THE GLOBAL VIEW OF TRANSSHIPMENT

PRELIMINARY FINDINGS
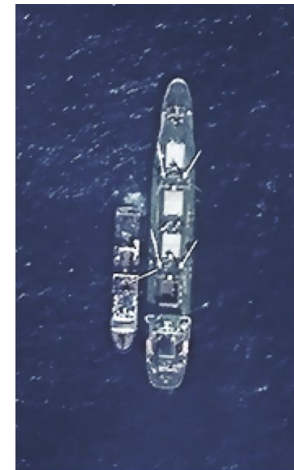
February 2017

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 2016, and we identified and tracked an estimated 90 percent of the world's refrigerated cargo ships (reefers). We mapped 86,490 instances in which these reefers exhibited rendezvous behaviors at sea for long enough to receive a transshipment, events that we call "potential transshipments," and 5,065 instances where we see a fishing vessel rendezvousing with the reefer, events we call "likely transshipments." 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 likely transshipment: 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 reefers 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 reefers 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 reefers visit after transshipment events, adding another layer of transparency.

2. Transshipments appear to be 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 transshipment 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

86 K Potential Transshipments (Reefer rendezvous behavior)

5 K Likely Transshipments (Rendezvous between reefer & fishing vessel)

Global Footprint of Transshipments 2012-2016

● Potential Transshipment
● Likely Transshipment

Global Fishing Watch
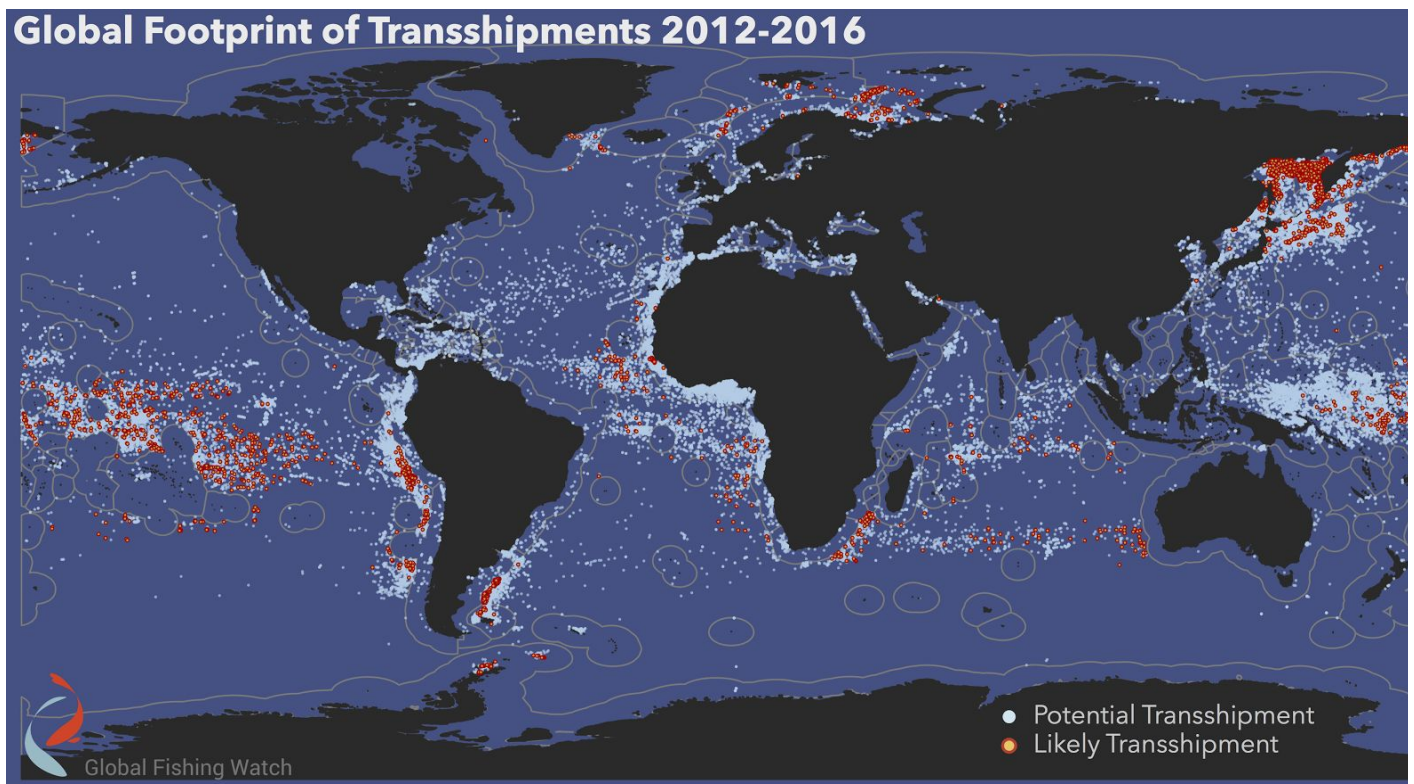
Global map of transshipments based on reefer encounters and reefer rendezvous behavior

3. Addressing transshipment will require global cooperation. About 40 percent of the transshipment events 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 show a complicated web of relationships. Over 40 percent of the potential and likely transshipment events are by vessels flying flags of convenience, meaning they are registered in a country with minimal regulation and oversight. Apart from Russian reefers, which typically meet up with Russian fishing vessels, we see encounters between vessels from a diverse range of nations and flag states. Finally, an analysis of reefer voyages shows that some 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 preliminary 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 reefers visit after likely transshipment
- Flag states involved in transshipment
- Two case studies of reefer behavior
- Next steps: New Data, Analyses, and Partnerships

Our list of likely and suspected transshipments is now published on our website, globalfishingwatch.org. These 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 base used to generate these data.

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Suggested Citation:
Kroodsma, D.A., N.A. Miller, and A. Roan 2017. "The Global View of Transshipment: Preliminary Findings." Global Fishing Watch and SkyTruth, February 2017. Available online at http://globalfishingwatch.org.

Global Fishing Watch is a partnership of Oceana, SkyTruth, and Google.

Introduction

What is Transshipment?
A transshipment is an event that occurs when two vessels meet to exchange cargo (e.g., supplies, fish, personnel). In principle, transshipments benefit fishing fleets because vessels are able to offload catch at sea and continue fishing. This can consolidate fuel costs within a fleet and move product to market more quickly. Transshipments often involve the use of refrigerated cargo vessels, also known as reefers, which collect the harvest of multiple fishing vessels and deliver it into port. Reefers may also carry supplies and personnel from a distant home port to fishing vessels at sea.

