transshipments based on transshipment vessel rendezvous behavior

3. Addressing transshipment will require global cooperation. About 42 percent of the likely and potential rendezvous occur on the high seas, an area that by definition requires international cooperation to manage. An analysis of the flags flown by vessels engaged in transshipment behavior shows a complicated web of relationships. Forty percent of the potential and likely rendezvous are by vessels flying flags of convenience, meaning they are registered in a country with minimal regulation and oversight. Apart from Russian transshipment vessels, which typically only meet up with Russian fishing vessels, we see likely rendezvous between vessels from a diverse range of nations and flag states. Finally, an analysis of transshipment vessel voyages shows that some vessels travel the entire globe, transferring catch literally around the world. All of these facts point to the management challenge of transshipment: managing it will require the cooperation of many nations.

In this revised report, we share these findings and suggest the next steps to address the transnational challenge that transshipments represent. We cover:

- Methodology for creating a global transshipment dataset
- Relationships between transshipment and IUU
- Patterns of transshipment in strategic locations along EEZ boundaries
- Ports that transshipment vessels visit after likely rendezvous
- Flag states involved in transshipment behavior
- Two case studies of transshipment vessel behavior
- Next steps: New Data, Analyses, and Partnerships

Our list of likely and suspected rendezvous is now published on our website, globalfishingwatch.org. These data are available to the broader community to better understand transshipments and improve the transparency of this industry. Later this year we will also publish much of the code used to generate these data.

A note on this revised report: This report is an updated version of a report released by Global Fishing Watch and SkyTruth in February of 2017. We have since received feedback from the wider community, which we have incorporated into revisions of our dataset and the figures in this report. Notable updates include:

- Our original report referred to "potential transshipments" and "likely transshipments." We have substituted these labels with "potential rendezvous" and "likely rendezvous" to accommodate readers who believed using "transshipment" was too definitive. Our new language better allows for the possibility that rendezvous may represent something other than transshipment, as vessels may meet at sea for a number of reasons.
- More than 300 vessels were flagged by our readers as being potentially unable to transship at sea. We reviewed each of these vessels, one by one, and while we found 111 were capable of transshipment at sea, 216 vessels from our original list are likely only capable of transshipping in port. These 216 vessels have been removed from our database. In our original report, these vessels accounted for 0.3% and 7.1% of likely and potential transshipments respectively. Although this new analysis shows they were unlikely to have engaged in transshipment, the overall patterns of transshipment behavior on a global scale remain unchanged from our original report.
- Additions: We have added 97 new transshipment vessels to our database and

extended our analysis of both potential and likely rendezvous through June 23 of 2017 (original analysis ran through December 31st of 2016), identifying an additional 699 likely rendezvous.

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Introduction

What is Transshipment?

A transshipment occurs when two vessels meet to exchange cargo (e.g., supplies, fish, personnel). In principle, transshipments benefit fishing fleets because vessels can offload catch at sea and continue fishing. These events consolidate fuel costs within a fleet and move product to market more quickly. Transshipments often involve the use of a variety of vessel classes, including fish tenders, fish carriers, and refrigerated cargo vessels (also known as specialized reefers), all of which may collect the harvest of multiple fishing vessels and deliver it into port. These vessels, collectively referred to as transshipment vessels in this report, may also carry supplies and personnel from a distant home port to fishing vessels at sea.

Transshipment introduces concerns over traceability and transparency in the seafood industry. Operators engaging in illegal, unreported, and unregulated (IUU) fishing are able to access reputable markets by mixing illegally caught fish with legal product during transshipment. The practice obscures supply chains and prevents an accurate measurement of the amount of marine life being taken from the sea, thus limiting our ability to fish the ocean sustainably. The Food and Agriculture Organization (FAO) of the United Nations estimates over 15 percent of annual global catch is IUU.[1] Transshipment has also been linked to human trafficking and can allow captains to keep their crew at sea indefinitely, resulting in de facto slavery.[2]

Policies on transshipment vary by Exclusive Economic Zone (EEZ), flag state, and region. In regions with comparatively high levels of management, all transshipment activities are tightly regulated, including comprehensive monitoring, independent verification of catch and transshipment, capacity to monitor and enforce conservation measures, as well as the opportunity to investigate transnational criminal activities. For example, in the Pacific Islands Forum Fisheries Agency (FFA), transshipment by purse seine vessels at sea is banned, and must take place at port.[3,4] This allows port states to verify all transshipments, collect data on catch, and independently investigate criminal activities and licensing violations. Another example of a strong regulation is enforced by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), which allows transshipment at sea, but has implemented a catch documentation scheme. All transshipments of toothfish product, whether at port or at sea, must be independently verified by observers, who certify documents indicating fish have been caught in a manner consistent with conservation measures.[5,6]

Weak regulatory frameworks allow transshipment to occur at sea with no independent observer, no verification of transshipment catches, and no monitoring of any potential transnational criminal activities. This occurs in fisheries with inadequate regulations, no regulations, or poorly enforced ones.

Methodology

AIS Data

We identified 641 transshipment vessels, including the majority of the world's specialized reefers, and then tracked the movements of these vessels using the Automatic Identification System (AIS), a type of transceiver that broadcasts a vessel's location every few seconds. Originally meant for collision avoidance, AIS can now be picked up by satellites and terrestrial receivers. This data is aggregated into global databases such as the one Global Fishing Watch obtains from the telecommunications company Orbcomm. The International Maritime Organization mandates all vessels larger than 300 tons on international voyages carry AIS, and most countries have adopted similar or stricter regulations for their EEZs. In 2016, more than

300,000 vessels broadcasted an AIS signal, of which about 70,000 were fishing vessels, and a few hundred were refrigerated cargo vessels.

Development of Reefer Database

Our database of transshipment vessels was compiled from the following sources:

1. Refrigerated cargo vessels, fish carriers, and fish tender vessels were identified using vessel lists from the International Telecommunications Union and major Regional Fisheries Management Organizations (RFMO).[7-15]
2. If a vessel participated in multiple encounters with fishing vessels, we conducted a web search and reviewed RFMO registries using information from the vessel's AIS to determine if the vessel was a reefer.
3. Additional reefers were found by investigating documentation on registry websites and other online resources and determining alternate identities that we were able to match in our database.
4. A vessel classification neural network, developed by Global Fishing Watch to predict vessel types based on movement patterns, was used to identify possible reefers. Vessels that were identified as likely reefers by this neural network were manually reviewed through web searches and RFMO registries.
5. After initial publication of our transshipment vessel list, the fisheries consultancy FishSpektrum performed a detailed review of the vessels, and suggested changes. We reviewed each of the 327 vessels they highlighted, removing 216, the majority of which were refrigerated container vessels, capable of transporting fish products in containers, but not transshipping at sea. The remaining 111 appeared to be able to transship at sea.

After developing the list, we verified vessel information using reputable online sources: the IHS shipping databases, MarineTraffic, ShipSpotting, VesselFinder, and FleetMon. Our database of transshipment vessels is now available through globalfishingwatch.org.

