



Photo by: Simon Age

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Analysis of the Southeast Pacific Distant Water Squid Fleet

GFW-2021-FA-SQUID2020

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AIS provides the only open-source monitoring tool for high seas fishing. AIS relies on voluntary transmission, and is restricted to the vessels which have AIS devices installed and operating, making the data records incomplete. An additional source of uncertainty in AIS-based data relates to poor satellite reception, in areas with high vessel traffic, such as the South China Sea and English Channel. That said, the reception is generally good in the focal area of this report, however, the boats operating within the squid fishery often use Class B AIS transponders that broadcast at a lower rate when the vessels move slower than two knots. The majority of squid vessels fish by drifting with the currents¹ at a speed less than two knots, therefore the AIS messages received by these vessels and estimates surrounding their AIS-based fishing effort will be conservative. Nevertheless, in the absence of any other information, these data can be used to characterize the spatial extent and relative activity of the squid fleet in the area.

'Encounter Events' are identified when AIS data indicates that two vessels may have conducted a transshipment, based on the movements of the two vessels. Global Fishing Watch identifies encounters from AIS data as locations where two vessels, a carrier and fishing vessel, were within 500 meters for at least two hours and traveling at a median speed less than 2 knots, while at least 10 km from a coastal anchorage.

¹ Taconet, M., Kroodsma, D., & Fernandes, J.A. 2019. Global Atlas of AIS-based fishing activity - Challenges and opportunities. Rome, FAO. page 352. <http://www.fao.org/3/ca7012en/CA7012EN.pdf>

Executive summary

The number of fishers that catch squid has increased in recent years, with fishing capacity in commercially important squid fisheries growing globally. The southeast Pacific is no exception. Between 1990 and 2018, the annual reported catch from the high seas has increased from ~5,000 to ~278,000 tons from three commission members; China, Chinese Taipei, and Republic of Korea ([SC7-SQ01 Squid](#)). The high seas distant water fleet has grown from a flag State reported 6 vessels in 1990 to 528 in 2019 ([SC8 - SQ01_rev1_clean](#)). The distribution of the jumbo flying squid ranges from southern Chile, up to north American waters, and extends out into the high seas, into an area that is jointly managed by Member States via the South Pacific Regional Fisheries Management Organization (SPRFMO). Fisheries targeting the jumbo flying squid (*Dosidicus gigas*) are of clear socio-economic importance in Chile, Peru and Ecuador on a commercial and artisanal fisher scale, as well as to the international distance water fleet.

During the 2020 Commission meeting, SPRFMO introduced its first Conservation and Management Measure (CMM) directly related to the management of the squid, however the fishery still lags behind fisheries targeting other species in the Pacific. For example, vessels are required to be authorized on the SPRFMO Vessel List, in order to fish within the SPRFMO area, however transshipment of squid (the at sea transfer of catch), unlike other targeted species in the Convention Area, do not require prior authorization from the flag States to confirm compliance with SPRFMO CMMs. The sustainability of the squid fishery, and the distribution of fishing effort is largely unknown. An understanding of the spatial distribution, composition and behavior of the squid fleet operating in this area should be studied in depth.

Global Fishing Watch (GFW) in support of partnerships with some coastal States in Latin America use remotely observed satellite data and artificial intelligence machine learning to better understand the extent and activity of the squid fleet operating in the southeast Pacific in 2020. By combining multiple sources of open-source data, namely AIS-based data on vessel positions and the publicly accessible SPRFMO vessel registry and implementation reports, we investigated fishing activity by vessel flag across the high seas squid fishing grounds in the southeast Pacific. A total of 615 squid fishing vessels were active in the region, 95% of which were flagged to China, operating at a combined total of ~95,000 fishing days within the year. SPRFMO members and cooperating or non-contracting parties (CNCPs) reported a list of 522 squid vessels that were active inside the SPRFMO Convention Area in 2020, over 10% (82) of the vessels identified as active by AIS could not be matched to this list; highlighting a potential risk that these vessels catch went unreported.

The at-sea vessel support of the squid fleet was extensive with a total of 59 carrier vessels active on AIS in the area. AIS-based estimates of encounters, which can indicate opportunities for transshipment were in the order of 1500. An analysis of the onward voyages of the carriers that had encounters with squid fishing vessels within the area of interest, highlighted the range of ports utilized by these carrier vessels. Carriers visited ports in Chile, Panama, Peru, China, Republic of Korea and Chinese Taipei, all of which are members or CNCPs to SPRFMO. With the exception of China, where the majority (77%) of port visits were made, the port State had designated its ports under the SPRFMO port control CMM.

Importantly, analysis of AIS signals revealed a far greater number of AIS active carrier vessels in the area (41) than the number reported on the SPRFMO Active List for 2020 (12). Carrier vessels observed meeting squid vessels in the SPRFMO Convention Area but not reported as active by the flag State poses a potential risk that the transshipment and catch was not reported.

SPRFMO CMM 04-2020 defines one type of IUU fishing activity as '*do not record and/or report their catches or catch related data made in the Convention Area, or make false reports*'. Accurate and complete catch reporting is vital for the sustainable management of the jumbo flying squid fishery, it is recommended that to better understand the level of unreported catch in the fishery the 82 fishing vessels and 29 carrier vessels identified in this report are reviewed to ensure they properly reported fishing and transshipment activity in 2020.

Our analysis demonstrates the utility of machine learning applied to AIS-based data to monitor fishing activity and improve transparency on a particular fishery. However, the analysis has caveats, AIS devices can be turned off, 42% of the vessels identified on AIS has data gaps longer than 24 hours and devices can be misused, 13% of the fleet exhibited AIS irregularities that lead to confusion in terms of identity or location. Our analysts have developed techniques to identify vessels misusing AIS but the practice still creates real challenges for monitoring control and surveillance (MCS) of the fleet. RFMO members and CNCPs should mandate the continual use of AIS Type-A in line with SOLAS regulation V/19.2.4 for distant water fishing and ensure AIS devices are legally operated.

Despite the caveats around the use of AIS within the squid fleet a large proportion of the fleet uses AIS. Of the 522 vessels reported as active inside the SPRFMO Convention Area, 519 could be matched to AIS tracking data; encouragingly high. These findings are promising, as they highlight the potential for AIS to be adopted as an additional data source to complement existing monitoring control and surveillance methods, if vessels broadcast signals as per the IMO standards and requirements.

To further investigate the AIS-based estimates of the squid fleet, additional data were derived from two other satellite sources, synthetic aperture radar (SAR) and visible infrared imaging radiometer suite (VIIRS). These additional data sources can complement AIS-based data, in particular they can be used to detect vessels not visible on AIS, named 'dark vessels'. From the analysis of one year of nightly VIIRS imaging and 113 SAR images taken in June and July, two vessels were detected on June 20, 2020 operating with lights within Peruvian. The detections were made using VIIRS and 3 vessels were identified close by with AIS gaps matching the time of the detections. The satellite imagery from 2020 appears to indicate that there was typically good compliance with EEZ limits by the distant water squid fleet and illegal fishing of this type was minimal, continued satellite monitoring and at sea patrols appear to provide a degree of deterrence and should be continued.

This analysis demonstrates how transparency and public data can be used as a tool by relevant authorities to conduct monitoring, control and surveillance efforts. States in the region are global leaders in advancing the adoption of transparency for greater ocean governance, providing a precedent for setting a high standard regarding transparency of high seas fishing in the region. A series of 11 recommendations to support the implementation of transparency and MCS within this squid fishery are made.

Summary of recommendations

Improved transparency	RFMO members and CNCPs should mandate the continual use of AIS Type-A in line with SOLAS regulation V/19.2.4 for distant water fishing.
Strengthening MCS through the adoption of new data and technology	AIS can be a valid tool for the monitoring of the fleet and the use of AIS to supplement existing MCS tools to support monitoring should be accepted by SPRFMO member States and CNCPs and incorporated in the Commission's compliance framework.
Improving working conditions	<p>AIS is an effective tool for monitoring duration at sea and when vessels with extended periods at sea request entry into port or enter coastal waters, inspection of the working conditions should be prioritized by the port or coastal authority.</p> <p>SPRFMO member States and CNCPs ratify and implement the International Labour Organisation's Work in Fishing Convention (2007) C188 to ensure safe and legal working conditions exist on board vessels operating inside the Convention Area.</p>
Addressing unreported fishing risks	It is encouraged that the flag State should investigate 82 vessels that operated inside the SPRFMO Convention Area but were not included in the Active List to confirm if they complied with the reporting requirements in CMM 18-2020.
Addressing unregulated fishing risks	<p>Three vessels were broadcasting an identity on AIS that could not be matched to a SPRFMO authorized vessel; it is recommended that flag States investigate to confirm the legitimacy of these vessels inside SPRFMO.</p> <p>Eleven vessels were not broadcasting true identity information and could not be matched with a SPRFMO authorisation. Flag States should verify that their flagged vessels are broadcasting accurate AIS information in line with IMO Resolution A.1106(29) to ensure transparency in their operations and safety of navigation.</p>
Transshipment monitoring and controls	<p>A transshipment authorization process for jumbo flying squid in line with other SPRFMO managed species would be recommended to support better monitoring and control of transshipments and help to ensure more accurate reporting.</p> <p>It is recommended to provide more information regarding transshipments, including the identity of the vessels involved; the location and time of each event in a timely manner.</p>
Port Controls	<p>It is recommended that China provide a list of designated ports where the minimum standards on port controls can be met for visiting foreign vessels.</p> <p>Data on implementation of CMM 07-2021 on port controls should be collated and made public.</p>
Dark vessel monitoring	<p>Investigation of VMS data by the flag State and SPRFMO Compliance Committee is recommended to confirm no irregularities occurred inside Peruvian waters by three vessels identified in this report in June 2020.</p> <p>Remote sensing analysis is continued by the coastal States and their partners to act as a deterrent to the risk of unauthorized IUU fishing inside their waters.</p>
IUU Listing	It is recommended that the SPRFMO members adopt a stronger IUU listing process that incorporates other IUU lists and accepts evidence of IUU fishing activity against its authorized vessels from non-members or non-CNCPs and from activity outside of the Convention Area. This is vital to ensure IUU fishing activity by the global high seas squid fleet can be effectively sanctioned and IUU vessels are not able to evade sanctions by moving to new regions.

Analysis of the Southeast Pacific Distant Water Squid Fleet

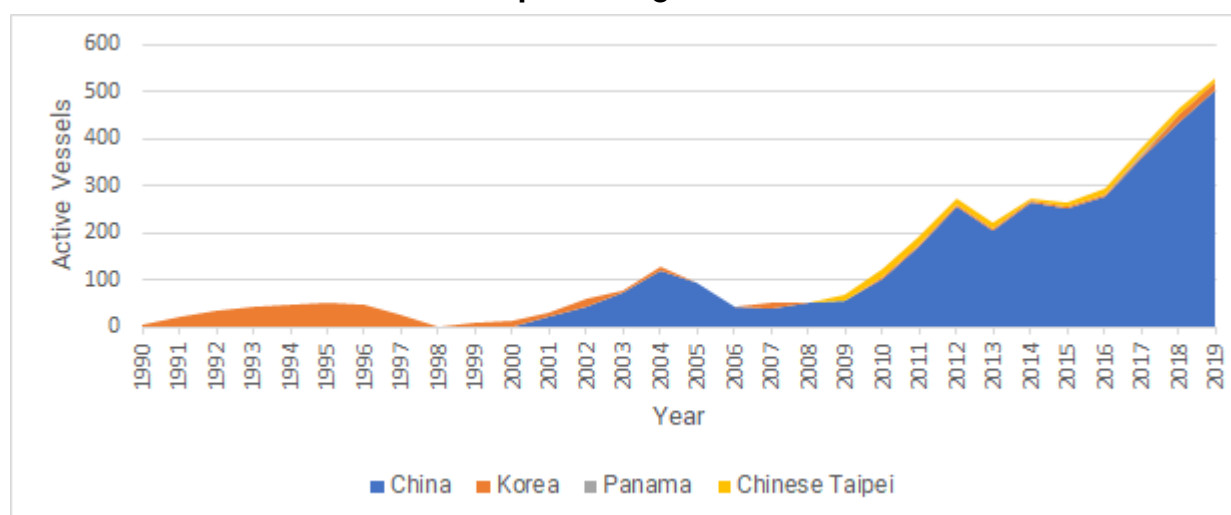
1 Overview

The jumbo flying squid (*Dosidicus gigas*) is the most abundant cephalopod species in the Southeast Pacific Ocean and one of the most important cephalopod fisheries in the world ([Ibáñez et al., 2015](#)). The range of this species extends from southern Chile to the North American coast ([FishSource](#)), falling within the remit of the South Pacific Regional Fisheries Management Organization (SPRFMO), where it is the second largest fishery of this intergovernmental management body.