The nature of 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. These consequences of transshipment limit 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 catches, and independently investigate criminal activities and licensing violations. Another example of strong regulation is 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 that catches 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 the majority of the world's 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 vessel 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 that 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 80,000 were fishing vessels, and a few hundred were refrigerated cargo vessels.

Development of Reefer Database
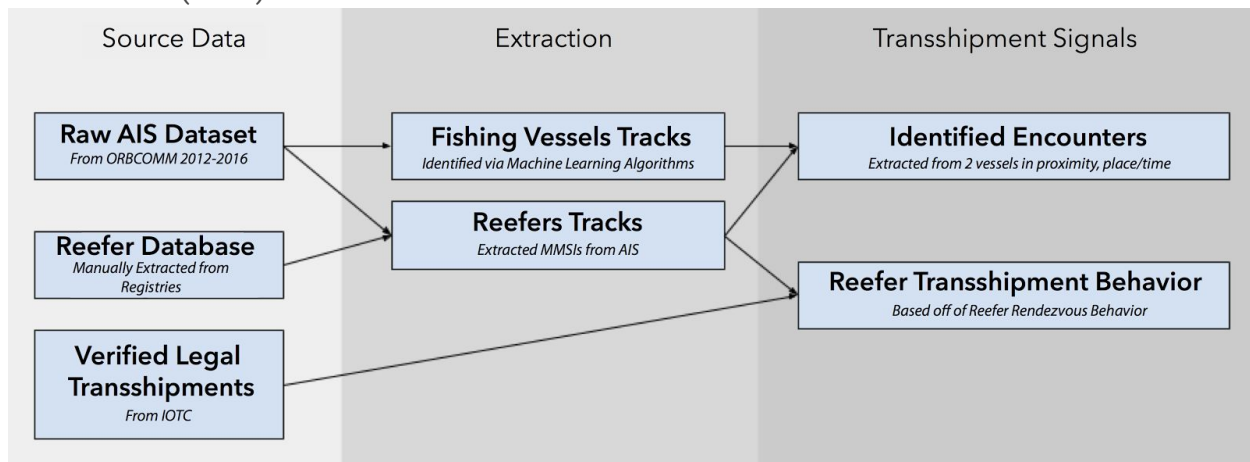Our database of reefers was compiled from the following sources:
1. Refrigerated cargo vessels, fish carriers, and fish tender vessels were identified using vessel lists from the International Telecommunications Union and major Regional Fisheries Management Organizations (RFMO).[7-15]
2. If a vessel 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.

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

We identified a total of 794 reefers. According to the US Central Intelligence Agency World Factbook, 882 refrigerated cargo vessels were active worldwide in 2010.[16] Assuming that the number of reefers has not significantly increased or decreased since 2010, **our dataset includes about 90 percent of the world's reefer vessels.** Some industry analysis suggests the number of reefers is decreasing, meaning that this 90 percent figure is a conservative estimate.[17] Almost all reefers are required to carry AIS. Ninety-eight percent of the refrigerated cargo vessels in our dataset are larger than 300 gross tons and the International Maritime Organization mandates that vessels heavier than 300 tons on international voyages carry AIS. Most countries have similar regulations for their EEZs.[18] If we are missing reefers in our dataset, they are likely to be either smaller reefers or vessels that do not make international voyages.

**Identifying Transshipments: Encounters and Rendezvous Behavior**
We identified potential and likely transshipments in two ways: **vessel encounters and rendezvous behavior by reefers**. We extracted these signals using our AIS and reefer databases with help from locations of known transshipments from the Indian Ocean Tuna Commission (IOTC).[19]

Source Data	Extraction	Transshipment Signals
Raw AIS Dataset — From ORBCOMM 2012-2016	**Fishing Vessels Tracks** — Identified via Machine Learning Algorithms	**Identified Encounters** — Extracted from 2 vessels in proximity, place/time
Reefer Database — Manually Extracted from Registries	**Reefers Tracks** — Extracted MMSIs from AIS	**Reefer Transshipment Behavior** — Based off of Reefer Rendezvous Behavior
Verified Legal Transshipments — From IOTC		

Vessel Encounters

To identify likely transshipment events, 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 that 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 **5,065 encounters between reefers and fishing vessels, or "likely transshipments,"** from 2012 through 2016.
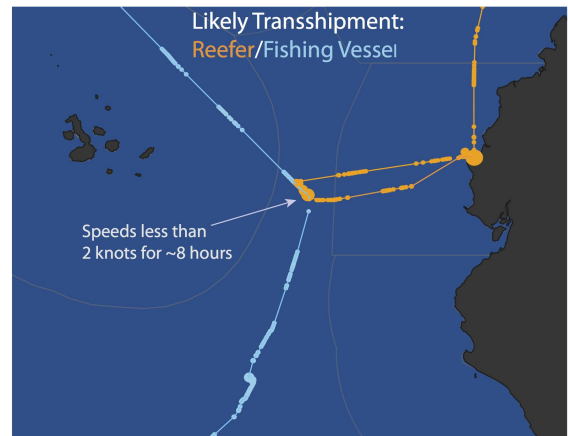

Yellow: ORION S (reefer), Blue: AMERICAN EAGLE (purse seiner), 2015-04-09. High seas between Ecuador and Galapagos Islands.

Rendezvous Behavior by Reefers

Refrigerated cargo 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 - 2016 and identified 86,490 events where a refrigerated cargo vessel exhibited these behaviors, which we identify as "potential transshipments."**

Not all of these rendezvous events are transshipments of fish. Some may represent transfers of fuel or cargo, and others may be the reefer simply waiting until it is scheduled to travel to its next location. Future research will estimate the fraction of these loitering events 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.
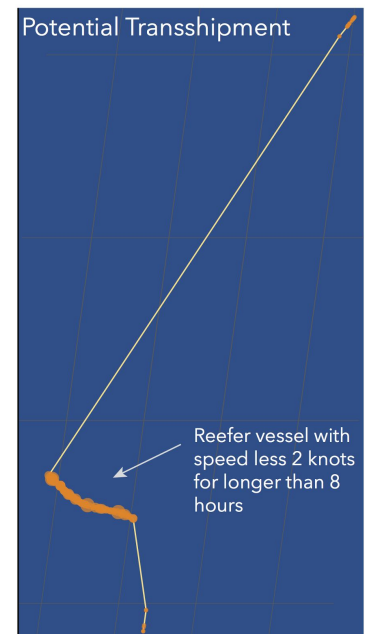
Sheng Hong No. 806, 2015-07-17, South of Mauritius, Indian Ocean.