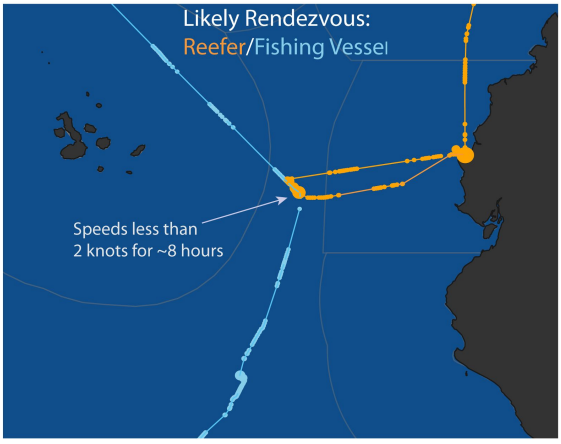
We identified a total of 641 transshipment vessels of which the vast majority are specialized reefer vessels, which possess refrigerated holds capable of receiving catch at sea. Given their size, and the fact that they often operate in the high seas, we expect many transshipment vessels are required to carry AIS. Ninety-nine percent of the transshipment vessels in our dataset are larger than 300 gross tonnage (GT) and the International Maritime Organization mandates that vessels larger than 300 GT on international voyages carry AIS. Most countries have similar regulations for their EEZs.[16] Our dataset is likely missing smaller transshipment vessels that operate exclusively near shore (such as some fish tenders or smaller fish carriers), but these are likely to be vessels with limited capacity or vessels that do not make international voyages.

Identifying Transshipments: Encounters and Rendezvous Behavior

We identified potential and likely rendezvous in two ways: **vessel encounters that included transshipment vessels and rendezvous behavior by transshipment vessels**. We extracted these signals using our AIS and reefer databases with help from locations of known transshipments from the Indian Ocean Tuna Commission (IOTC).[17]

Encounters – Likely Rendezvous

To identify likely rendezvous, we identified all interactions between two vessels which remained within 500 meters of each other for longer than 3 hours while traveling at less than 2 knots. These parameters balance the need to detect vessel pairs in close proximity for extended periods of time while recognizing satellite coverage and inconsistent AIS transmission rates may limit our ability to identify long periods in which vessels are in immediate contact (see data caveats below). We filtered our results to include only events where one of the vessels was a refrigerated cargo vessel and the other a fishing vessel. This left us with **5,783 encounters between transshipment vessels and fishing vessels, or "likely rendezvous,"** from 2012 through July 2017.

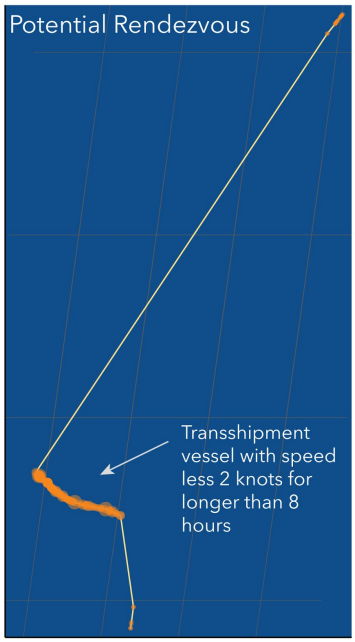


Yellow: ORION S (reefer), Blue: AMERICAN EAGLE (purse seiner), 2015-04-09. High seas between Ecuador and Galapagos Islands.

Loitering Events – Potential Rendezvous

Transshipment vessels exhibit specific rendezvous behaviors during transshipments. We identified these behaviors by analyzing known, observer-reported transshipments from the Indian Ocean Tuna Commission (IOTC; 5,874 transshipments between 2009 and 2015). Through our analysis, we identified reefers that exhibited similar patterns of moving less than 2 knots for longer than 8 hours. Distinctive C-shaped tracks and abrupt shifts in course following a period of slow speeds characterized most transshipment events. Following these metrics, **we analyzed 117 million reefer positions from 2012 - 2017 and identified 71,468 events where a transshipment vessel exhibited these behaviors, which we identify as "potential rendezvous."**

Not all of these rendezvous events are transshipments of fish. Some may represent transfers of fuel or cargo, and others may be the vessel simply waiting until it is scheduled to travel to its next location. Future research will estimate the fraction of these rendezvous that are transshipments of fish. For this report, we present these events as a proxy for transshipment of fish at sea, recognizing that it is not a one-to-one relationship.



Sheng Hong No. 806, 2015-07-17, South of Mauritius, Indian Ocean.

Caveats

For this report, we call an event where a transshipment vessel encounters a fishing vessel a "**likely rendezvous**" and an event where a transshipment vessel exhibits rendezvous behavior a "**potential rendezvous.**" Our set of "likely rendezvous" is a subset of "potential rendezvous." In nearly all cases, including the *Chitose* case study presented later in this report, we are not able to verify whether the transshipment actually occurs. Any reference to transshipments

throughout this report is simply where we see likely or potential rendezvous behavior in our data. Also, we identified several thousand instances of transshipment vessels meeting up with non-fishing vessels, or meeting up with other transshipment vessels. For this initial report, we exclude these events, and focus only on encounters between fishing vessels and transshipment vessels. We also did not investigate transshipment between different fishing vessels.

We restricted our analysis to events occurring at least 20 nautical miles from shore to avoid capturing encounters occurring in ports. This distance is still well within the 200 nautical mile limit of EEZs. Future analysis will consider distance from port instead of distance from shore so as to capture vessels close to shore but far from port.

One data challenge arises from to the limitations of the satellite receivers used to detect AIS signals. Satellites can fail to receive messages from fishing vessels for two reasons:

1. High vessel density: A satellite can only record a limited number of messages at once, and when there are too many vessels beneath a satellite, some AIS signals are not recorded. As a result, in areas of high vessel density such as the South China Sea or regions off the coast of Europe, we cannot observe a vessel's movements as accurately.
2. Satellite coverage: Based on the number of satellites and their orbital patterns, there can be several hours a day when there is no satellite overhead to receive signals.

Fortunately, these limitations are being addressed by the launching of more satellites. In 2012, only two Orbcomm satellites, the satellite provider for Global Fishing Watch, were operating, and now 18 are in orbit. In addition, we continue to enrich our data through new relationships with multiple satellite providers. The limitations posed by satellite-derived AIS do not apply along the coastlines of most developed countries, where terrestrial antennas, which are not as affected by vessel density, are present.

In addition, some vessels will not appear in the dataset for the following reasons:

1. Vessels may intentionally turn off their AIS transmitters.
2. Vessels may not have AIS at all. Regulations vary by country, and in international waters, vessels under 300 gross tonnage are not required to use AIS.
3. AIS transmitters vary in quality, which results in patchier coverage of vessels with poorer quality hardware.
4. Some fishing vessels use invalid Marine Mobile Service Identity (MMSI) numbers. For this analysis, we ignored these vessels, as they are difficult to identify. Doing so excluded less than one percent of our total encounters.