This species is of clear socio-economic importance, both commercially on the high seas within the SPRFMO area and within the Exclusive Economic Zones (EEZ) of Chile and Peru, as well as for small-scale fishers. In particular, in Peru where the squid fishery constitutes the largest artisanal fishery.

The high seas squid fishery has seen a substantial increase in fishing effort and associated catch in the SPRFMO Convention Area. Between 1990 and 2018, the annual reported catch from the high seas has increased from ~5,000 to ~278,000 tons from three commission members; China, Chinese Taipei, and Republic of Korea ([SC7-SQ01 Squid](#)). The fleet has grown from around 6 vessels in 1990 to 528 in 2019 ([SC8 - SQ01_rev1_clean](#)). As a result, the squid fleet represents 74 percent of the total vessels registered to SPRFMO in 2020 and are classified by the commission as liners, often referred to as squid jiggers and fish carrier vessels, and they have a significant footprint in the region (Figure 2).

Figure 1: SPRFMO distant water active squid fleet growth 1990 - 2019



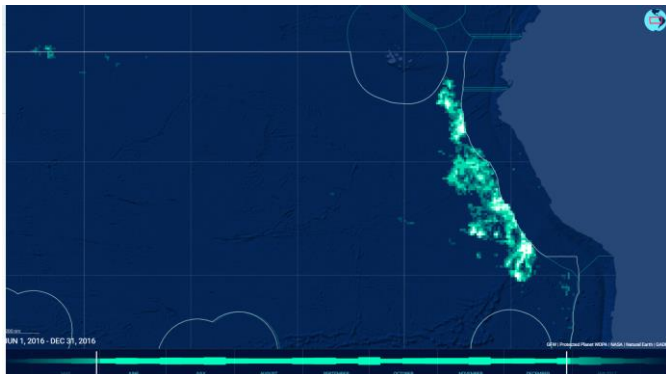
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In support of partnerships with some coastal States in Latin America, Global Fishing Watch has been monitoring the activity of the squid fleet in the Southeast Pacific Ocean to understand the footprint of the fleet, as well as its behavior and risks of illegal, unreported and unregulated (IUU) fishing. In June and July 2020, Global Fishing Watch reviewed AIS data from high seas south and east of Ecuadorian Galapagos' EEZ, identifying 356 squid vessels operating in the region between June 15 and July 29. Furthermore, in October of 2020, Global Fishing Watch reviewed AIS data

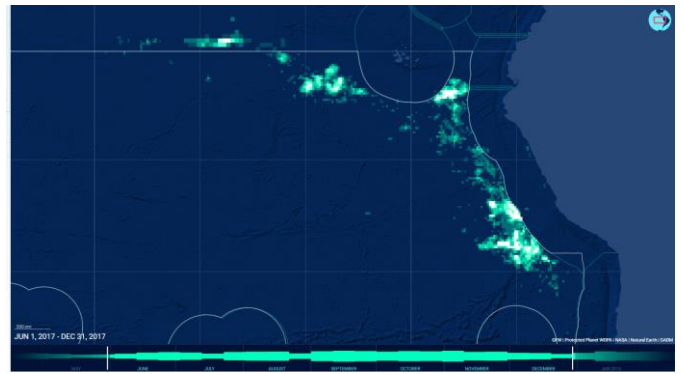
from the southeast Pacific, identifying approximately 384 squid jigger vessels and 9 carrier vessels operating within Peru's EEZ limits and southern high seas.

Figure 2: AIS-based fleet distribution and fishing activity, 2016-2020

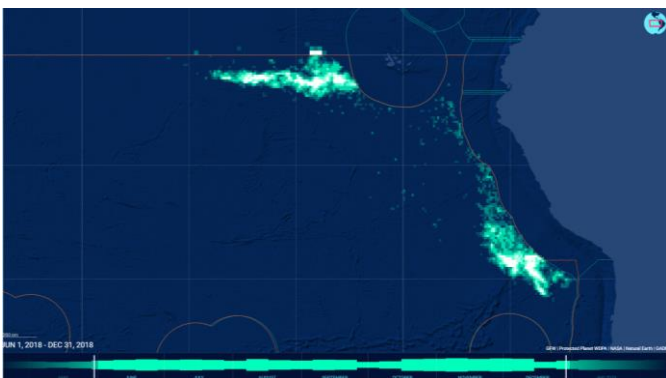
AIS based estimates of the fleet distribution and fishing activity of the squid vessels per year (2016, 2017, 2018, 2019 & 2020) between June and December. Vessels operate close to the EEZ limits of Peru, Chile, and Ecuador extending into the Pacific High Seas Area.



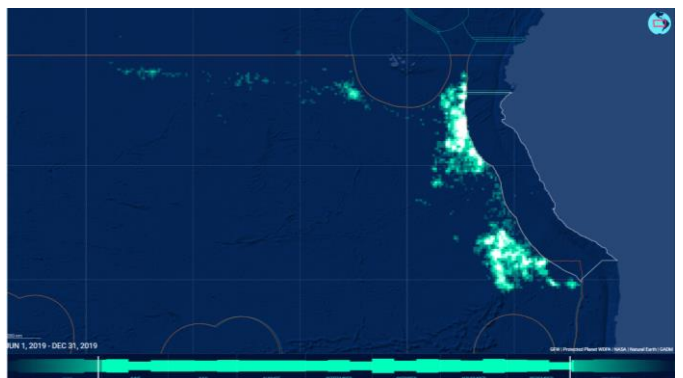
Jun - Dec 2016



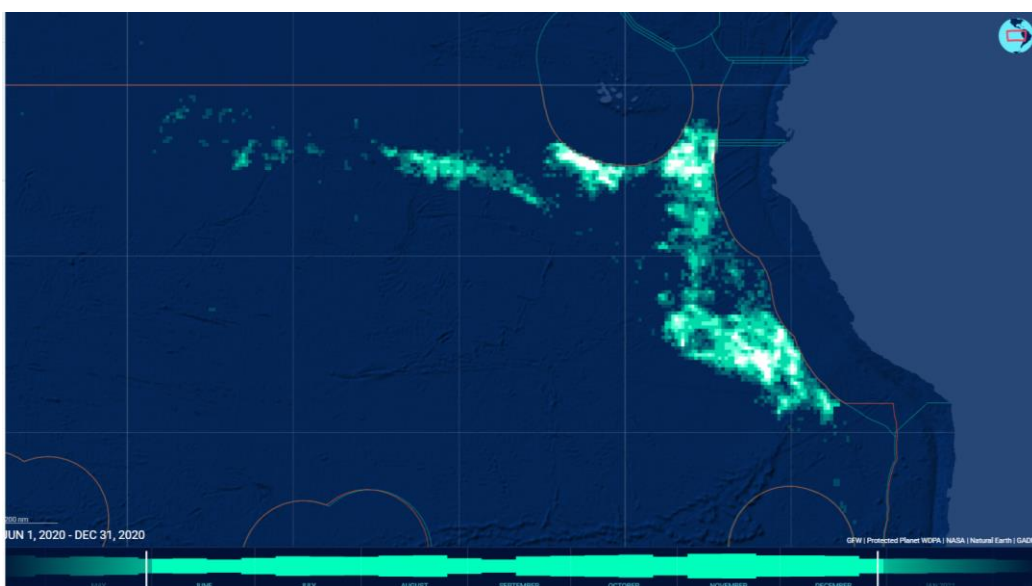
Jun - Dec 2017



Jun - Dec 2018



Jun - Dec 2019



Jun - Dec 2020

1.1 Aim of the analysis

The sheer size of the fleet and the volume of catch being extracted is causing alarm in many quarters. Coastal States, [media](#), and civil society are concerned over the activity within the fleet and question the sustainability of the fishery. Using our public data and machine learning, Global Fishing Watch is investigating this fleet. Initially we will investigate the squid fleet activity through the southeast Pacific Ocean during 2020 and follow-on reports will be produced on the activities of the 2021 fleet. Our analysis draws on a combination of sources of information:

1. Automatic identification system (AIS),
2. Synthetic aperture radar (SAR),
3. Visible infrared imaging radiometer suite (VIIRS),
4. SPRFMO registry and compliance reports.

The report will outline compliance challenges and seek to inform inspection, enforcement and compliance efforts conducted by SPRFMO and its members. The report will also inform civil society of the key factors to consider in seeking to secure the sustainability of the squid fishery.

The analysis focuses on the area of interest (AOI) described below (Figure 3) between January and December, 2020. This area was selected based on historic activity of the squid fleet in the region in particular along Peru's EEZ, around the Ecuadorian Galapagos' EEZ, and an area on the equator about 1000 nautical miles west of the Ecuadorian Galapagos' EEZ.

Figure 3: Area of interest within the Southeast Pacific



2 Vessel tracking analysis

Using AIS data and the Global Fishing Watch fishing effort algorithm for night time squid fishing² a total of 634 unique MMSI numbers associated with 615 vessels completed an estimated total of 876,366 fishing hours or 94,559 fishing days over the year (Figure 6).

The status of the top 10 vessels detected in the AOI is summarized in Table 1.

Table 1: Top 10 squid fishing vessels operating in the Southeast Pacific, 2020

Note: [Click to see the full list of vessels](#)³

Vessel	MMSI	Fishing days ⁴	AIS positions	Vessel class	Flag*
ZHOUYU919	412549083	342	169,299	Squid jigger	CHN
ZHOUYU920	412549084	339	168,494	Squid jigger	CHN
ZHOUYU922	412549086	337	178,469	Squid jigger	CHN
ZHOUYU917	412549081	337	165,650	Squid jigger	CHN
ZHOUYU916	412421037	336	203,500	Squid jigger	CHN
CHANGSHUN8	412329632	335	195,143	Squid jigger	CHN
ZHOUYU921	412549085	332	180,389	Squid jigger	CHN
ZHOUYU915	412421038	331	202,909	Squid jigger	CHN
RONGYUANYU168	412328791	329	25,232	Squid jigger	CHN
JINHAI717	412420996	329	85,986	Fishing	CHN

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Key Finding 1a: The number of AIS messages received per vessel operating inside the focal area varied significantly, ranging from 169,299 transmissions received over 342 days to vessels with only 50 transmissions from just one single day. The squid jigger ZHAN HAI 3, for example, had long periods with no AIS data. This boat was detected on AIS as entering the AOI in early February 2020, then following seven weeks with only a couple of days of AIS transmission, was detected as leaving the area in March 2020. **A gap of this length is unlikely caused by a reception issue and is consistent with the possibility of the AIS device being deliberately disabled. Vessels with limited AIS data available are less trackable in their movements and patterns of life and compliance with EEZ limits and transshipment regulations is unknown.**

Key Finding 1b: Of the 615 unique vessels identified operating inside the study AOI 260 (42%) had gaps in AIS data inside the study AOI longer than 24 hours. The total number of days where vessels had AIS data gaps was 3524 days. During a gap in AIS data the vessel's activities or compliance is unknown and causes the most concern when they occur close to coastal States EEZ limits.

² Global Fishing Watch has developed algorithms to automatically detect different types of fishing activity from vessel tracking data. Kroodsma, D. et al, 2018. [Tracking the global footprint of fisheries](#). Science, 359(6378), pp.904-908.

³ https://docs.google.com/spreadsheets/d/1_5SNthDaxZoG5PI03vqujmYwF3T8XhLHEXv9VpSwO3Q/edit#gid=1992095341

⁴ This study considered a 'fishing day' as any 24-hour period where the Global Fishing Watch algorithm detected at least 1 hour of movements that were consistent with night time squid jigging.