Caveats

For this report, we call an event where a reefer encounters a fishing vessel a "**likely transshipment**" and an event where a reefer exhibits rendezvous behavior a "**potential transshipment.**" Our set of "likely transshipments" is a subset of "potential transshipments." 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 transshipment behavior in our data. Also, we identified several thousand instances of reefers meeting up with non-fishing vessels, or meeting up with other reefers. For this initial report, we exclude these events, and focus only on fishing vessel-reefer encounters. 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 is due 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. Also, these limitations 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 tons 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 related to transshipment.

While some fishing vessels turn off their AIS from time to time, the practice is significantly more rare 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 hours, and found that these gaps represented only a small percentage of the total time reefers were active. **We estimate that reefers 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 refrigerated vessels captures the majority of their footprint.

Global Patterns and Trends

**Transshipment is Most Common in the High Seas and Russian EEZ**
About 43 percent of the likely and potential transshipment events happen in the high seas, with the remaining 57 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.

Location of Likely/Potential Transshipment Events
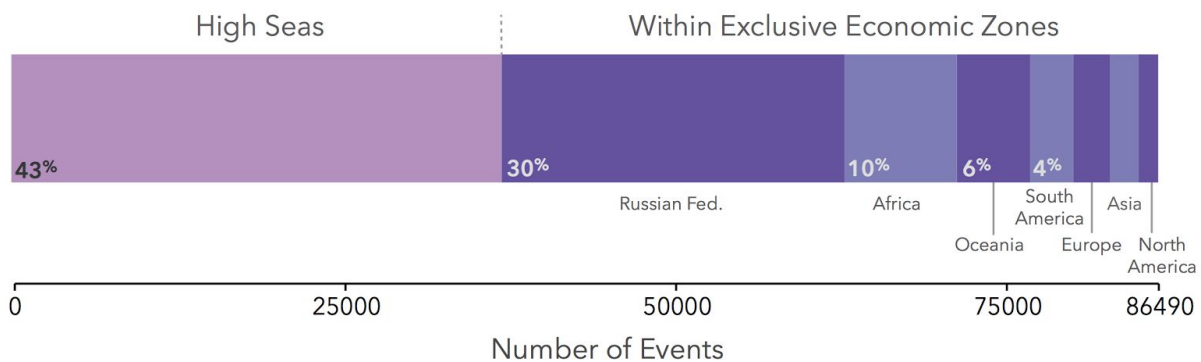
*Europe, Asia, and North Amerca represent 3%, 2% and 1%, respectively

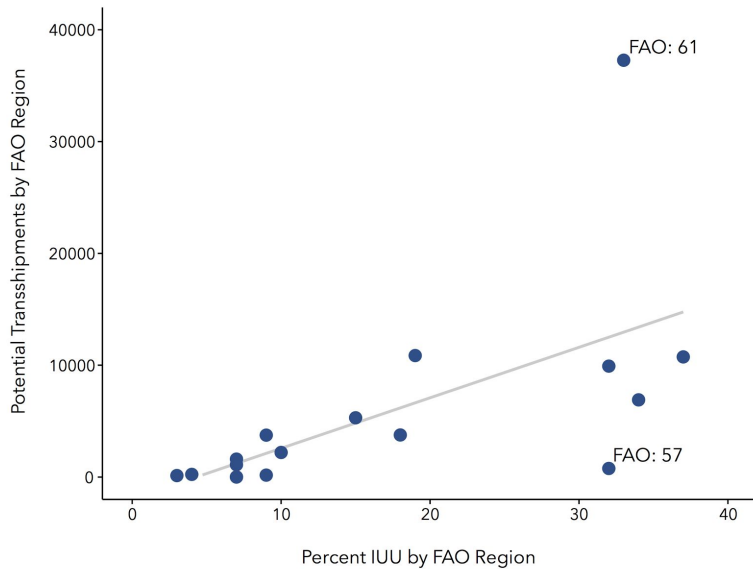## Regions With More IUU Have More Suspected Transshipment
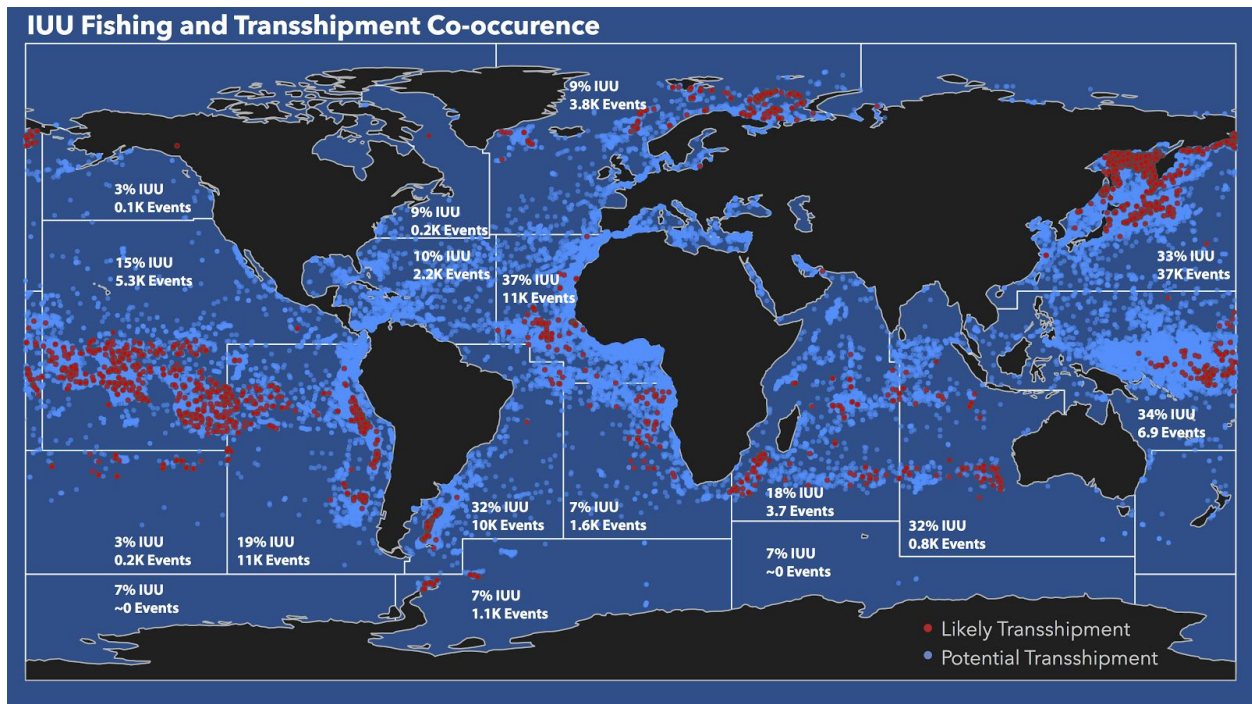
Percent IUU (Agnew et al. 2009) and Total Number of
Likely and Potential Transshipments by FAO Region