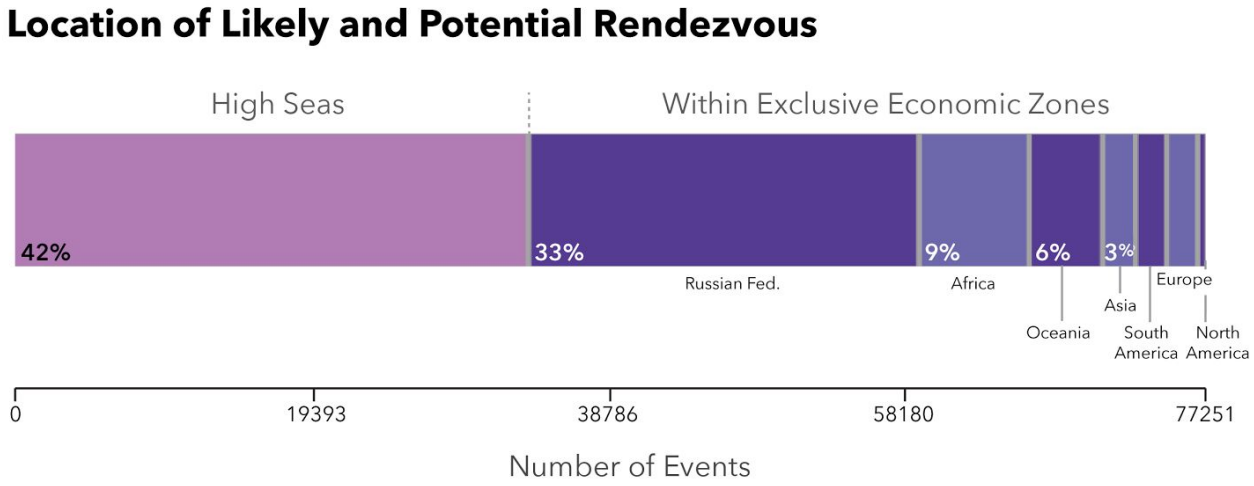
We have observed fishing vessels turning off their AIS in some areas of significant transshipment, including near the coast of West Africa, outside the Argentinean EEZ, and in some parts of the Indian Ocean. In future analysis, we hope to quantify this disabling of AIS and determine if it is related to transshipment.

While some fishing vessels turn off their AIS from time to time, the practice is significantly less prevalent among reefers. We analyzed all the gaps in transmission from reefers that started and ended more than 10 nautical miles from shore and lasted more than 24 hour. We found that these gaps represented only a small percentage of the total time transshipment vessels were active. **We estimate that transshipment vessels in our dataset only show 24 hour or longer gaps in their track approximately 2 percent of the time while at sea**. Therefore, we are confident that the AIS data for transshipment vessels captures the majority of their footprint.

Global Patterns and Trends

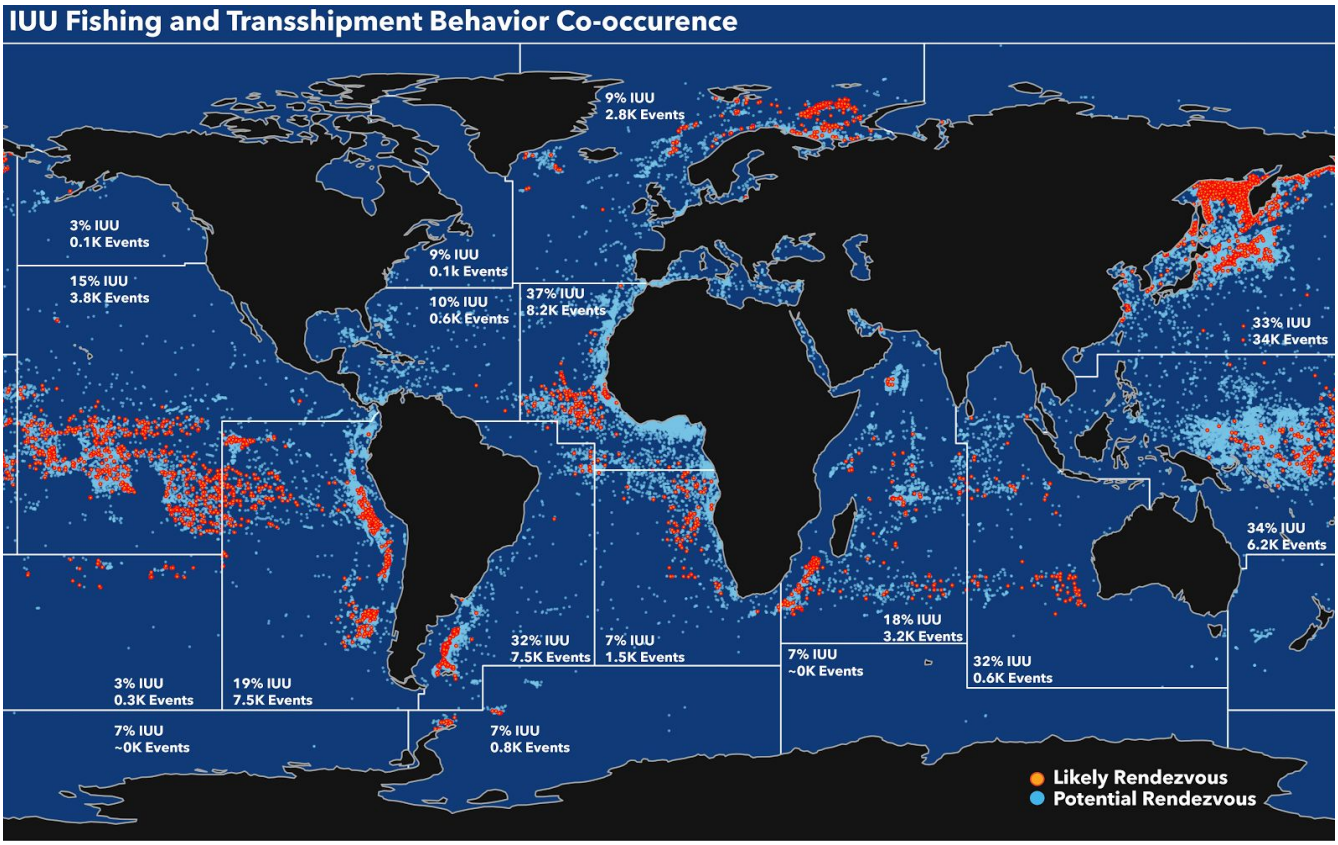
Transshipment is Most Common in the High Seas and Russian EEZ

About 42 percent of the likely and potential rendezvous occur in the high seas, with the remaining 58 percent within EEZs of different nations. About a third of the total events occur in the EEZ of Russia, where transshipment appears to be a standard part of how their fishing fleet operates. After the high seas and Russia, transshipment is most common in the EEZs of Africa and Oceania.



*Europe, Asia, and North America represent 3%, 3% and 1%, respectively

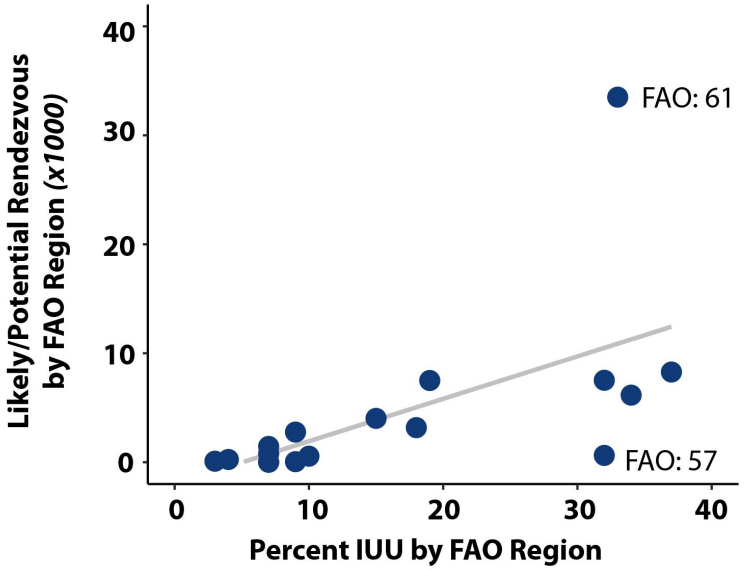
Regions With More IUU Have More Transshipment Behavior



In general, we find that regions with a higher percent of IUU fishing have more potential and likely rendezvous. The correlation between potential rendezvous and the percentage of catch suspected to be IUU for each FAO region, as based on Agnew et al. 2000,[18] is decent (R^2 = 0.32), especially if we account for the following outliers:

FAO Region 61 (East Russia/Japan): We see a much higher number of rendezvous due to Russia's common industry practice of using transshipment vessels.