Recommendation 1: A fleet of this size is a challenge to monitor for coastal States and Management Bodies. AIS provides a level of transparency and oversight not afforded by the what is currently being reported. RFMO members and CNCPs should mandate the continual use of AIS Type-A in line with SOLAS regulation V/19.2.4 for distant water fishing.

Key Finding 2: The International Labour Organization identifies “days at sea” as an indicator of risk in their Fishing Labour Risk Analysis⁵. In addition, a [recent study](#) found total time on the high seas and distance from port to be two key indicators of forced labour in fisheries. AIS analysis of the Southeast Pacific distant water squid fleet identified vessels with long trip lengths into the study AOI and away from port. One example is the squid jigger [ZHOU YU 919](#), which entered the area of interest in December 2019 and appeared to operate continually until June 2021 where at the time of writing the vessel was transiting west across the Pacific. This raises concern about the working conditions on board the vessel and suggests that the vessel is at high risk of using forced labour.

Recommendation 2a: AIS is an effective tool for monitoring duration at sea and when vessels with extended periods at sea request entry into port or enter coastal waters, inspection of the working conditions should be prioritized by the port or coastal authority.

Recommendation 2b: SPRFMO member States and CNCPs ratify and implement the International Labour Organisation's Work in Fishing Convention (2007) C188 to ensure safe and legal working conditions exist on board vessels operating inside the Convention Area.

Clear seasonal and spatial patterns in the squid fleet operating in the region are evident. Squid fishing vessels changed their fishing grounds throughout the year (Figure 4 and 5), with the highest AIS-detected fishing effort in October, November, and December (Figure 6). The seasonal movement of the squid fleet can be characterized in 2020 as:

- **January-March:** Fishing vessels concentrated close to the western limit of the Ecuador EEZ (Galapagos).
- **April-June:** vessels moved from western Ecuador EEZ (Galapagos) to the high seas adjacent to Peru's EEZ. A small fraction of vessels was found to be operating near Argentina's EEZ during May.
- **July-September:** Vessels transited through the Chile EEZ to the high seas adjacent to Peru and Ecuador's EEZs. Vessels concentrate their activity south of Ecuador EEZ (Galapagos) and outside the northern end of Peru's EEZ.
- **October-December:** Vessels operate further south along Peru's EEZ limits and west of Ecuador EEZ (Galapagos).

There is a wide distribution of the squid fleet in the Southeast Pacific; additionally, a fleet is operating in the South Atlantic Ocean. The AIS data revealed that within the Southeast Pacific, the zones with the most significant scale and persistence of the fleet were in the limits of Peru's EEZ and the Ecuador EEZ (Galapagos). On the other hand, approximately 12 percent of the squid fleet operated off the Argentinian coast; then it moved to the AOI. Conversely, roughly 21 percent of the fleet that operated in the AOI moved to the South Atlantic Ocean, off the Argentinian coast.

⁵ 2020. ILO training package on inspection of labour conditions on board fishing vessels.

https://www.ilo.org/wcmsp5/groups/public/--ed_dialogue/--sector/documents/instructionalmaterial/wcms_766744.pdf

Figure 4: AIS-detected squid fishing activity by quarter

AIS-detected squid fishing activity in the Southeast Pacific with the average and maximum number of active vessels within the AOI during each quarter of 2020.

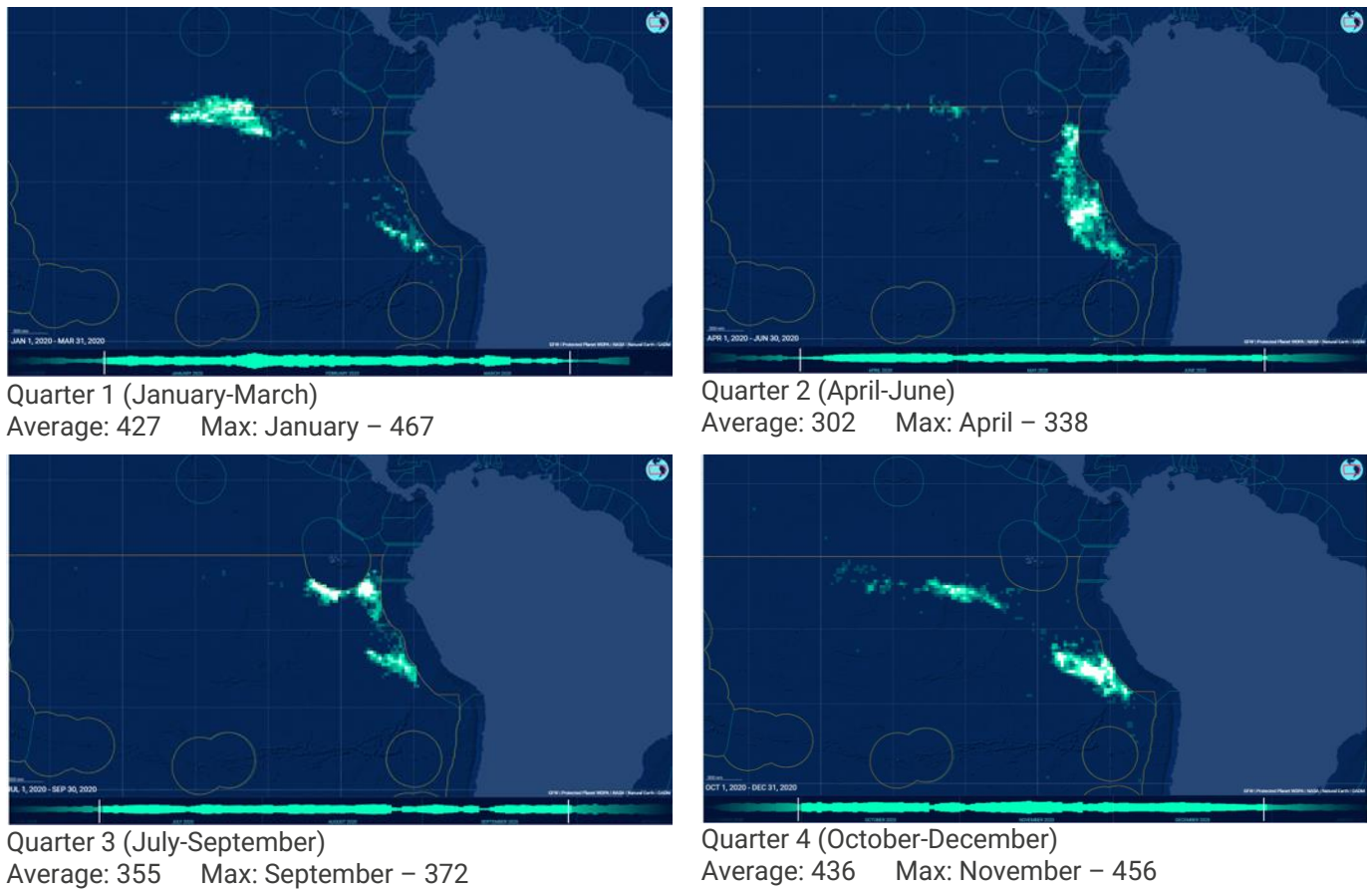


Figure 5: Quarterly fishing activity of squid vessels

The fishing activity of squid vessels found operating at some point during 2020 within the Southeast Pacific AOI (pink area), color coded by yearly quarter. Note: The activity seen in the southwest, close to the New Zealand EEZ is caused by vessels offsetting their position on AIS from their actual position inside the AOI, more details can be found in section AIS irregularities.

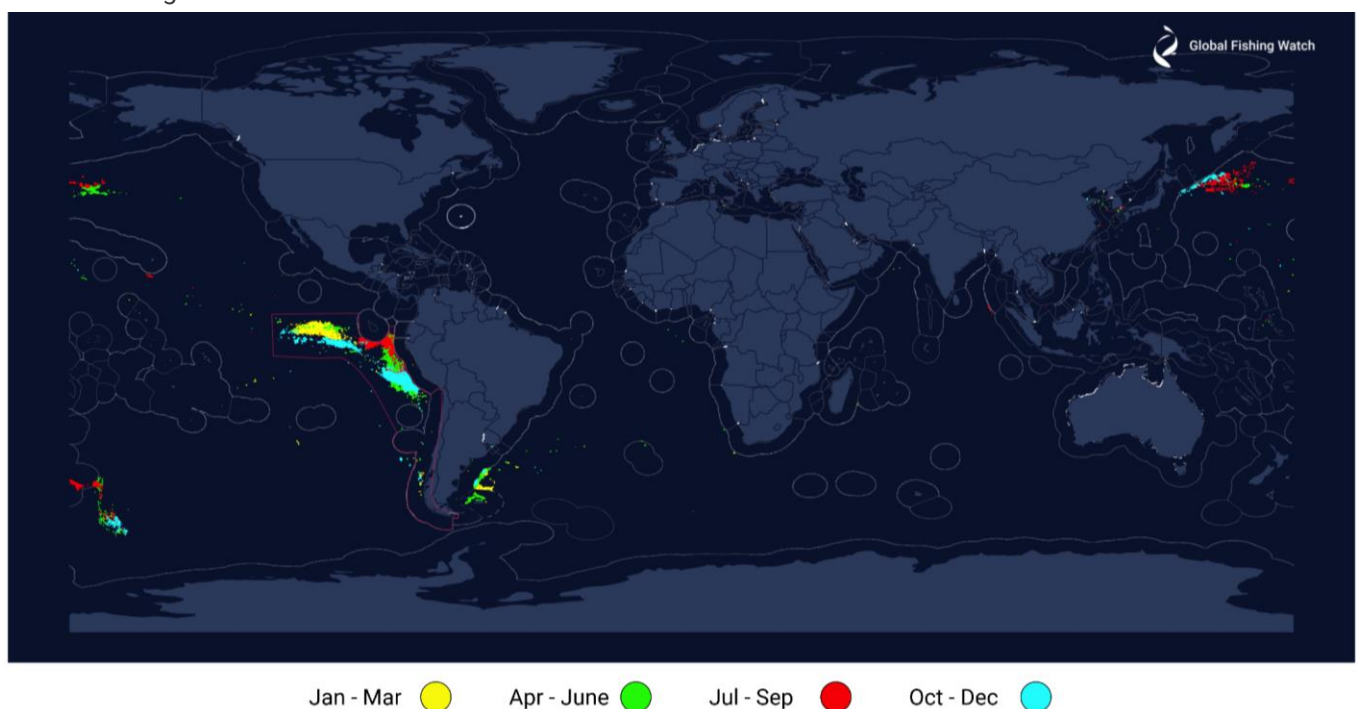


Figure 6: Monthly fishing hours of squid vessels

AIS-based estimates of fishing hours by vessel flag state per month for squid vessels operating in 2020 in the southeast Pacific area of interest (China included: right hand side, China excluded: left hand side).



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2.1 Reviewing the list of active vessels in the AOI

SPRFMO CMM 005 (Record of Vessels) requires members to report to the Secretariat the vessels authorized to fish in the SPRFMO Convention Area as well as a list of active vessels⁶ reported by member States each year as part of an implementation report. This analysis cross references the reported data with what is observed on AIS inside the SPRFMO Convention Area. The resulting findings are useful for identifying potential IUU risks which can be further investigated by the relevant competent authorities using VMS data, logbooks and port inspections.

Comparing AIS data with the [SPRFMO Record of Vessels](#) and the active vessels from the [2020 list of authorized vessels](#) produces the following findings:

Key Finding 3: There is a high proportion of vessels targeting squid in the SPRFMO Convention Area using AIS. It was identified that from 522 squid vessels reported as active inside the SPRFMO Convention Area by the member States in 2020, Global Fishing Watch was able to match 519 to AIS tracking data.

Recommendation 3: AIS can be a valid tool for the monitoring of the fleet and the use of AIS to supplement existing MCS tools to support monitoring should be accepted by SPRFMO member States and CNCPs and incorporated in the Commission's compliance framework.

Three Chinese squid vessels (LU RONG YUAN YU 882, LU RONG YUAN YU 581, and LU RONG YUAN YU 582) reported on the [SPRFMO active vessels list](#) but no AIS positions were detected inside the SPRFMO Convention Area in 2020. The vessel LU RONG YUAN YU 882 does not appear to have broadcast on AIS since March 2019, LU RONG YUAN YU 581 and LU RONG YUAN YU 582 only started broadcasting on AIS in October 2020 when the vessels were outside of the SPRFMO area. It is reasonable to presume that the vessels did operate inside the SPRFMO Convention Area in 2020 as reported by the flag State but were not broadcasting AIS at the time.