In general, we find that regions with a higher percent of IUU fishing have more potential and likely transshipment events. The correlation between suspected transshipments and the percentage of catch suspected to be IUU for each FAO region, as based on Agnew et al. 2000,[20] is decent (R^2 = 0.32), especially if we account for the following outliers:

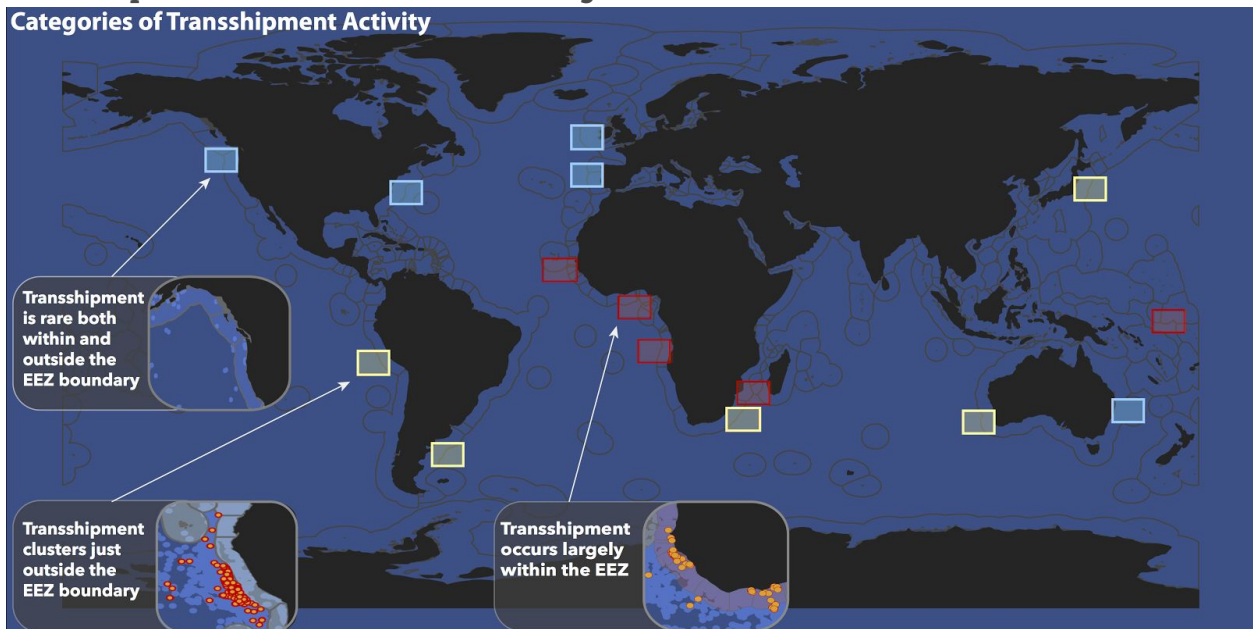FAO Region 61 (East Russia/Japan): We see a much higher number of transshipments due to Russia's common industry practice of using reefers.

Potential Transshipments More Common in Areas of Higher IUU
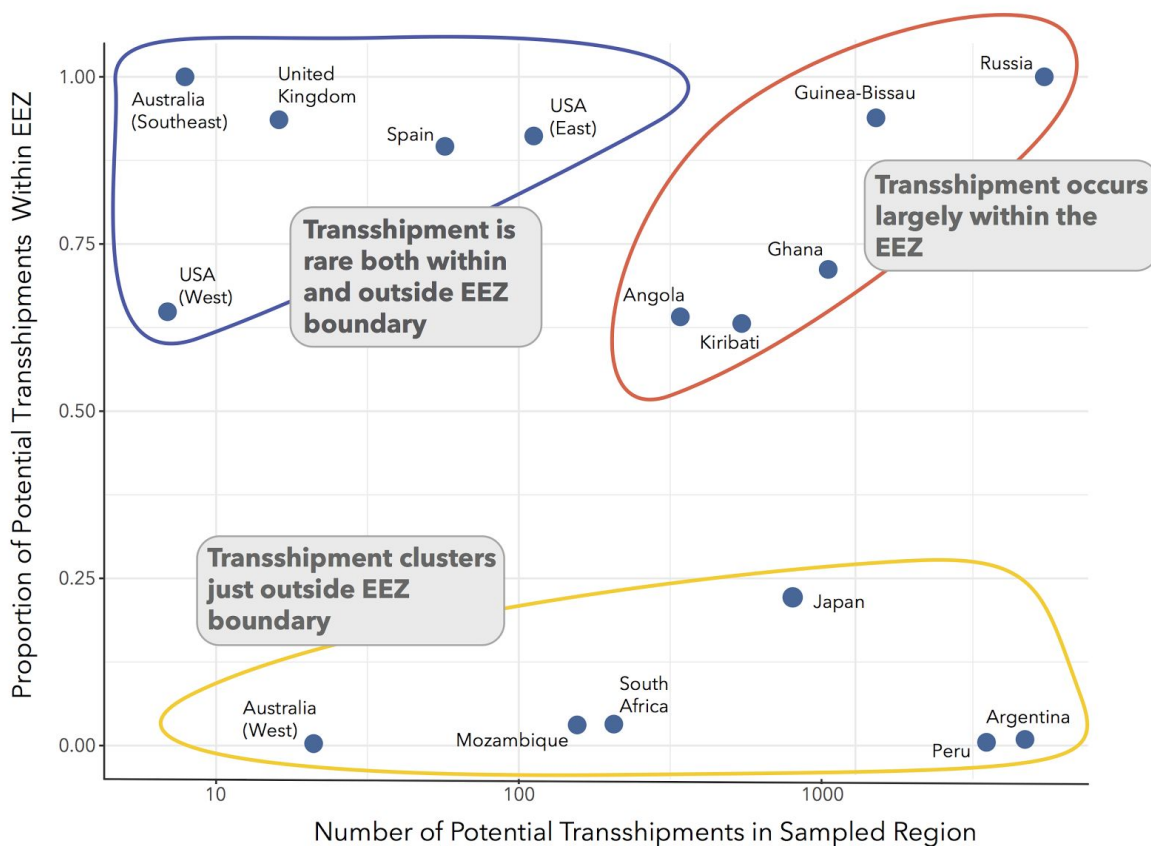