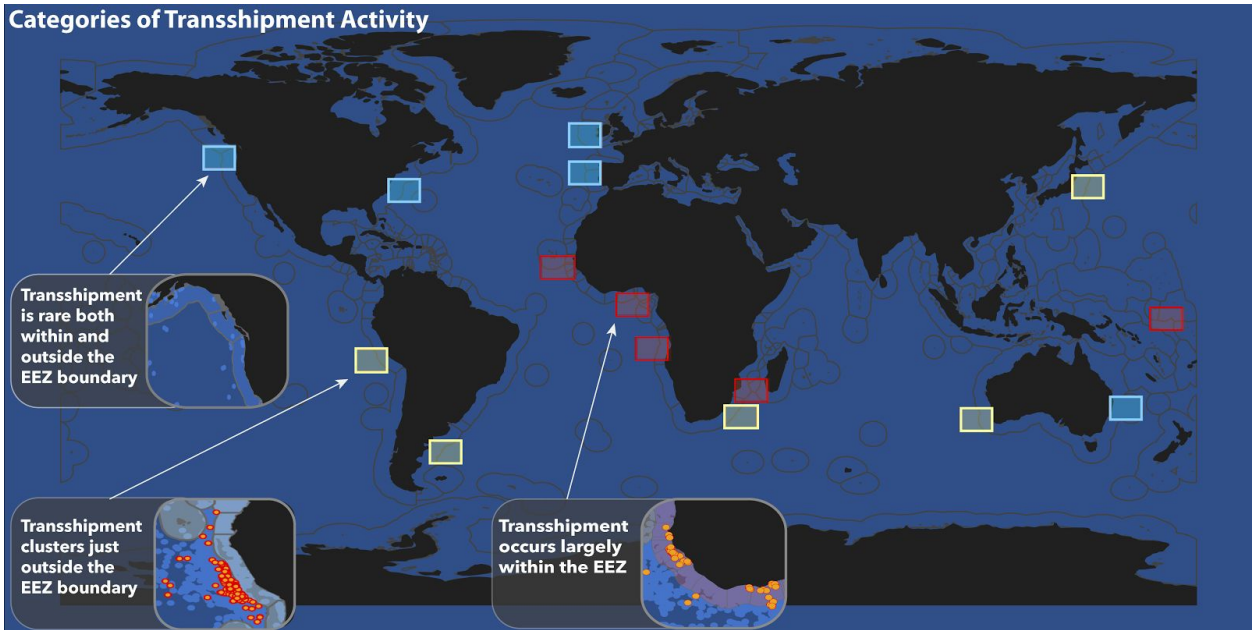
Likely and Potential Rendezvous Are More Common in Areas of Higher IUU



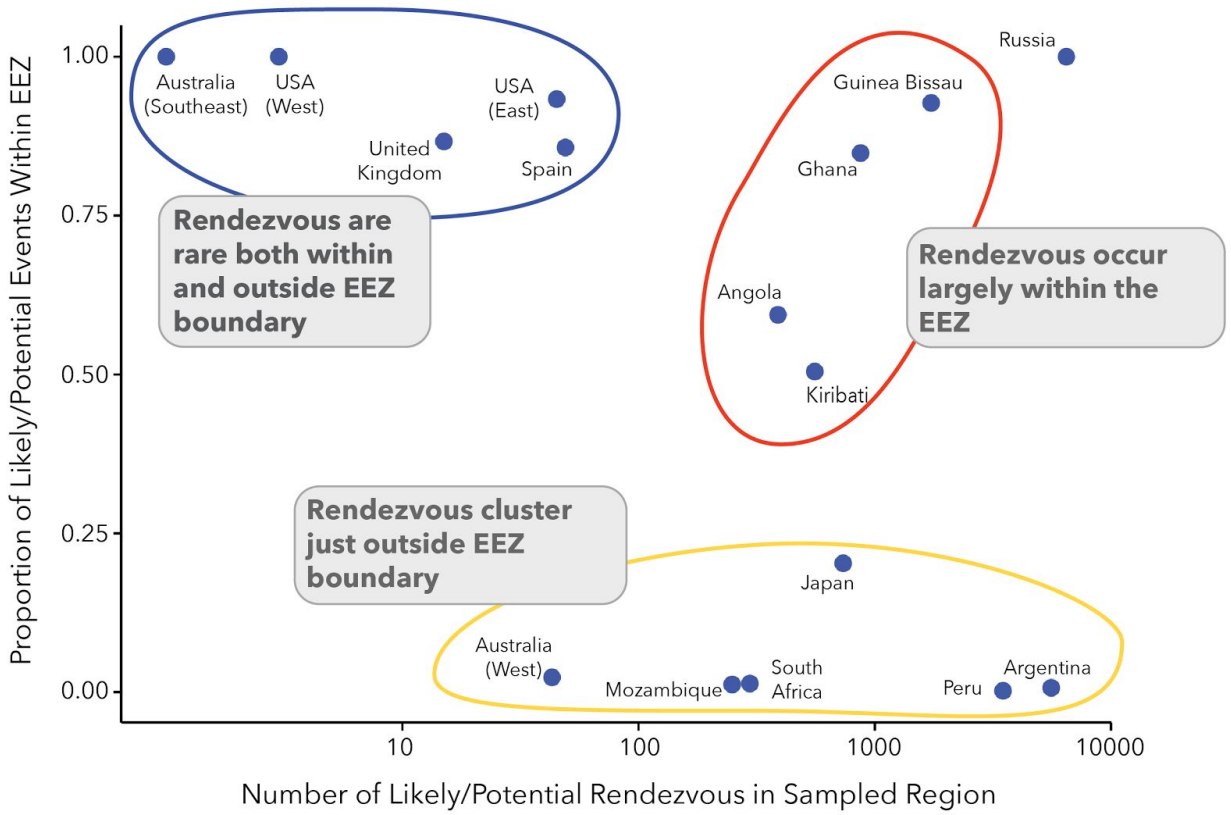
FAO Region 57 (West of Australia): We believe this is a dead zone in our data due to lack of good AIS coverage in Southeast Asia and Indonesia.

This correlation could be because regions with more IUU have more fishing, and thus more transshipment. While we do not know what causes this correlation, it is troubling that an activity that makes it difficult to track the catch of fishing vessels occurs most frequently in regions with major regulatory challenges.