Key Finding 4: A total of 82 squid vessels flagged to China were identified as active inside the SPRFMO Convention Area according to the AIS tracking data but not listed as active by the member State (China) for 2020 ([Click to see the full list of vessels](#)). These vessels appear as [authorized by SPRFMO](#) but are not reported as being active in the SPRFMO Convention Area in the calendar year 2020. The LUWEIYUANYU 018 (MMSI number 412329404, International Maritime Organization (IMO) 8782642), is one example. In 2020, this vessel broadcasted 27,172 AIS positions with a total of 2,718.4 fishing hours that represent 283 fishing days ([map visualization](#)) inside the SPRFMO Convention Area, but is not listed as active by its flag state China for 2020. This mismatch between vessels present on the SPRFMO Active list for 2020, and the 82 squid vessels observed on AIS inside the SPRFMO Convention Area highlights the potential risk of vessels being in operation without being held accountable to report their catches or transshipments to the flag State or SPRFMO as is required under Article 27 of the Convention.

Recommendation 4: CMM 04-2020 defines one form of IUU fishing activity as vessels that '*do not record and/or report their catches or catch related data made in the Convention Area, or make false reports Pursuant to Management of the Jumbo Flying Squid Fishery*'. The flag State should investigate the 82 vessels to confirm if they complied with the reporting requirements in CMM 18-2020, catch reporting is a vital prerequisite for the sustainable management of the Jumbo Flying Squid Fishery and possible IUU risk.

⁶ SPRFMO CMM 05 requires that the Secretariat maintains lists of vessels which have participated in fishing activities in the Convention Area. www.sprfmo.int/assets/0-2021-Annual-Meeting/CTC8/CTC8-Doc07-rev1-Commission-Record-of-Vessels-Implementation-Report.pdf

Figure 7: Active vessels within the SPRFMO according to AIS but not listed as active

The AIS positions for 82 vessels which were detected as operating inside the SPRFMO Convention Area but not listed as active by the member State.



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Key Finding 5: A total of 14 vessels were found to be operating inside the AOI in 2020 that could not be matched to the Commission Record of Vessels Authorized to Fish in the Convention Area. SPRFMO CMM 05-2019⁷ for the Establishment of the Commission Record of Vessels Authorized to Fish in the Convention Area in 2020 required member States to authorize vessels to operate inside the SPRFMO Convention Area and notify the Secretariat. The purpose is to ensure vessels operating inside the Convention Area are being monitored, reporting catch and compliant with all CMMs. The unmatched vessels were either broadcasting an identity on AIS but that identity did not match an authorization record or the vessel was not broadcasting a clear identity on AIS (Table 2, Figure 8).

Recommendation 5:

5a. Identified Vessels - Three vessels were broadcasting an identity on AIS that could not be matched to a SPRFMO authorized vessel (Table 2: SPRFMO authorization status Unmatched). All three vessels' movements during 2020 were consistent with squid fishing however, it is recommended that these vessels are investigated by the flag State to confirm from VMS and logbooks their identity, activity, target species and authorization to fish inside the SPRFMO Convention Area. It should be noted that the ZHOU PU 818, during the process of completing this analysis was added to the SPRFMO register (May 2021) with a backdating to include the 2020 calendar year. The ZHOU PU 818 however was not included in the SPRFMO Active List for 2020 and it remains in this section for awareness.

5b. Unidentified vessels - A vessel is considered unidentified when the AIS data lacks information on name, IMO number, MMSI, call sign or other information that helps to identify its name or flag (Table 2: SPRFMO authorization status Unidentified). The vessel using the MMSI number 440616000 is included here despite its AIS occasionally broadcasting a viable name. The broadcast name KUMYANG 103 is used by another vessel with more identity information so it is assumed that the vessel's true identity is unknown and the other name broadcast (999999999) by this MMSI is false, see table 2. The flag State should investigate apparent manipulation of AIS information and cooperate with coastal and port States to provide detailed information on vessel activity that appears to occur along or within EEZs. In addition, the flag States should verify that their flagged vessels are broadcasting accurate AIS information in line with IMO Resolution A.1106(29) to ensure transparency in their operations and safety of navigation.

⁷ <https://www.sprfmo.int/assets/Fisheries/Conservation-and-Management-Measures/2019-CMMs/CMM-05-2019-5Mar2019.pdf>

Table 2: Unidentified or unmatched vessels

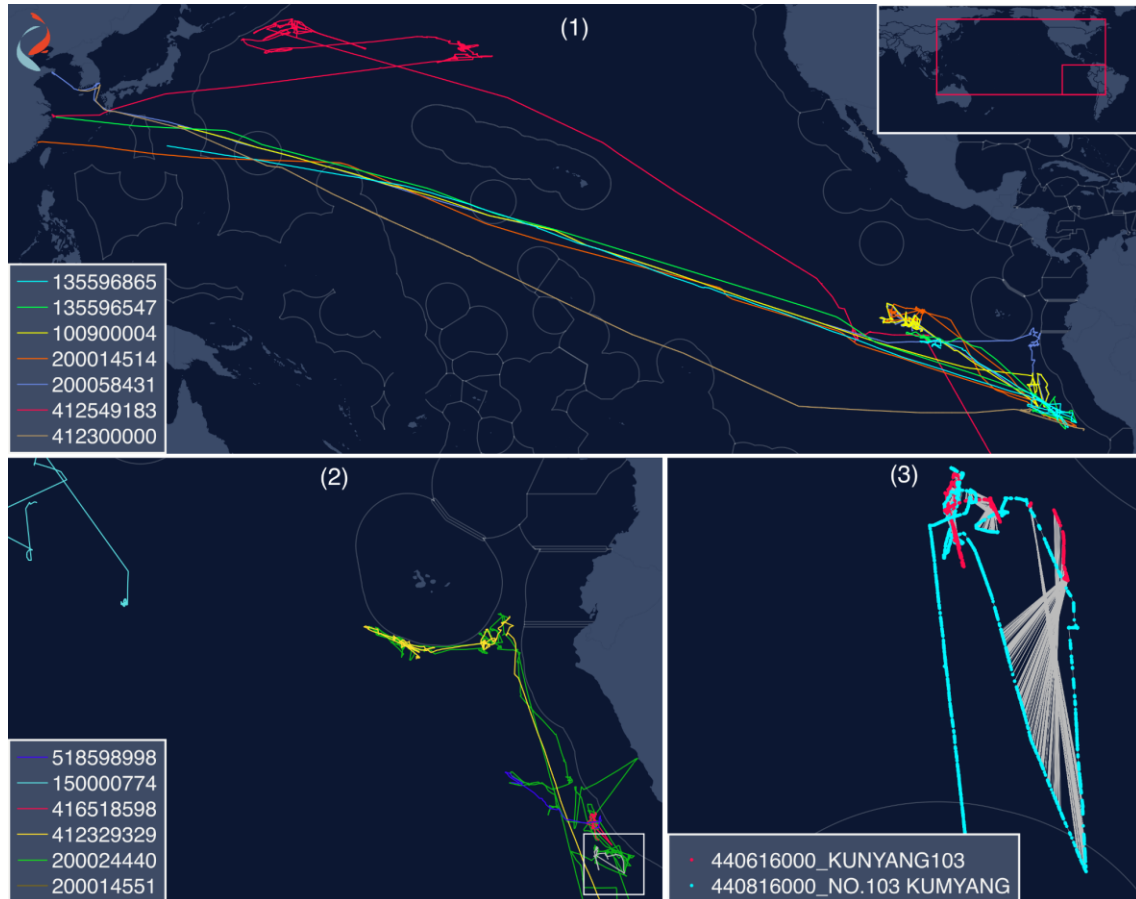
Fourteen vessels were observed operating inside the SPRFMO Convention Area in 2020 that could not be matched to an authorized vessel, either because the SPRFMO authorization was unmatched, or the vessel was unidentified.

	MMSI	Vessel name	IMO number	Callsign	Flag	SPRFMO authorization
1	416518598	XINGJIHAIYUN			TWN	Unmatched
2	412549183	ZHOUPU818	9904625	BZU5X	CHN	Unmatched
3	412329329	LURONGYU55599		55599	CHN	Unmatched
4	518598998	unknown			Unknown	Unidentified
5	440616000	999999999		BBZI9	KOR	Unidentified
6	412300000	unknown			CHN	Unidentified
7	200058431	HH@			Unknown	Unidentified
8	200024440	unknown			CHN	Unidentified
9	200014551	unknown			Unknown	Unidentified
10	200014514	unknown			CHN	Unidentified
11	150000774	G00004-			CHN	Unidentified
12	135596865	unknown			Unknown	Unidentified
13	135596547	unknown			Unknown	Unidentified
14	100900004	unknown			CHN	Unidentified

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Figure 8: Unidentified or unmatched vessel tracks

The AIS based tracks for 14 vessels which were detected as operating inside the area of interest, but could not be matched to a SPRFMO authorized vessel in 2020. Map 3 includes the two MMSI broadcasting the same name but from different locations simultaneously.



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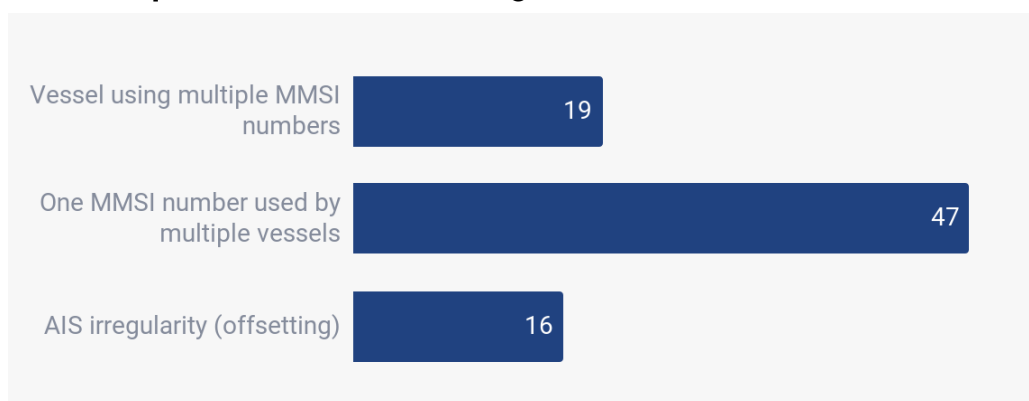
3 AIS misuse and irregularities

The AIS system was primarily designed for safe navigation and the reduction of collisions at sea. Depending on the functionality of the device, some elements of the system can be tampered with, including changing the vessel identity information, changing the MMSI number, and some systems even appear to allow for the manipulation of a ship's position. The International Maritime Organization (IMO) includes broadcasting falsified AIS data as a fraudulent activity when done to 'materially alter the ship's identifying information or to reflect the AIS data of an entirely different vessel'.

Manipulation of AIS needs to be understood and Global Fishing Watch has established expertise to ensure that such manipulation is detected and the analysis formulated with such activity corrected to represent the likely truth.

Three types of AIS irregularities were observed in the fleet (Figure 9); Vessels using multiple MMSI numbers, one MMSI number used by multiple vessels, and false locations (Figure 10). Additionally, 11 vessels lacked information for their identification (e.g., MMSI, IMO, etc).