FAO Region 57 (West of Australia): We believe this is a dead zone in our data due to lack of good AIS coverage in Southeast Asia and Indonesia.

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.

Transshipments Cluster Inside and Along Exclusive Economic Zones

Categories of Transshipment Activity

Transshipment is rare both within and outside the EEZ boundary

Transshipment clusters just outside the EEZ boundary

Transshipment occurs largely within the EEZ

Patterns of Transshipment Inside and Outside Exclusive Economic Zones

We see three behavioral patterns based on where transshipments occur. Many countries have little transshipment 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 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 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 in the EEZs of African nations and Kiribati reflect IUU fishing? Is the high level of transshipment right 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 simply because these regions are more economical locations to fish? Answering these questions will require further investigation and comparison with logbook and observer data.

Vessel Identities

Flag State Trends

Reefers 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 reefer dataset include Panama, Liberia, and the Bahamas. **In fact, FoCs are flown by 48 percent of reefers in our database, and 44 percent of the likely transshipments are undertaken by reefers flying these flags**. Another 34 percent of likely transshipments are Russian reefers, most of which are transshipping within the Russian EEZ at the Sea of Okhotsk. To determine FoCs, we used the list compiled by the International Transport Workers Federation.[21] Note that almost a third of reefers changed registrations and flags between 2012 and 2016, and are thus counted more than once on the chart below.

Flag States of Reefers in our Database

Count of Reefer MMSI
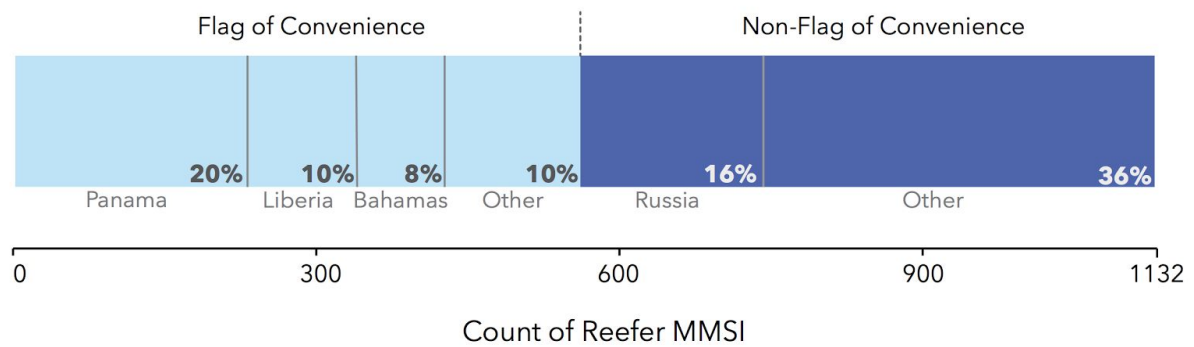
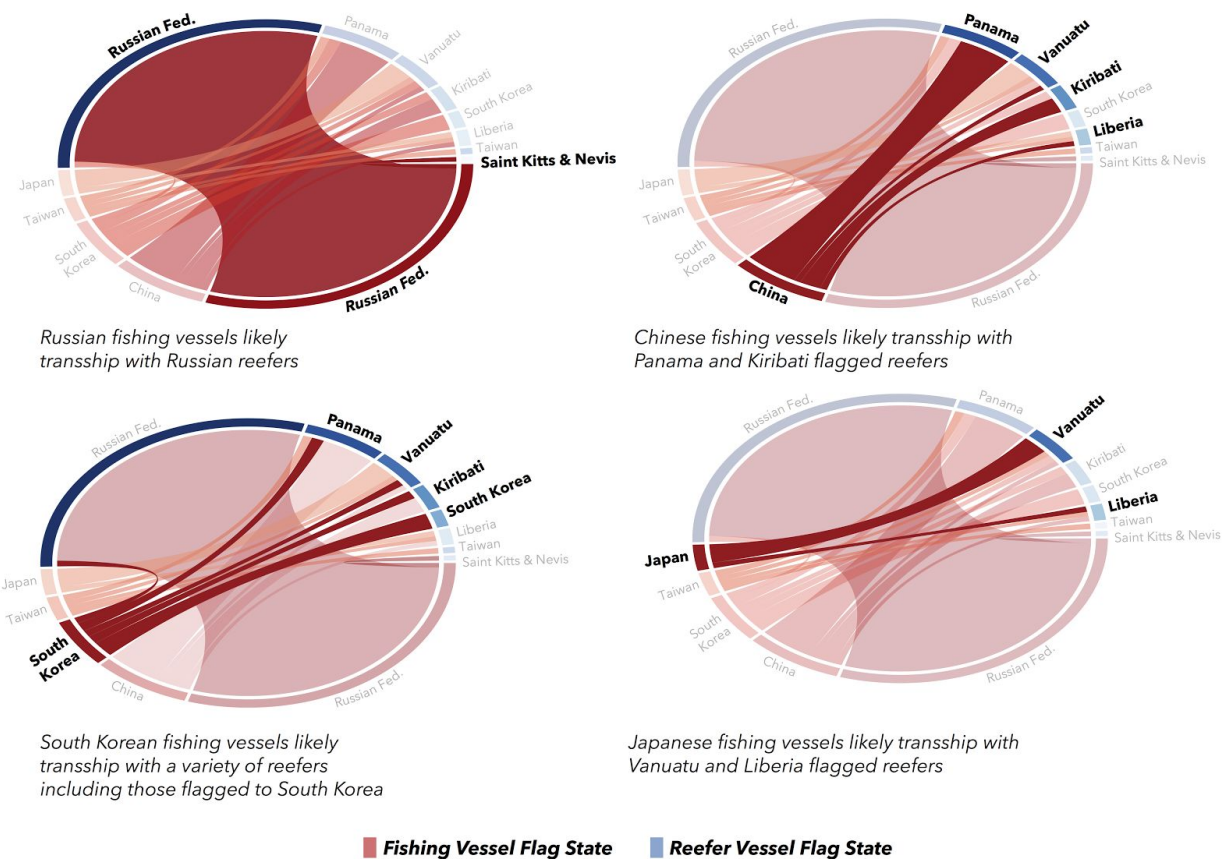## Potential Transshipment Events by Flag State of Reefer