Transshipment Behavior Clusters Inside and Along Exclusive Economic Zones



Patterns of Likely and Potential Rendezvous Inside and Outside Exclusive Economic Zones



We see three behavioral patterns based on where potential rendezvous occur. Many countries have little transshipment behavior inside or near their EEZ. These often tend to be regions with strong regulation and enforcement, such as in North America and Europe. Other countries see transshipment behavior occur right along their EEZ boundary, such as off the coast of Peru, South Africa, or western Australia. These are generally countries with well-respected EEZ boundaries and rich fishing grounds in the nearby high seas. Finally, some countries have significant transshipment behavior occurring well within their EEZ. These events within the EEZ could be to due to a combination of limited monitoring and enforcement, as in the case of West Africa, and being far from port or market, as is the case for Russia's fleet in the Sea of Okhotsk.

These three categories require further investigation. Do the high levels of transshipment behavior in the EEZs of African nations and Kiribati reflect IUU fishing? Is the high level of rendezvous along the boundaries of countries such as Australia, Japan, and Argentina the result of vessels taking catch from within the EEZ and illegally offloading it to vessels outside, or does it stem from these regions being more economical locations to fish? Answering these questions will require further investigation and comparison with logbook and observer data.

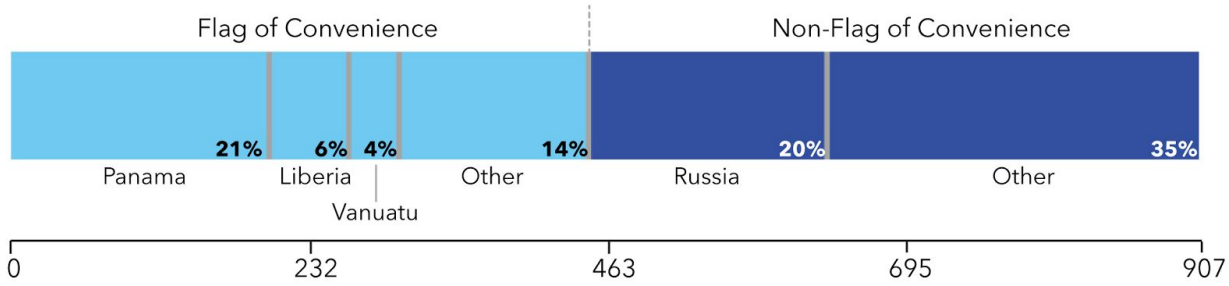
Vessel Identities

Flag State Trends

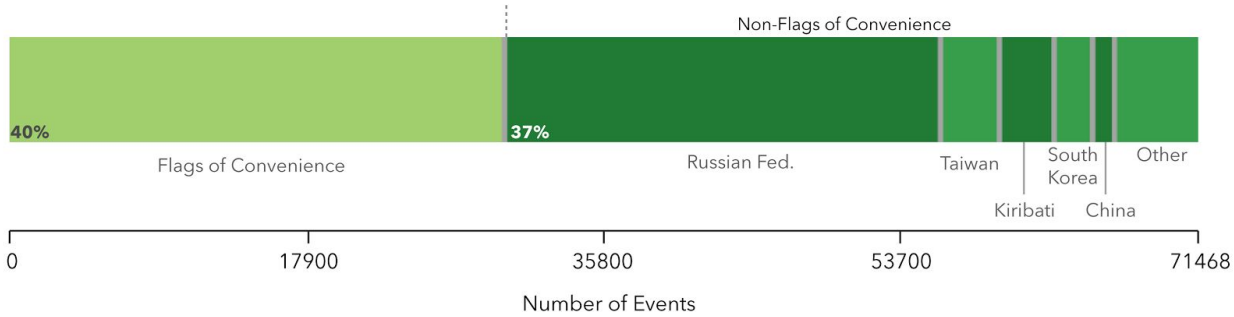
Transshipment vessels often sail under what is known as a "**Flag of Convenience**" or FoC. This means they are registered in (and fly the flag of) a country that may have no true link to their fishing operations. Many countries issuing FoCs are known to sell vessel registrations with few to no restrictions. Those that are prevalent in our transshipment vessel dataset include Panama, Liberia, and Vanuatu. **In fact, FoCs are flown by 45 percent of transshipment vessels in our**

database, and 40 percent of the potential rendezvous are undertaken by transshipment vessels flying these flags. Another 37 percent of likely rendezvous are Russian transshipment vessels, most of which operate within the Russian EEZ at the Sea of Okhotsk. To determine FoCs, we used the list compiled by the International Transport Workers Federation.[19] Note that almost a third of transshipment vessels changed registrations and flags between 2012 and July 2017, and are thus counted more than once on the chart below.

Flag States of Transshipment Vessels in our Database

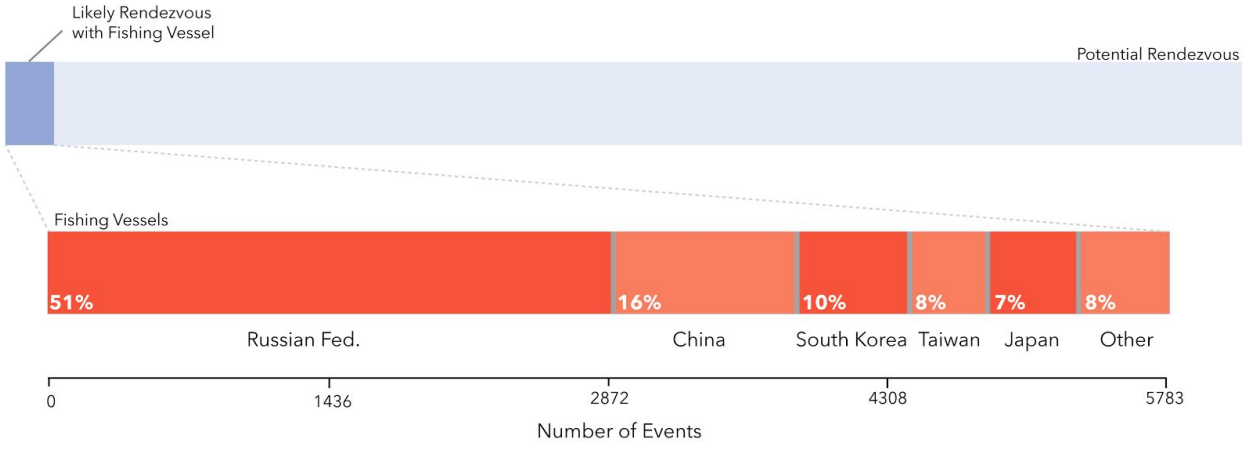


Flag States of Transshipment Vessels Involved in Potential Rendezvous



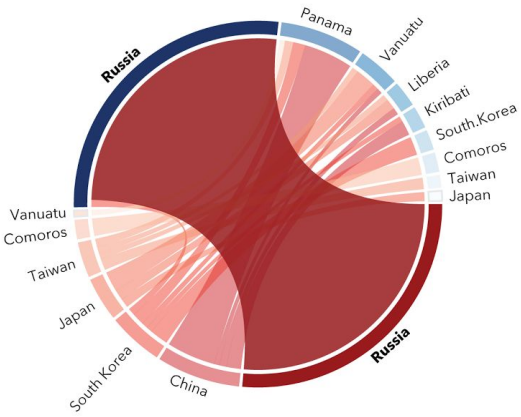
About six percent of our potential rendezvous are also likely rendezvous in which we see a fishing vessel meet up with the transshipment vessel. In these cases, we can identify both the fishing vessel and the transshipment vessel. A majority (51 percent) of these likely events are by Russian fishing vessels, primarily fishing and rendezvousing in the Sea of Okhotsk. The majority of the remaining likely rendezvous involve fishing vessels flying flags of Asian countries: China, South Korea, Japan, and Taiwan.