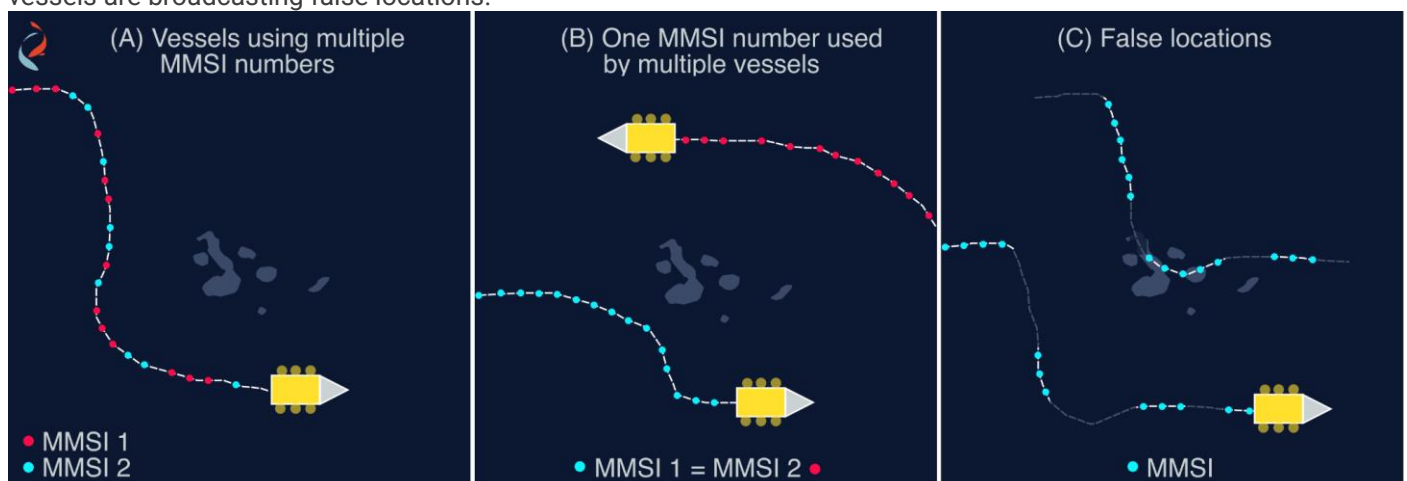
Figure 9: Number of Squid Vessels with AIS irregularities



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Figure 10: AIS Irregularities observed in the squid fishing fleet

Examples of AIS irregularities observed in the squid fishing fleet. A) Example of a track having vessels using multiple MMSI numbers, B) Track example when one MMSI number is used by multiple vessels, C) Track example when vessels are broadcasting false locations.



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3.1 Vessels using multiple MMSI numbers

This type of irregularity happens when the vessel broadcasts its AIS location using two MMSI numbers; the MMSI number is unique for each vessel and the number should be assigned by the flag State. Consequently, operating a vessel with different numbers is irregular and potentially contravening IMO regulations and flag State rules on maritime radio licensing.

Nineteen squid vessels appear to be using multiple AIS devices with different MMSI numbers (see [Appendix 1](#), Table 1) and between them they are operating 41 MMSI numbers within the AOI during 2020 (Figure 12). The fishing vessels with multiple AIS were flagged to two countries; 18 to China and 1 to Korea, all of which were authorized by the SPRFMO. Individual vessel analysis of these 19 vessels is detailed in [Appendix 1](#).

Nine of the 19 squid vessels using multiple MMSI had different vessel names for different AIS units onboard and we see two different patterns of use for multiple AIS units:

1. Using multiple MMSI numbers at the same time while transiting or conducting fishing operations, as in the case of ZHOU YU 921; CHANG TAI 812; SHUN ZE 85.
2. Vessels using different MMSI numbers by segments of their tracking data like the Chinese squid vessels YONG XING 1; FU YUAN YU 878; SHUN ZE 805. In the case of YONG XING 1 the vessel on AIS will appear to change identity for different periods of the same fishing trip, sometimes YONG XING 1 flagged to China and other times as HONG RUI 198 flagged to Argentina or HONG RUI 198 flagged to the Republic of Korea.

Figure 11: Fishing vessels using multiple MMSI numbers

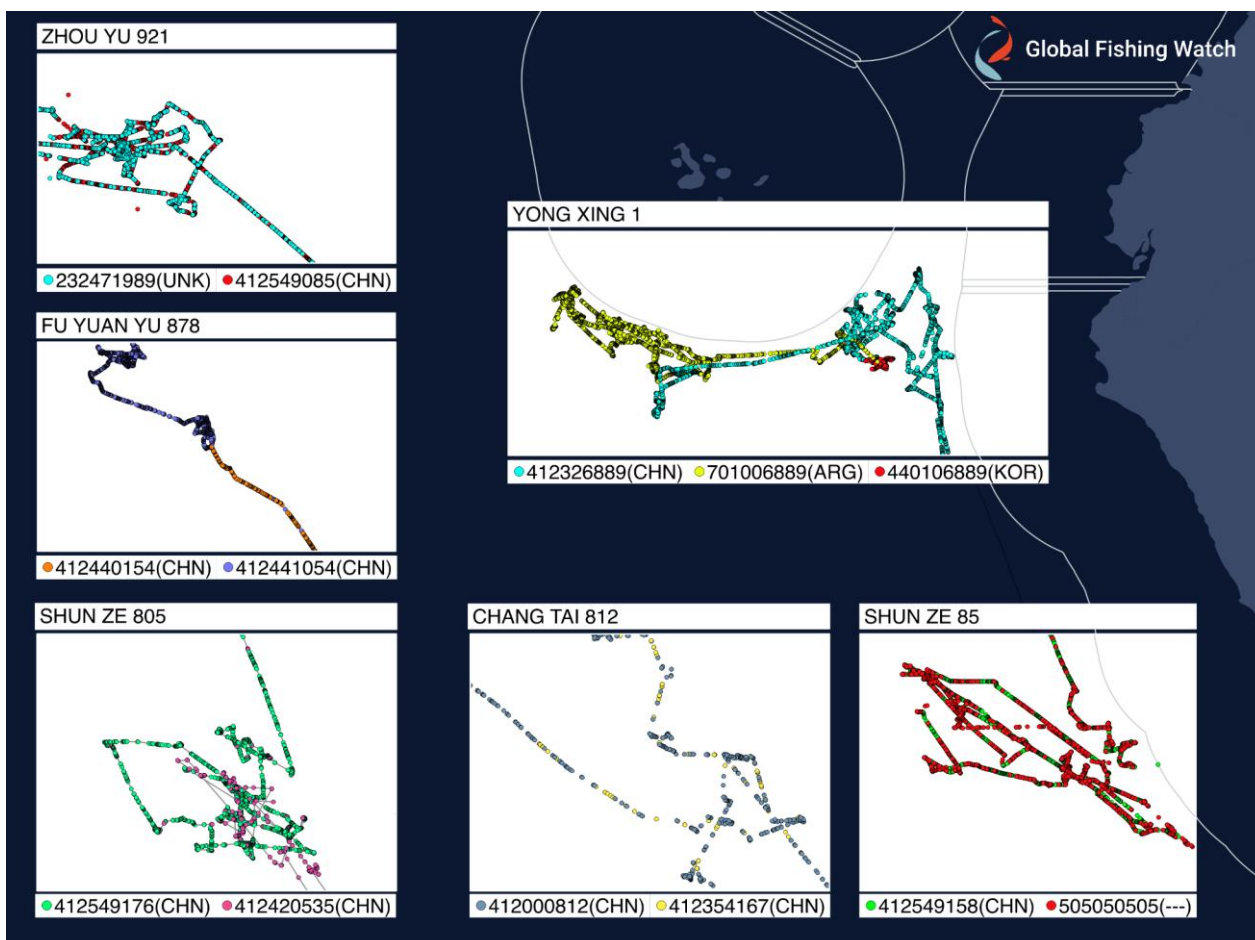
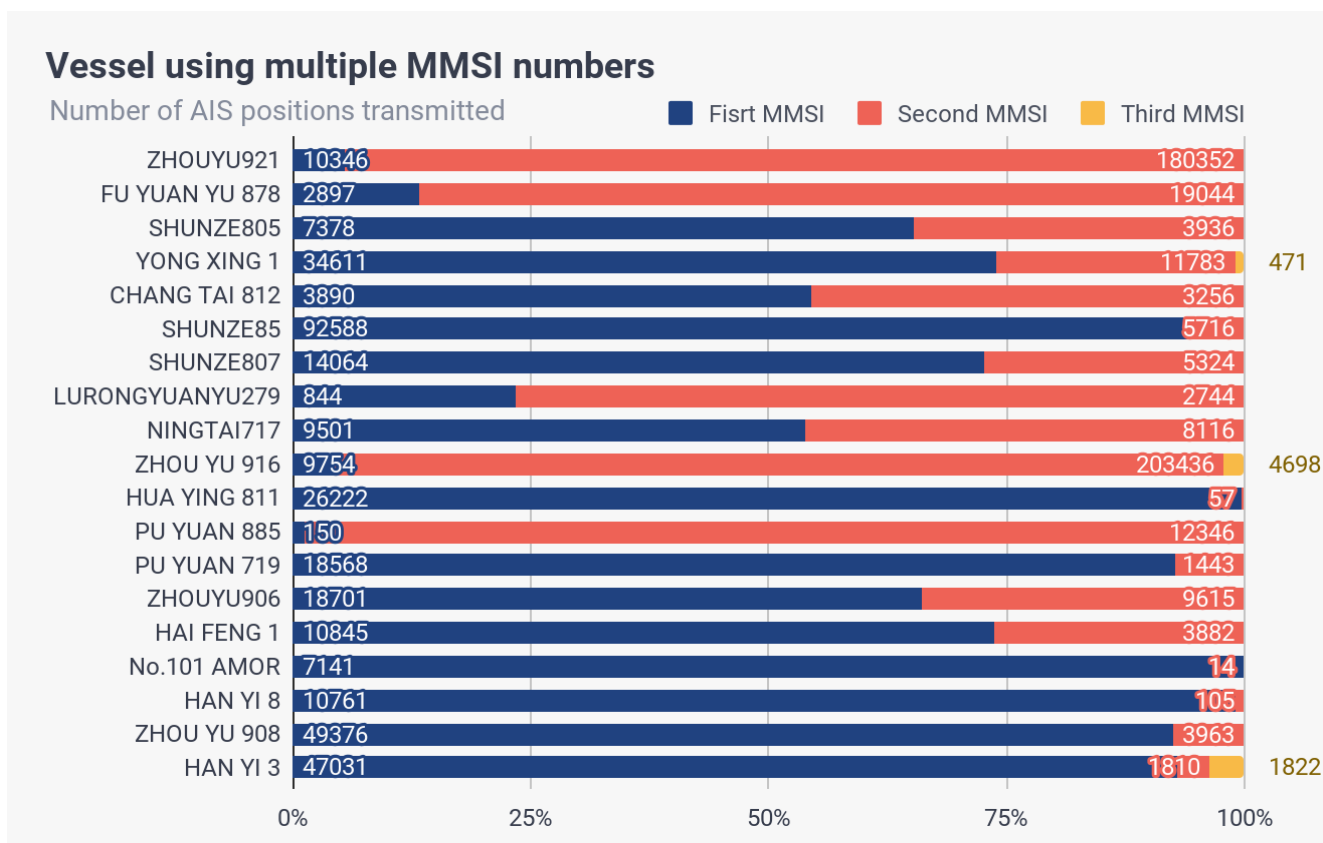


Figure 12: AIS positions transmitted by squid vessels using two or more MMSI numbers



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The pattern of AIS signals received per MMSI for squid vessels operating with more than one unique MMSI number was variable. Some vessels, like the CHANG TAI 812 and NING TAI 717 received an equal number of AIS positions per MMSI number. Alternatively, some vessels received more than 90 percent of the total AIS positions on one MMSI for instance the HUA YING 811, PU YUAN 885, and HAN YI 8. For a minority few, the MMSIs used by a vessel matched on all but a couple of digits e.g. the PU YUAN 885 received signals from MMSI number 412120464 and 412420464; and the HAN YI 8 received signals from 412420561 and 412428561.

Whether the discrepancies in MMSI numbers reflect different broadcasting devices, are due to satellite signal detection error, or human error at the point handling the AIS device is unknown. The true reason behind vessels operating with multiple AIS devices with different MMSI and identity information is not clear; it does however, highlight the real challenge of monitoring, control, and surveillance of these vessels from remotely observed data.