Number of Events
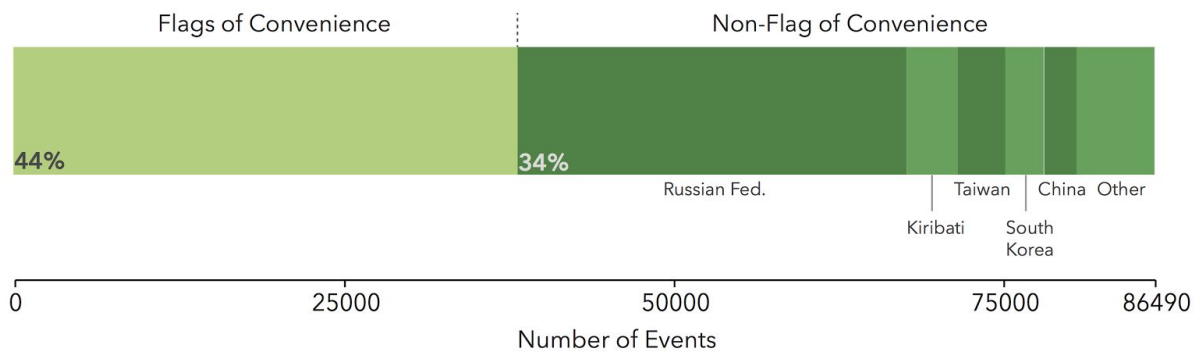
About six percent of our potential transshipments are also likely transshipments, where we see a fishing vessel meet up with the reefer. In these cases, we can identify both the fishing vessel and the reefer. A majority (56 percent) of these likely events are by Russian fishing vessels, primarily fishing and transshipping in the Sea of Okhotsk. The majority of the remaining likely transshipments with a fishing vessel involve those flying flags of Asian countries: China, South Korea, Japan, and Taiwan.

Flag States of Fishing Vessels Involved in Likely Transshipment Events
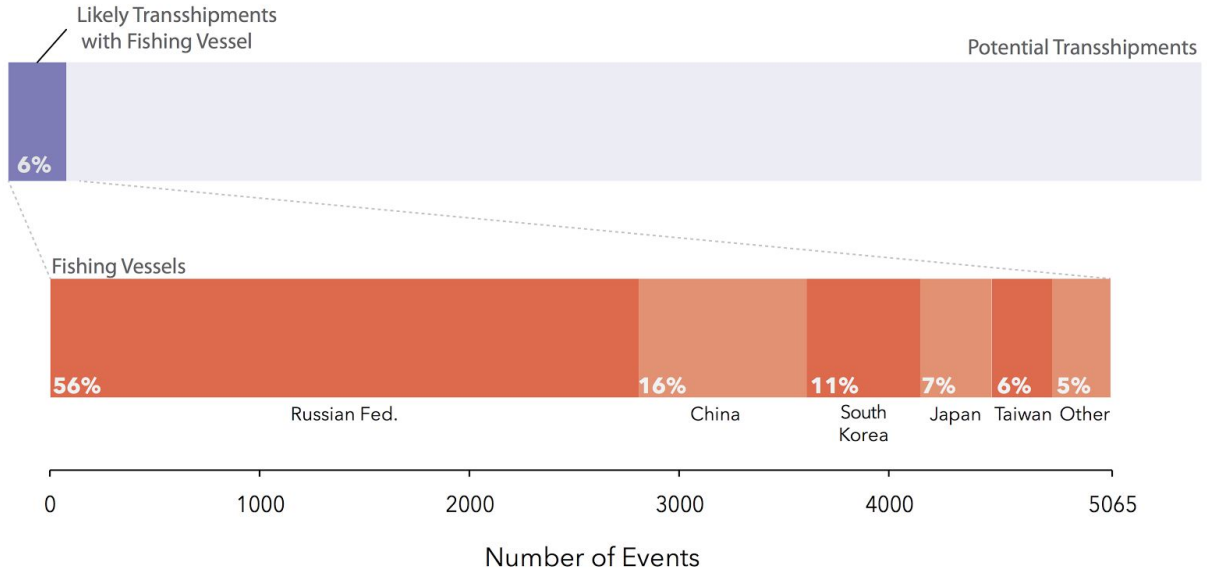
We also analyzed the flag states of the reefers that these fishing vessels rendezvoused with, and we identified common pairings of flag states.

Top Flag State Pairs Involved In Likely Transshipments

Russian fishing vessels likely transship with Russian reefers

Chinese fishing vessels likely transship with Panama and Kiribati flagged reefers

South Korean fishing vessels likely transship with a variety of reefers including those flagged to South Korea

Japanese fishing vessels likely transship with Vanuatu and Liberia flagged reefers

■ *Fishing Vessel Flag State*   ■ *Reefer Vessel Flag State*

These relationship graphics include only the most common flag states of reefers 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 reefers they most commonly meet up with fly FoCs, including Panama, Vanuatu, and Liberia.

Port Analysis

Ports Visited by Reefer After Transshipment

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 9,500 anchorages, we determined that in 2015, 73 anchorages had at least one reefer visit shortly after engaging in a likely transshipment 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[22]) were excluded. We identified the fishing vessels involved in likely transshipment with these reefers and used Global Fishing Watch's algorithms to estimate the hours each of these vessels spent fishing in the month before the transshipment. The map below shows these fishing locations and the top ports visited by the reefers following these likely transshipments.