Flag States of Fishing Vessels Involved in Likely Rendezvous

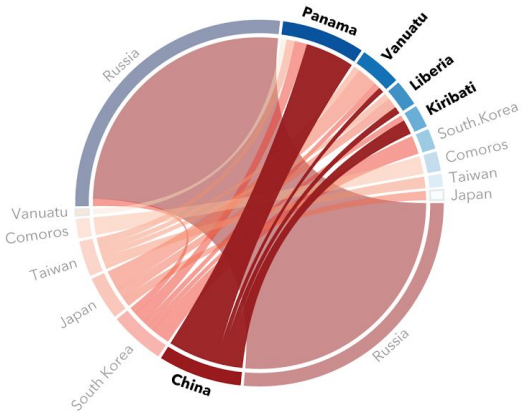


We also analyzed the flag states of the transshipment vessels that these fishing vessels rendezvous with, and we identified common pairings of flag states.

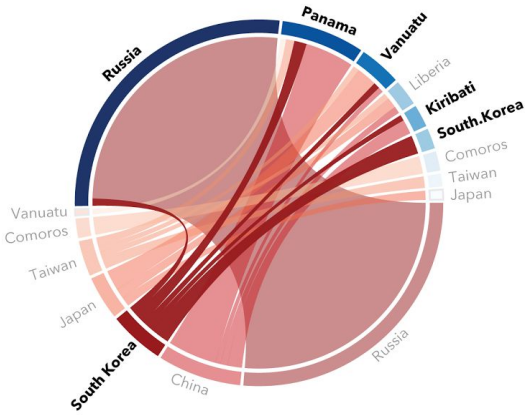
Top Flag State Pairs Involved In Likely Rendezvous



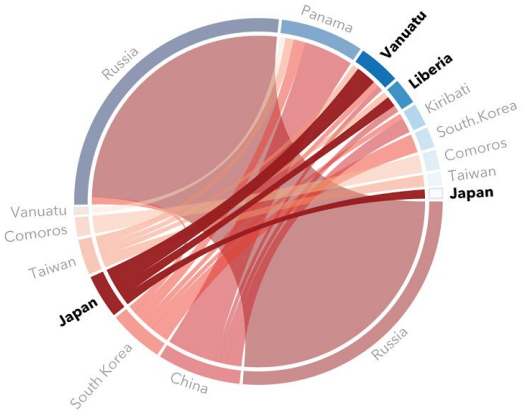
Russian fishing vessels appear to rendezvous only with Russian transshipment vessels



Chinese fishing vessels rendezvous predominantly with Panama and Kiribati flagged transshipment vessels



South Korean fishing vessels rendezvous with a variety of transshipment vessels including those flagged to South Korea



Japanese fishing vessels primarily rendezvous with Vanuatu, Liberian, and Japanese flagged transshipment vessels

Fishing Vessel Flag State ***Transshipment Vessel Flag State***

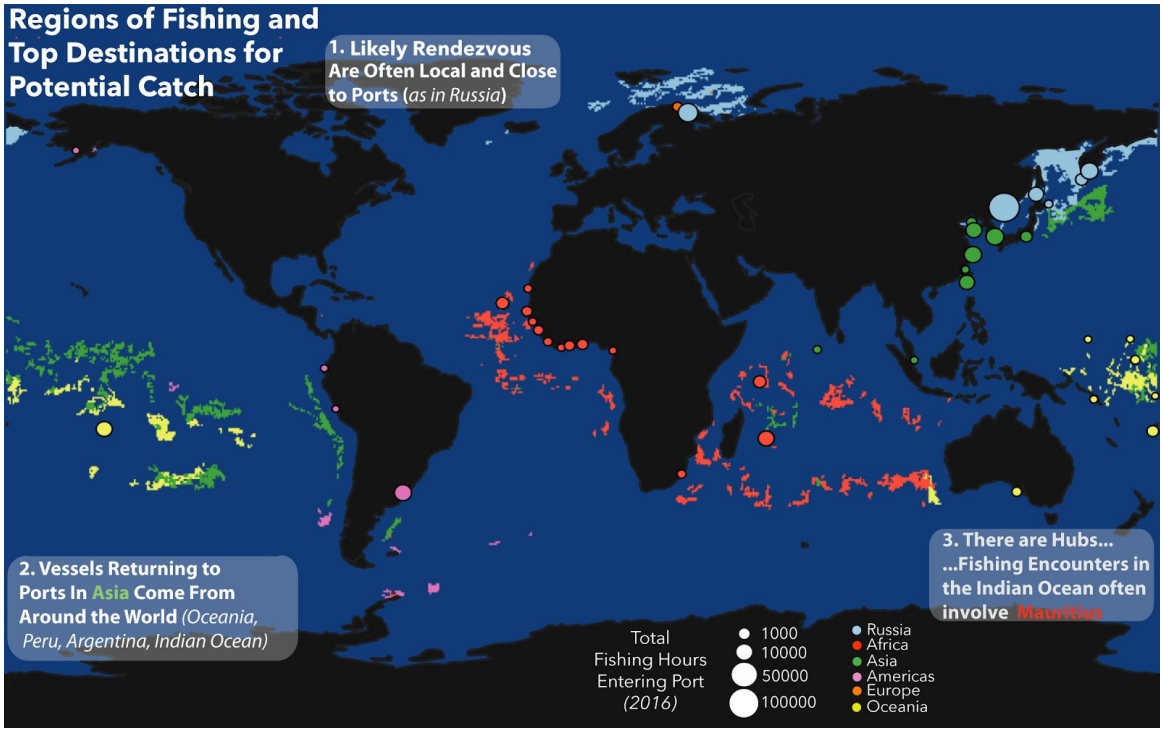
These relationship graphics include only the most common flag states of transshipment vessels and fishing vessels. We see that Russian fishing vessels meet almost exclusively with Russian reefers. The remaining major fishing vessels are mostly flagged to Asian countries, and the transshipment vessels they most commonly meet up with fly FoCs, including Panama, Vanuatu, and Liberia. Interestingly, Comoros flagged fishing vessels are found to rendezvous entirely with Comoros flagged transshipment vessels. All of these interactions occur outside of the IOTC, primarily in West Africa (within the EEZ of Guinea Bissau almost exclusively). Recently several of these vessels were arrested for illegal transshipment in Guinea Bissau, bolstering the our position that at least some of these likely rendezvous, represent actual transshipment operations.

Port Analysis

Ports Visited by Transshipment Vessel Following Likely Rendezvous

Global Fishing Watch is developing a global database of anchorages, which is created by identifying where vessels with AIS anchor for more than 48 hours. Drawing on this developmental dataset, which includes about 14,503 anchorages, we determined that in 2016, 59 anchorages had at least one transshipment vessel visit shortly after engaging in a likely rendezvous with a fishing vessel. Locations where vessels remained for less than 24 hours, where no facilities existed for offloading catch (e.g., Berkeley Sound, Falklands), or where

landing of catch is not permitted (e.g., Svalbard[20]) were excluded. We identified the fishing vessels involved in likely rendezvous with these transshipment vessels and used Global Fishing Watch's algorithms to estimate the hours each of these vessels spent fishing in the month before the likely rendezvous. The map below shows these fishing locations and the top ports visited by the transshipment vessels following these likely rendezvous.