3.2 One MMSI number used by multiple vessels

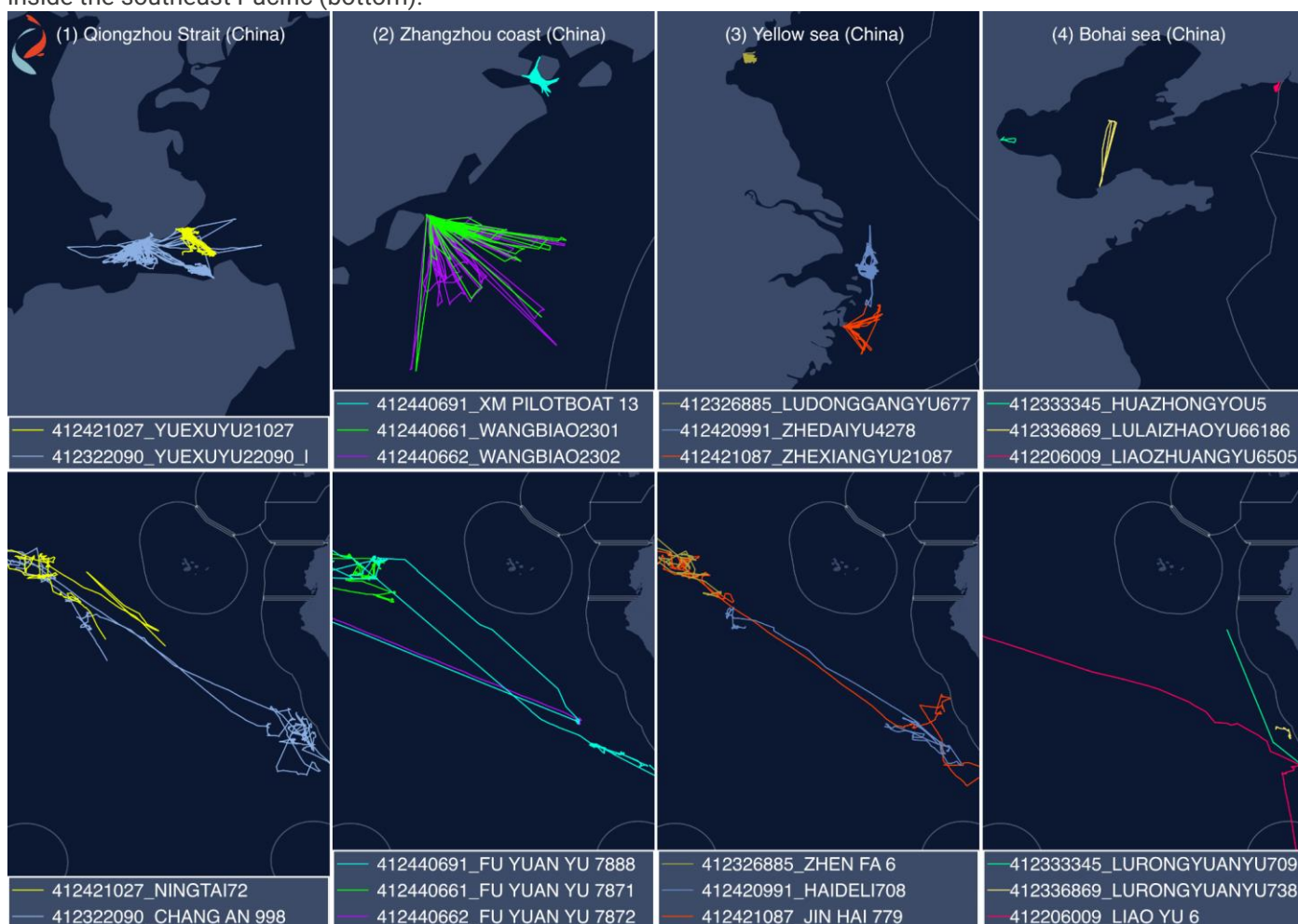
When a vessel owner applies for a VHF radio license a unique MMSI should be provided by the competent authority of the flag State. The MMSI should be unique to a specific vessel however we see cases of more than one vessel using the same MMSI. This is likely either a mistake in issuing the number by the competent authority or at least one of the vessels is broadcasting an unauthorized MMSI.

A total of 47 Chinese vessels from the list of 615 vessels used an MMSI number that is in use by at least one other vessel. The most common cases detected were when the second vessel broadcasting the same MMSI number was located within Chinese waters (Table 3), as the case of

the MMSI 412322090, where one vessel CHANG AN 998 was fishing in the high seas adjacent to Peru and the second vessel YUEXUYU22090 was operating along the Qiongzhou Strait in China (Figure 13). Additionally, from 47 vessels, the authorization status of three vessels could not be confirmed in the SPRFMO Record of Vessels; the ZHOU YU 810 (412671870), ZHOU PU 818 (412549183), and non-identified vessels using the MMSI 100900004.

Figure 13: AIS track of MMSI numbers used by two vessels at the same time

AIS track of 11 MMSI numbers used by two vessels at the same time and with activity inside Chinese waters (top) and inside the southeast Pacific (bottom).



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3.3 False AIS position messages

In some instances, vessels can broadcast an AIS position outside of the reception footprint of the receiving satellite. The false AIS positions make the vessel look like they are operating in an offset location to where they actually are. This could be a result of data getting corrupted or a product of the system being tampered with in a deliberate attempt to disguise a vessel's location. Follow up from the relevant authorities would help determine the cause of such an issue. Global Fishing Watch has developed a [technique](#)⁸ to correct the offset where a vessel's track is repositioned

⁸ Details of this offset correction can be found in a GFW blog from 2016 <https://globalfishingwatch.org/data/when-vessels-report-false-locations/>

within the footprint of the receiving satellite and stationary objects like coastlines and ports are used to identify the most likely true positions for the vessel.

Sixteen squid vessels were identified with AIS positions outside of the receiving satellites footprint, all the vessels were flagged to China and the false AIS positions made the vessels look like they were operating in the southwest Pacific (Figure 14). These vessels have a constant offset of -41.696 degrees of latitude and -85.393 degrees of longitude. It is unknown if this is a fault with the AIS units or a deliberate way of concealing their location. Once a corrected latitude and longitude has been applied the true track of the vessels indicate fishing on the high seas inside the AOI without any indication of operating inside the Galapagos or Peruvian EEZs (Table 3).

Figure 14: Vessels within the squid fleet that are broadcasting false locations

Example of AIS tracking data from vessels within the squid fleet that are broadcasting false locations. False positions cause vessels to appear near New Zealand because all vessels are using exactly the same offset. Nevertheless, their positions can be corrected to show their true location with the fishing fleet near the high seas adjacent to Peru and Ecuador EEZs. One vessel, MMSI 200024440 shown in spring green, has broadcast no identification.

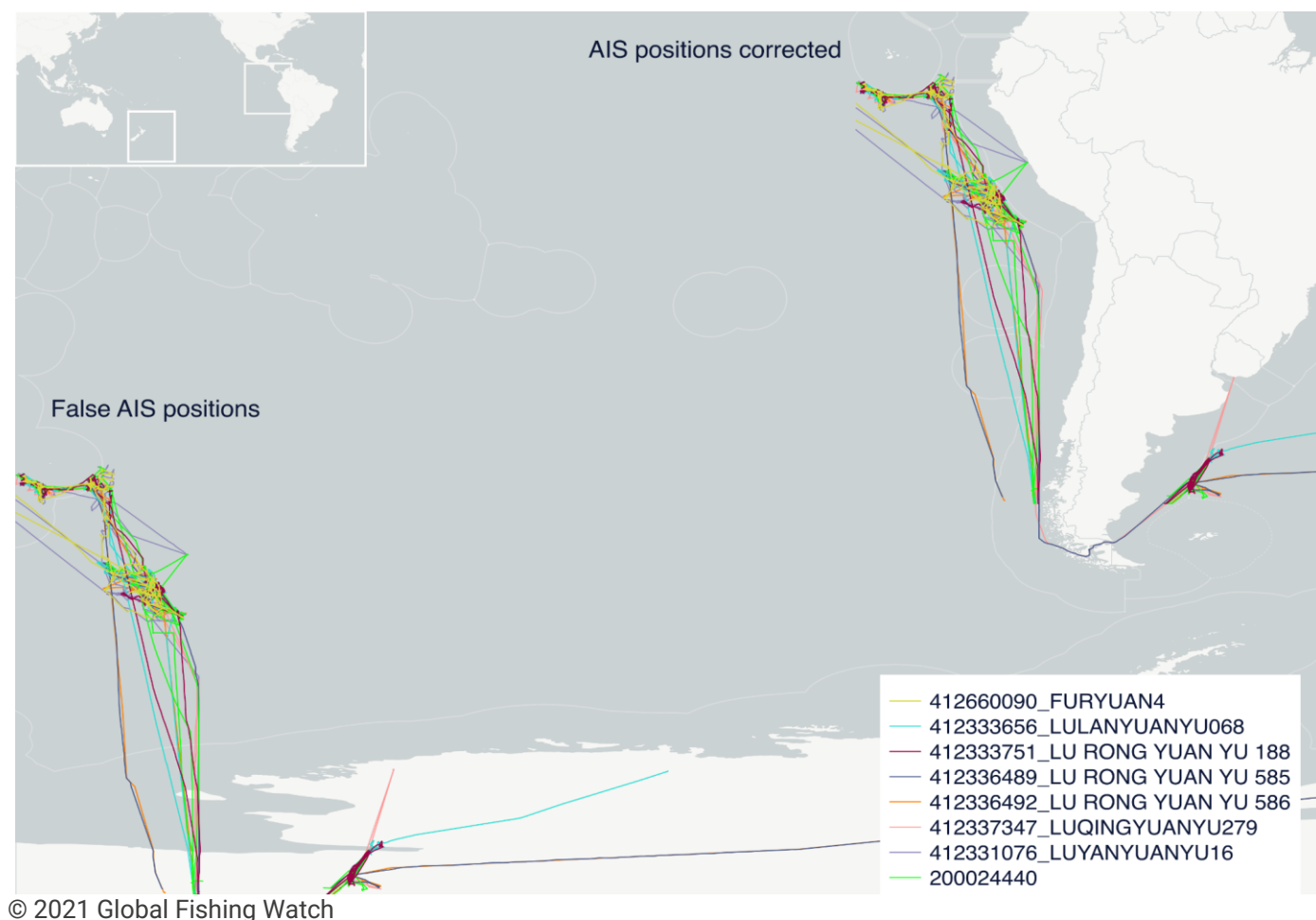


Table 3: Vessels detected with AIS irregularity

	MMSI	Vessel name	IMO	Callsign	Flag	SPRFMO authorization
1	412660090	FU YUAN 4	8777051	BITD	CHN	Authorized
2	412333656	LULANYUANYU068	9843170	BZTS8	CHN	Authorized
3	412333751	LU RONG YUAN YU 188	9840776	BZTS4	CHN	Authorized
4	412336489	LU RONG YUAN YU 585	8797958	BZZY4	CHN	Authorized
5	412336492	LU RONG YUAN YU 586	8797960	BZZY5	CHN	Authorized
6	412337347	LU QING YUAN YU 279	9872028	BZYQ9	CHN	Authorized
7	412331076	LU YAN YUAN YU 16	8708256	BCFG8	CHN	Authorized
8	200024440	Unidentified (*)	-	-	-	Unknown
9	412207532	JULONGJIAYA12	8540276	BZYT5	CHN	Authorized
10	412421087	JINHAI779	9844502	BZW3N	CHN	Authorized
11	412549046	HONGPU9	9892250	BZUH5	CHN	Authorized
12	412440453	FUYUANYU788	8784418	BVSL7	CHN	Authorized
13	412333654	LULANYUANYU058	9843144	BZTS6	CHN	Authorized
14	412420276	PU YUAN 802	8779932	BZ1VA	CHN	Authorized
15	412421111	JIN HAI 866	8779190	BZU4R	CHN	Authorized
16	412660070	FU YUAN 2	8777049	BITB	CHN	Authorized

(*) the vessel using the mmsi 200024440 could be the LU RONG YUAN YU 775.

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Key Finding 6: Although there is a high proportion of AIS use by the distant water squid fleet inside the study AOI there is also multiple instances of AIS misuse and irregularities. The most significant is the transmission of false vessel information.

Recommendation 6: SPRFMO member States and CNCs enforce national regulations around the registration and use of AIS that implements IMO Resolution A.1106(29).