Top Destinations for Likely Transshipped Catch, 2015
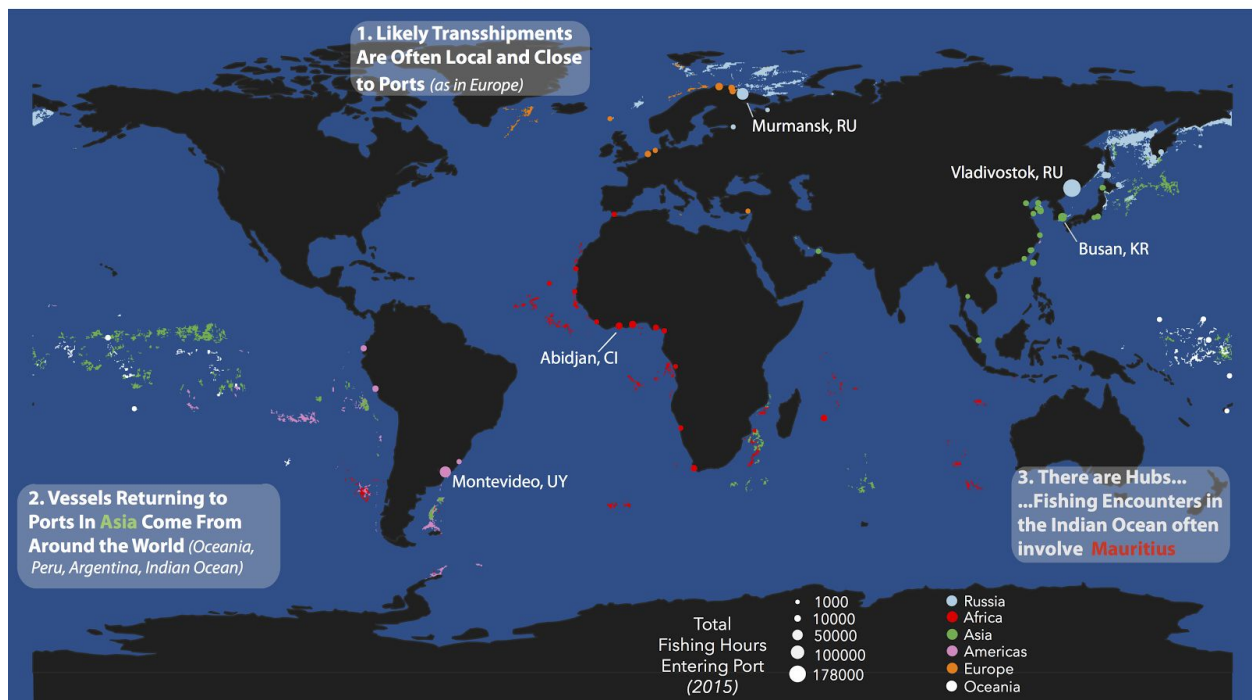

Colored ocean regions identify locations of fishing activity in the month prior to a likely transshipment, and colored points along the coastlines identify ports the reefers visited following these events. Note that this graphic makes no effort to quantify fishing effort offloaded during the potential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

Top Ports by Fishing Effort (2015)

Port/City	Continent	Total Fishing Effort* (hrs)
Vladivostok, Russia	Russia	178000
Montevideo, Uruguay	South America	65000
Murmansk, Russia	Russia	54000
Busan, South Korea	Asia	18000
Abidjan, Cote d'Ivoire	Africa	12000

Fishing effort potentially transsported on a refrigerated cargo vessel

Total Fishing Hours Landed by Continent (2015)
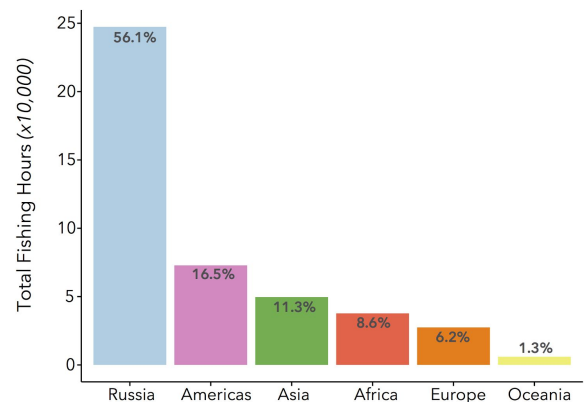
After transshipping, reefers tended to visit ports near the location of transshipment. The exceptions we saw include:

- Asian reefers (mostly Chinese) had a global presence with likely transshipments in Oceania and off the coast of Peru and South Africa before returning to their home ports in China.
- Reefers engaging in transshipments 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 transshipments and does not estimate fishing effort offloaded during potential transshipment events.

Case Studies

Reefer: Leelawadee

One interesting transshipment event was reported on the SkyTruth Blog in January of 2017.[23] 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 it do not have AIS, so this event is a potential transshipment event in our database.
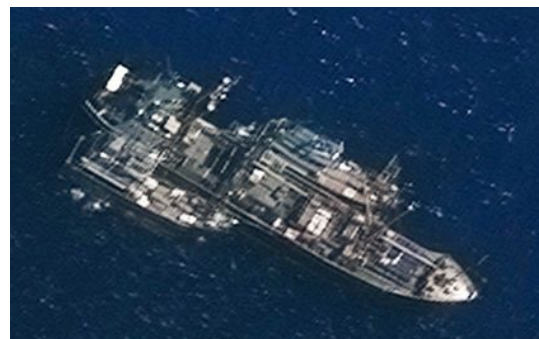
The *Leelawadee* and the Thai fleet it operated with had been operating in the waters of Indonesia and Papua New Guinea, and had been involved in