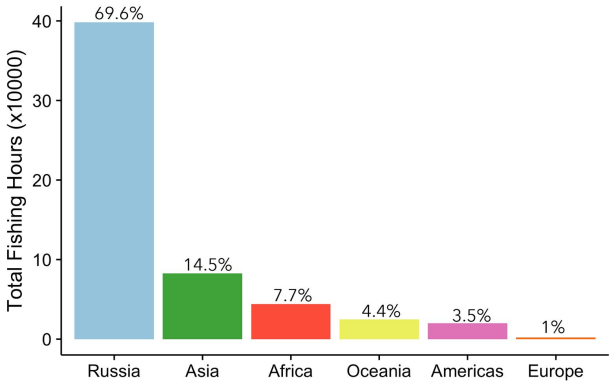
Colored ocean regions identify locations of fishing activity in the month prior to a likely rendezvous, and colored points along the coastlines identify ports the transshipment vessels visited following these events. Note that this graphic makes no effort to quantify fishing effort offloaded during the potential rendezvous.

Top Ports by Fishing Effort (2016)

Port/City	Continent	Total Fishing Effort* (hrs)
Vladivostok, Russia	Russia	327000
Murmansk, Russia	Russia	30000
Busan, South Korea	Asia	22500
Petropavlovsk, Russia	Russia	21000
Zhoushan, China	Asia	20600
Montevideo, Uruguay	South America	19600

**Fishing effort potentially transported on a transshipment vessel*

Total Fishing Hours Landed By Continent (2016)



After likely rendezvous, transshipment vessels tended to visit nearby ports. The exceptions we saw include:

- Asian transshipment vessels (mostly Chinese) had a global presence with likely rendezvous in Oceania and off the coast of Peru and South Africa before returning to their home ports in China.
- Reefers engaging in rendezvous throughout the Indian Ocean often went to port in Mauritius, which is becoming an economic hub for commercial tuna fishing.

The main port in terms of fishing effort was Vladivostok, in the Sea of Okhotsk. Otherwise the other major ports spanned the globe with the top destinations in South America and Asia. The fishing effort recorded here is only from likely rendezvous and does not estimate fishing effort offloaded during potential rendezvous.

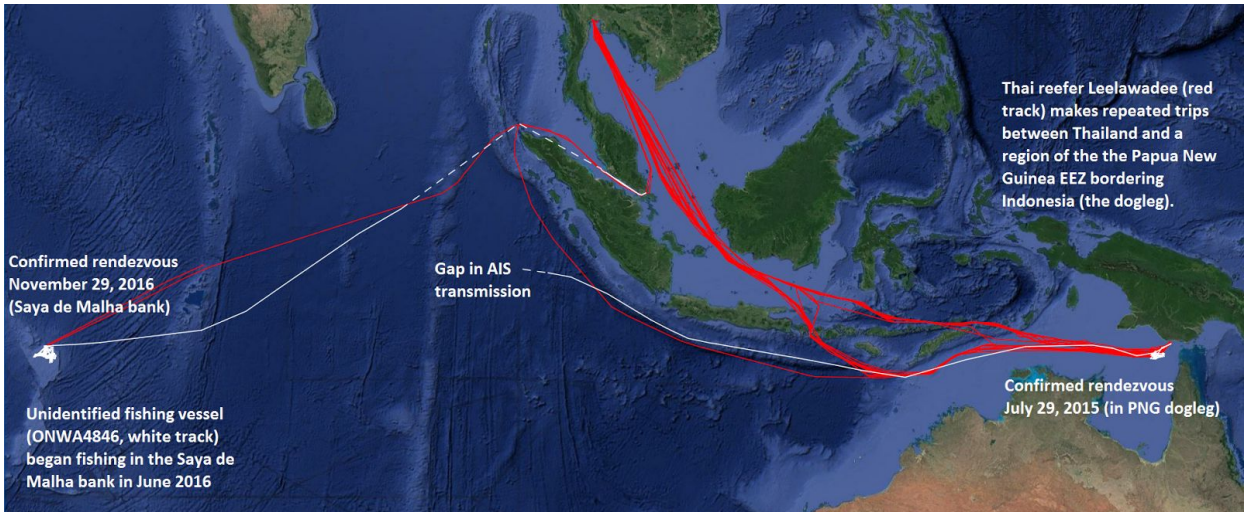
Case Studies

Reefer: Leelawadee

One interesting transshipment event was reported on the SkyTruth Blog in January of 2017.[21] The image on the right was obtained by DigitalGlobe after SkyTruth provided location data for the *Leelawadee*, a Thai-flagged reefer. The image is in the Saya De Malha Bank, in the Indian Ocean northeast of Madagascar. The two vessels meeting with the Leelawadee do not have AIS, so this event is labeled as a potential rendezvous in our database rather than a likely rendezvous.

The Leelawadee, a Thai reefer, and two unidentified vessels, Saya De Malha Bank, Indian Ocean. ***Imagery by DigitalGlobe © 2017.***

The Thai fleet that the Leelawadee operated with had been fishing in the waters of Indonesia and Papua New Guinea and had been involved in illicit activity, including illegal fishing and human trafficking.[22] In 2015, Indonesia banned foreign fishing vessels, and the fleet appears to have moved its operations across the Indian Ocean. According to a Greenpeace report,[23] the fleet has continued to engage in similar behavior. Transshipment has likely allowed these vessels to continue operating far from their home port. These events appear to demonstrate that when regulations increase in one region as they did in Indonesia, fishers just move to another region. This case study shows how a national approach to transshipment regulation might simply push pressures to other parts of the globe.



Track of the Leelawadee (red) and an unnamed fishing vessel (white) rendezvousing in Papua New Guinea waters in July 2015, then again on the Saya de Malha bank in November 2016.[21]

Reefer: Chitose

The *Chitose* is a Singaporean flagged vessel that we followed over three separate trips spanning the globe in 2016. Below is a map for each trip documenting the various activities of interest, including potential and likely rendezvous. The tracks indicate behaviors aligning with three major themes common in other transshipment vessel voyages:

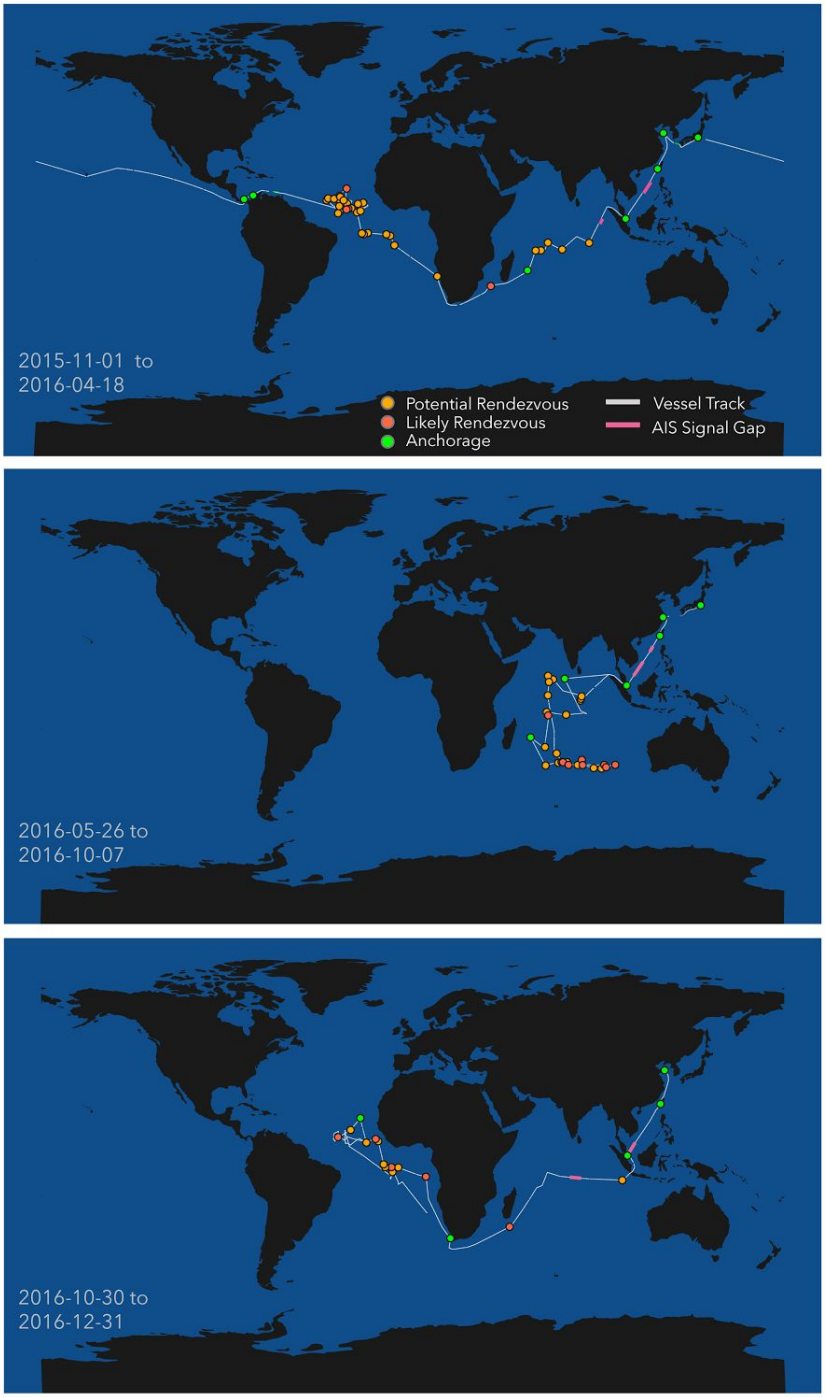
- Voyages are typically months long and the vessel engages in multiple rendezvous all over the world.
- When transshipment vessels finish a trip, they usually return to the same ports. For the *Chitose*, these ports were in Singapore, China, and Japan.
- Likely rendezvous occur in multiple areas potentially bringing in catch from fisheries that span the globe.

From vessel location data, we can identify certain events like rendezvous, port visits, data gaps, and interactions with vessels engaged in fishing.

For example, we can identify that in the Indian Ocean and much of the South Atlantic, the *Chitose* primarily meets with Taiwanese flagged longliners, and, to a lesser extent, Japanese longliners. Port visits provide insights into the infrastructure that enables transshipment, and the additional markets that transshipped catch may enter. In addition to port visits in Asia, the *Chitose* visited Mauritius, Cape Town, and Cape Verde.

Using AIS data to develop these comprehensive trip reports, which identify transshipments and port visits, may lead to insights related to regulation and policy violations, economic drivers, and catch management challenges. Further analysis will seek to identify social networks for individual vessels, as well as global patterns of association.

Vessel Name: Chitose



Conclusion

This analysis, the first of its kind, uses AIS to reveal global patterns of transshipment behavior. Transshipment at sea, which has hitherto occurred over the horizon and out of sight, is now an activity we can track.

We find that transshipment is a challenge without borders. Numerous reefers circumnavigate the globe, engaging in likely rendezvous with fishing vessels in multiple locations before returning to port. About 42 percent of likely rendezvous occur on the high seas, and a similar proportion are by transshipment vessels with so-called flags of convenience. In other words, a significant portion of transshipments may occur in waters where no country has jurisdiction, or are undertaken by a vessel that is registered to a country with lax oversight and limited connection to the vessel. Any effort to address IUU fishing and crimes associated with transshipment should have an eye to the global extent of this activity. The case study of the *Leelawadee* provides a good example. Stricter regulation in Indonesia may have resulted in the Thai fleet associated with this vessel simply moving its operations across the Indian Ocean, thus shifting IUU pressure from one region to another. We need a global approach, and AIS, with near-global coverage, can play a role.

Another challenge is that we are limited in our ability to determine the legality of specific events. While we show that transshipment behavior is more prevalent in areas with higher IUU fishing, and that transshipment behavior clusters suspiciously along EEZ boundaries, we don't have logbook or observer data to determine if these events represent IUU fishing. By making our data on likely and potential rendezvous publicly available, we are increasing transparency on these events and enabling other players to make those determinations.

Increased transparency is just the first step. Now that transshipment behavior is no longer completely out of sight, we hope that this information and our public data will empower other researchers, organizations, and regulatory agencies to better address the global challenge of transshipment at sea.

Where We Are Headed

While we were able to explore transshipment behavior as it relates to EEZs, IUU, and flag states and see an example of real-world impact, we believe our findings are just the start of something much bigger.

New Data: VMS
With additional time and resources, we hope to expand our scope to include various Vessel Monitoring Systems (VMS) datasets, a complement to AIS that is highly reliable but proprietary and therefore usually inaccessible. Indonesia has made their VMS data publically available through Global Fishing Watch. with the **increased coverage we have begun validation and improved our algorithms, increasing our ability to identify transshipments as well as providing new tools and insights to governments to aid in management and enforcement.** Peru has also committed to making their VMS data available.

New Vessels: Bunkers
We are expanding our analyses to consider the entire commercial fishing ecosystem which allows distant water fishing vessels to remain at sea for extended periods of time. Bunkering, or refueling vessels, are another component of this system, and we have begun mapping likely rendezvous between these vessels and fishing vessels at sea as well. Combined with

transshipment vessel rendezvous and detailed ownership data, we are developing a global view of the 'social network' which sustains global commercial fishing in the high seas.

Comprehensive Trip Reports
Our work on transshipment will play a large role in generating comprehensive trip reports on all historical events for a given vessel. These events include rendezvous, port visits, fishing, transit, and intentional AIS avoidance. **We will be able to build a social map of vessels associated with one another and the ports they visit in order to understand the network of relationships and communities within the commercial fishing industry**.

Impactful Partnerships: Academia, Experts, & Government
Our partners have expressed interest in this dataset for their research and projects. In academia, we will likely see new science and publications result from studying global data. Regional experts can play a role in conducting case studies, the findings from which can provide insights about potential regulatory approaches. Finally, we hope government bodies that manage fisheries will leverage this data to develop more effective policies to manage the challenges posed by transshipment.

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