4 Support Vessels - Transshipment and Bunkering

A large part of the business model for operating high seas fleets, like the southwest Pacific squid fleet, is that vessels are supported by refrigerated cargo vessels called carrier vessels and fuel tankers called bunkering vessels. Carrier vessels meet with fishing vessels at sea in order to move the catch off the fishing vessel (i.e., 'transshipment') and take it to port. Carrier vessels also carry out crew changes and resupply the fishing vessels with food and other essentials. Bunker vessels provide a fuel bunkering service at sea. The reason behind both of these at-sea-services is to allow fishing vessels to fish for longer without having to return to port.

The SPRFMO currently requires carrier vessels to be authorized by the flag State and included on the Commission Record of Vessels; a register that is publicly available. Unlike some of the other target fisheries for which transshipment of catch is regulated by SPRFMO under CMM 2018 and 2021, a transshipment event of jumbo flying squid does not need to be authorized by the flag State of the fishing or carrier vessels, removing the opportunity for even the most basic flag State oversight. Irrespective of target catch, currently SPRFMO does not have any management measures in place that apply to fuel bunkering of fishing vessels at sea.

Based on AIS data, we identified 59 support vessels operating within the AOI in 2020. Forty-one of which were carrier vessels and 18 bunker vessels. The majority of these carrier and bunker vessels were flagged to Panama, followed by China, Liberia, and finally Chinese Taipei with a single flagged carrier vessel.

4.1 Encounters

Analysis of the AIS data identified fifty-nine support vessels had a total of 1,519 encounters with squid fishing vessels in the Southeast Pacific region. Support vessels were flagged to four countries; Panama with 32, China with 19, Liberia with 7 and Chinese Taipei with one, and one vessel of unknown flag (Figure 17). The majority of encounters were conducted by carriers flagged to Panama and China, which accounted for 68 percent and 17 percent of the total, respectively. Encounters were highly concentrated in the western and southern Galapagos EEZ, and off Peru's EEZ (Figure 15). Of the potential support vessels identified here, only one did not have authorization from SPRFMO. This vessel was broadcasting an MMSI number 412353550 but without a vessel name, IMO number, or other information for its identification. This vessel was removed from the list once it was identified as being involved in a criminal case in Australia and Papua New Guinea in August 2021. The vessel appeared to loiter close to the squid fleet in 2020 prior to its [arrest](#)⁹ but no encounters were identified on AIS.

Figure 15: Distribution of encounters between support vessels and squid vessels

Encounters by non-fishing vessels with active fishing squid jiggers, aggregated by carrier flag State. Each dot represents a possible transshipment event.



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⁹ <https://asiapacificreport.nz/2020/09/27/arrested-ship-crew-deny-bunkering-other-marine-charges-in-png-court/>

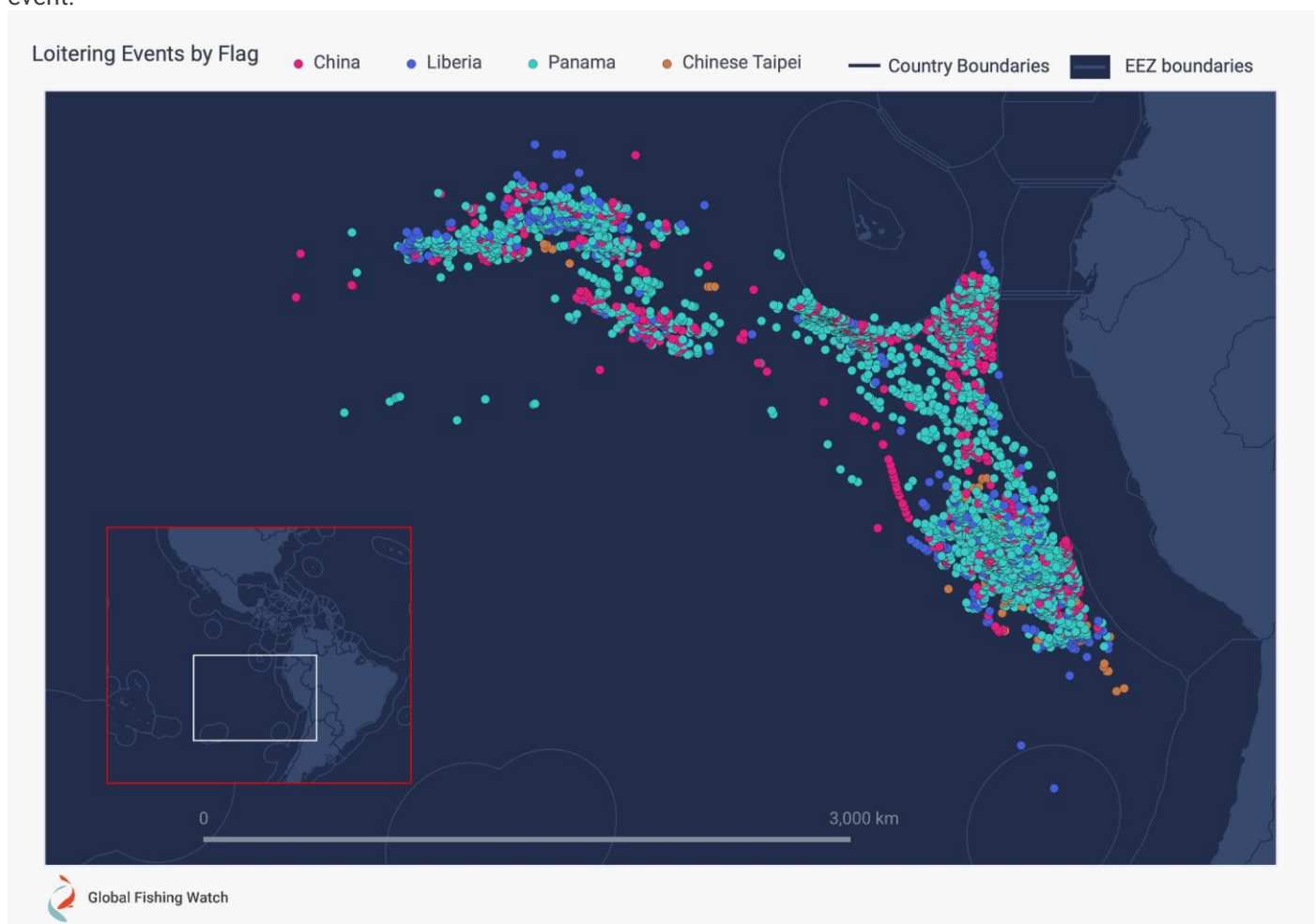
4.2 Loitering events

Loitering Events are identified when a single carrier vessel exhibits behavior consistent with encountering another vessel at-sea, but no second vessel is visible on AIS, also known as a 'dark vessel'. Loitering events are estimated using AIS data to determine vessel speed, duration at a slow speed and distance from shore. Loitering events are an important source of information that can be used as a first step to identifying where vessels with unexplained slow speeds may warrant further investigation. Slow speeds however may not necessarily indicate transshipment activity and can be related to any number of unrelated events, such as a mechanical issue.

Fifty-three non-fishing vessels had a total of 4,683 loitering events in the Southeast Pacific during 2020 (Figure 16). Carriers with those events were flagged to Panama, Liberia, China, and Chinese Taipei (Figure 18). In most cases vessels with loitering events had at least one encounter event (Figure 19). Carriers with a small number of AIS-based estimates of encounter events all have detected loitering events. This could indicate that additional encounters may be occurring at sea which are not apparent with AIS data alone.

Figure 16: Distribution of loitering events by support vessels

Loitering events by non-fishing vessels, aggregated by carrier flag State. Each dot represents a possible loitering event.



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Key Finding 7a: Transshipment in the SPRFMO region for squid occurs at a scale that is challenging for management yet operates with weaker controls than other species in SPRFMO or overlapping RFMOs like IATTC. Allowing transshipments to occur without a provision for flag

State authorization and even the most basic checks against IUU catch being transshipped creates a loophole for vessels that weakens transshipment controls for the whole region. Additionally, a lack of transparency regarding what is being reported as a squid transshipment makes oversight by flag, coastal or port States challenging.

Key Finding 7b: The information available via SPRFMO on transshipment activities in 2020, and what the AIS-based analysis revealed appear to show some concerning differences.

1. There is a marked difference in the number of transshipments reported in 2020 by the SPRFMO member States¹⁰ as compared to the number of encounters estimated from AIS. [China](#)¹¹ reported a total of 2,930 transshipments where a Chinese vessel unloaded jumbo flying squid. This reported number is substantially more than the detected 1,039 AIS-based encounters. These transshipments were likely captured as loitering events, which occurred when a carrier vessel was identified on AIS, but no AIS transmission was received from the fishing vessel at the time.
2. Despite AIS detecting fewer encounter events, 41 carrier vessels were active on AIS in the area, as compared to the 12 registered on the SPRFMO Active Vessel List for the Convention Area in 2020.
3. There appears to be conflicting information between the [Active List](#) and [Panama's Implementation Report](#)¹².

Recommendation 7: CMM 12-2020 recognizes that *'transshipment at sea is a common global practice, but that unregulated and unreported transshipment of catches of fishery resources, in particular on the high seas, contributes to distorted reporting of catches of such stocks and supports illegal, unreported and unregulated (IUU) fishing in the Convention Area'*. Given the scale of the differences between what is being reported by members and Cooperating non-Contracting Parties (CNCP) and what appears to be happening on the water through AIS analysis it is recommended the Commission urgently looks to strengthen the authorization process, monitoring, reporting, and transparency of transshipments from the jumbo flying squid fishery thus:

1. Mandate a transshipment authorization process for jumbo flying squid in line with other SPRFMO managed species to support better monitoring and control of transshipments and help to ensure more accurate reporting.
2. Secretariat, members and CNCPs crosscheck different data sources, including AIS to validate the reporting of transshipments in the SPRFMO jumbo flying squid to ensure vessels are reporting transshipments and catch properly. This is a vital requirement for implementing CMM 18-2020 - *Conservation and Management Measure on the Management of the Jumbo Flying Squid Fishery* provisions on catch reporting, observer coverage and active vessel reporting.
3. Provide more information regarding transshipments, including the identity of the vessels involved¹³; the location and time of each event in a timely manner.
4. Adopt AIS as a complementary data source to existing monitoring control and surveillance tools, which has been shown to provide a process of validating reported transshipments

¹⁰ <https://www.sprfmo.int/measures/compliance-reports/implementation-reports/>

¹¹ <https://www.sprfmo.int/assets/0-2021-Annual-Meeting/CTC8/Implementation-Reports/CHN-China-Implementation-Report-2020-10-23.pdf>

¹² <https://www.sprfmo.int/assets/0-2021-Annual-Meeting/CTC8/Implementation-Reports/PAN-Panama-Implementation-Report-2020-10-28.pdf>

¹³ The quantities transshipped by specific vessels is commercial information and would not be expected in public reports however the identification of vessels involved in authorised transshipment with geospatial and temporal data would support greater transparency and validation of transshipment activity.

and help identify potential cases where further investigation at key enforcement points like ports can be prioritized.

5. Strengthening AIS requirements for fishing fleets, either regionally through SPRFMO CMMs agreed by the members, as is the case in the Forum Fisheries Agency (FFA) Good Standing or at the national level as is the case of the European Union members, United States and Canada, who regulate AIS use for their fishing vessels operating beyond national waters.