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

illicit activity, including illegal fishing and human trafficking.[24] 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,[25] the fleet has continued to engage in similar behavior. Transshipment has likely allowed these vessels to continue operating far from their home port. Also, when regulations increased in one region, Indonesia, the result appears to be that fishing pressures increased in another region. This case study shows how a national approach to transshipment regulation might simply push pressures to other parts of the globe.
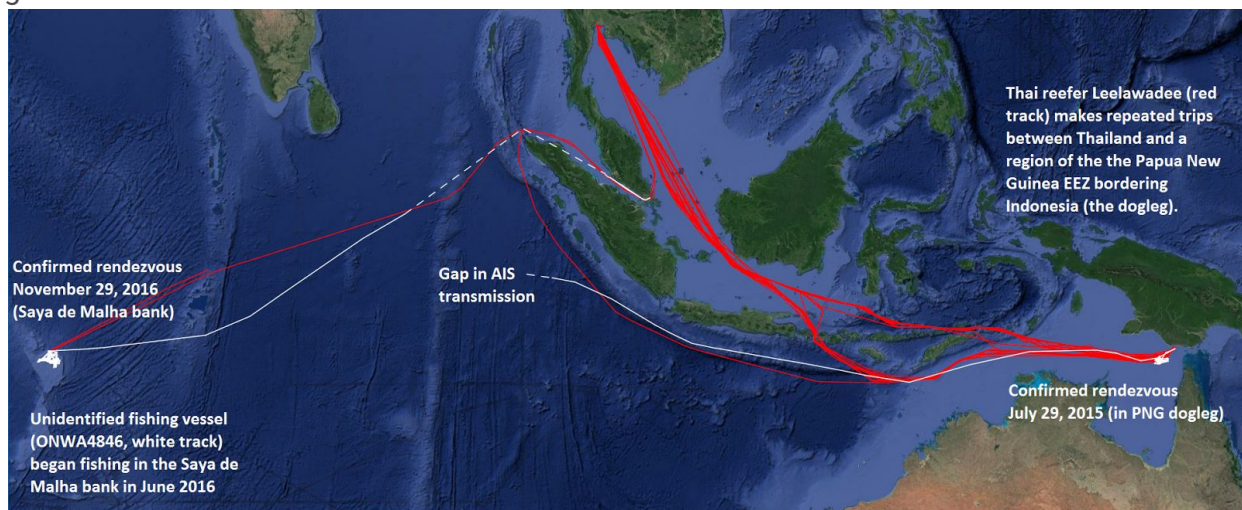
Track of the Leelawadee (red) and an unnamed fishing vessel (white) rendezvousing in Papua New Guinea

waters in July 2015, then again on the Saya de Malha bank in November 2016.[23]

Reefer: Chitose

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

- Reefer trips are typically months long and the reefer engages in multiple transshipments all over the world.
- When reefers finish a trip, they usually return to the same ports. For the *Chitose*, these ports were in Singapore, China, and Japan.
- Reefer transshipments occur in multiple areas bringing in catch from fisheries that span the globe.

From vessel location data, we can identify certain events like transshipments, port visits, data gaps, and their 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 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
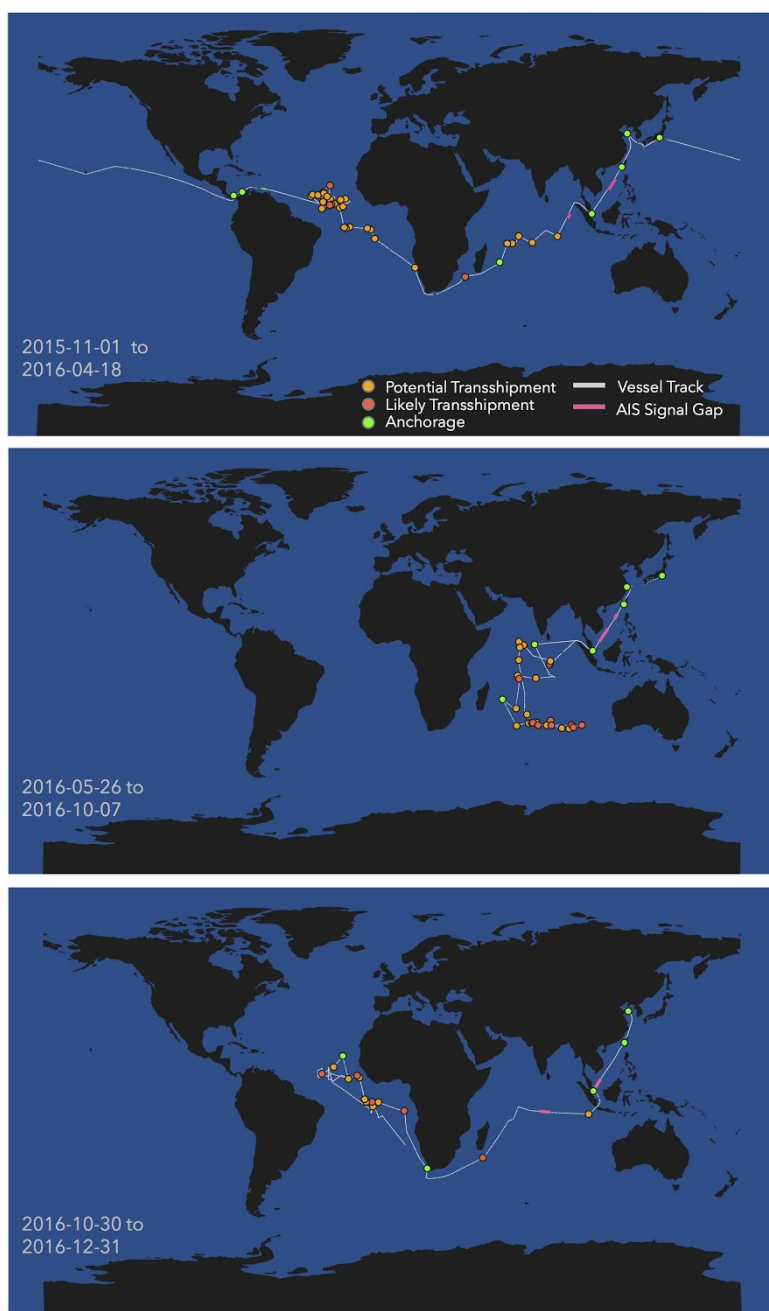
Conclusion

This analysis, the first of its kind, uses AIS to reveal global patterns of transshipment. 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 transshipments with fishing vessels in multiple locations before returning to port. Also, about 40 percent of transshipment events occur on the high seas, and a similar proportion are by reefers with so-called flags of convenience. In other words, a significant portion of transshipments 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 is more prevalent in areas with higher IUU fishing, and that transshipment 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 transshipments 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 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 trends that relate 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. A few countries are talking with Global Fishing Watch about incorporating their data into our platform. **Using VMS data for validation will increase vessel coverage and improve our algorithms, increasing our ability to identify transshipments as well as providing new tools and insights to governments to aid in management and enforcement.**

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 transshipments, 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 key 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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