Table 4: Top 10 Support vessels operating in the Southeast Pacific

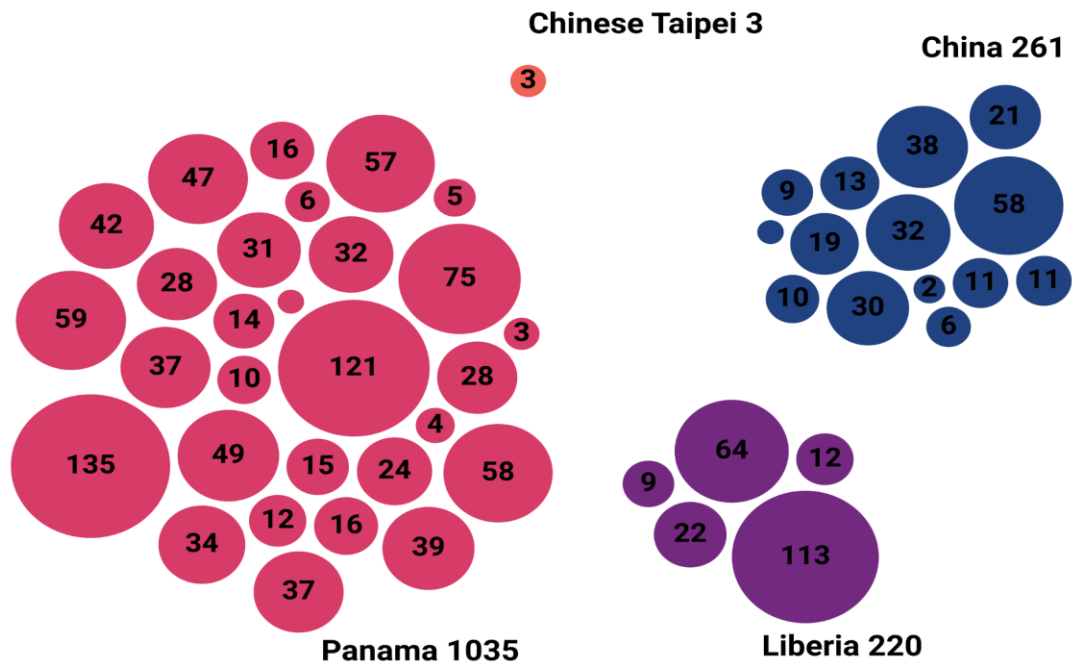
List of the top 10 non-fishing vessels operating in the Southeast Pacific region during 2020. [Click to see the full list of vessels.](#)

Number	MMSI	Vessel name	Flag	Type	Number of encounters with squid vessels
1	371596000	HAIGONGYOU303	PAN	Bunker Vessel	135
2	374245000	OCEANSPLENDID	PAN	Bunker Vessel	121
3	636019127	HAIXING	LBR	Bunker Vessel	113
4	351383000	CHENGHANG	PAN	Carrier Vessel	75
5	636017561	HESHUN	LBR	Carrier Vessel	64
6	374198000	HAIFENG718	PAN	Carrier Vessel	59
7	357172000	YONGHANG3	PAN	Carrier Vessel	58
8	412421071	XINJILILENG6	CHN	Carrier Vessel	58
9	351960000	MINGHANG5	PAN	Carrier Vessel	57
10	356399000	HETAI	PAN	Carrier Vessel	49

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Figure 17: Summary of encounters with squid vessels by support vessel flag State

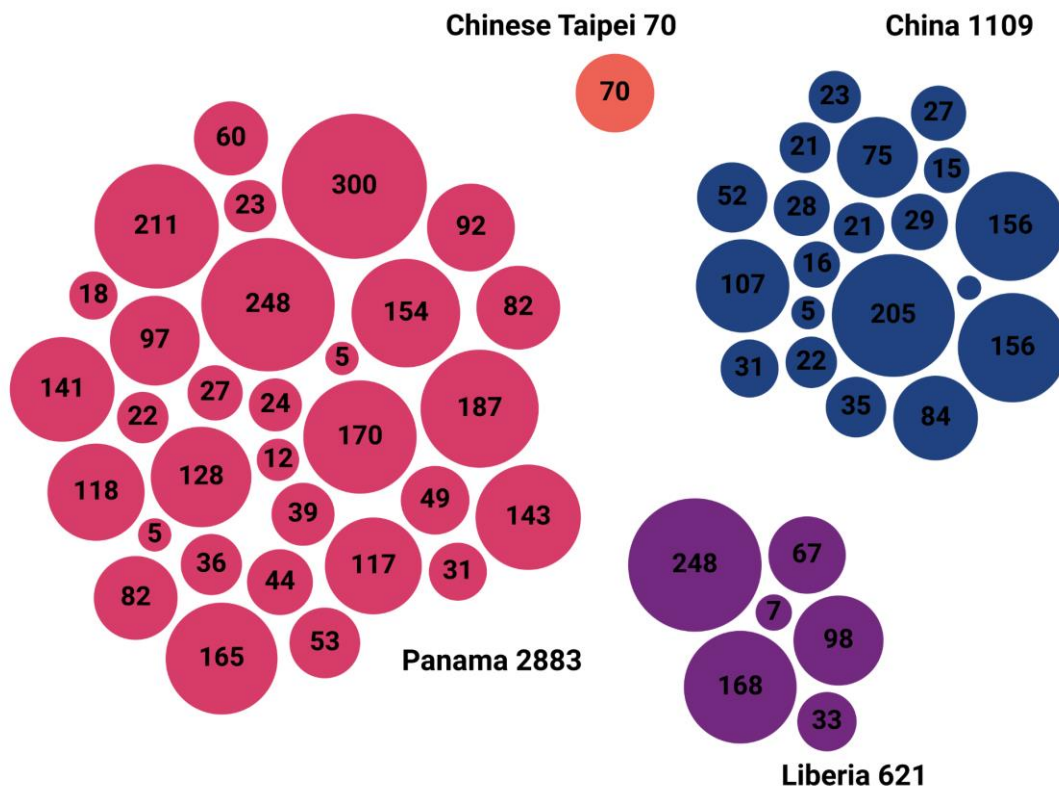
2020 encounters by non-fishing vessels with active fishing squid jiggers. Colors correspond to the flag State and each bubble represents individual carriers with the number inside each bubble being the number of encounters it had.



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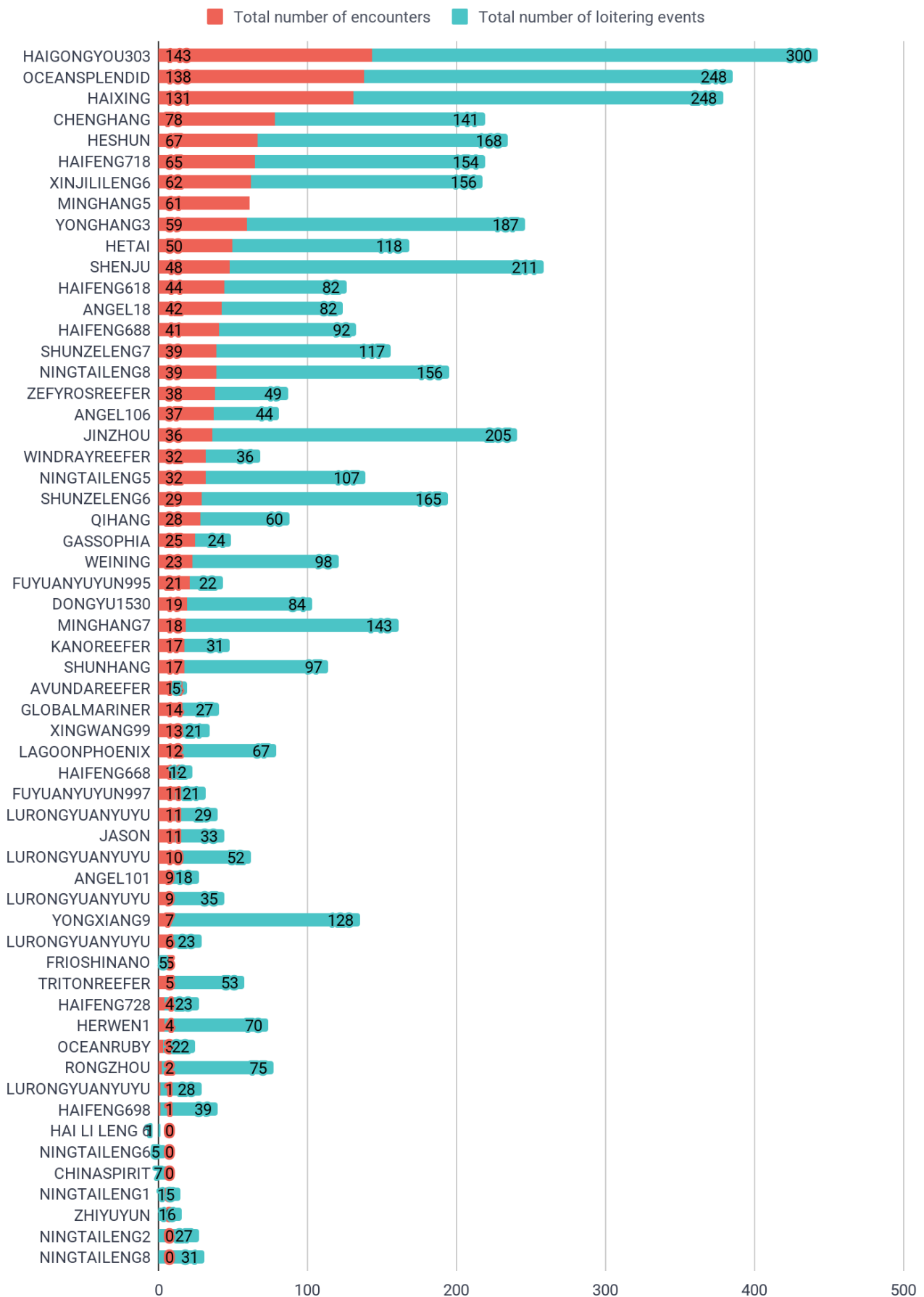
Figure 18: Summary of loitering events by support vessel flag State in 2020

Loitering events by support vessels. Colors correspond to the flag State and each bubble represents individual carriers with the number inside each bubble being the number of loitering events it had.



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Figure 19: Comparison of encounters and loitering events for support vessels



5 Port State Analysis

Port States used by the high seas squid fleet operating in the SPRFMO Convention Area provide one of the best opportunities for carrying out vessel compliance checks, especially if they have ratified and are implementing the Port State Measures Agreement (PSMA). There are two distinct port activities by the fleet that present this opportunity, visits by the fishing vessels to Latin American ports for services like refueling, crew changes and resupply and when the catch is landed by carrier vessels in port.

5.1 Port visits by fishing vessels to Latin America ports

In 2020 AIS analysis identified 19 port visits by 13 squid vessels to Chimbote and Callao ports, mostly in the months between September and December.

As the only port State utilized along the Pacific Latin American coastline Peru as a PSMA state has a unique opportunity to provide a degree of enforcement regarding the activities of squid vessels operating on the high seas. In August 2020 Peru passed a Supreme Decree (number 016-2020-PRODUCE) that when requires foreign squid vessels utilizing its ports to operate with a Peruvian VMS system. In the absence of a system for VMS data sharing between flag State and port State, this is an innovative solution to support Peru's implementation of PSMA. To date 5 vessels have complied with the requirement although, it is not known what impact Covid-19 is having on port use in the region by foreign vessels. Further data sharing and cooperation between coastal States in the region alongside steps to build a comprehensive risk assessment and inspection program will support Peru's implementation of PSMA and provide a key enforcement point for squid vessels operating on the high seas.

5.2 Port visits by carrier vessels after squid transshipments

The purpose of transshipment is to get the catch to the supply chain as efficiently as possible and this is usually through the closest port to the processing facility.

Key Finding 8: A total of 77 port visits (Figure 20) by carrier vessels after an encounter with a squid vessel inside the study AOI were identified from AIS in 2020. Carriers visited ports in six countries: Chile, Panama, Peru, China, the Republic of Korea, and Chinese Taipei (Table 8). The country with the most port visits was China with 46 visits, representing 60 percent of the total port visits (Figure 21). The second port with the most visits was Balboa in Panama, where a total of 21 visits (27%) were registered.

All the port States identified for carriers visiting after operating inside the study AOI are members or a CNCP to SPRFMO. Furthermore, in line with CMM 07-2019 - *Conservation and Management Measure on Minimum Standards of Inspection in Port* all of the ports visited have been designated by the member or CNCP except for China which is yet to designate ports.

Recommendation 8:

8a Designated ports. It is recommended that China provide a list of designated ports where the minimum standards on port controls can be met for visiting foreign vessels. Effective implementation of comprehensive port State controls, paired with information sharing, and cooperation amongst member States and other RFMOs can help decrease the risk of IUU-caught fish entering the supply chain and can increase transparency of transshipment activity at sea and in port.

8b Implementation and transparency. SPRFMO should continue to support its members and CNCPs to implement comprehensive port State controls, in line with CMM 07-2021, to ensure good governance and effective oversight. Data on implementation of CMM 07-2021 should also be collated and made public.

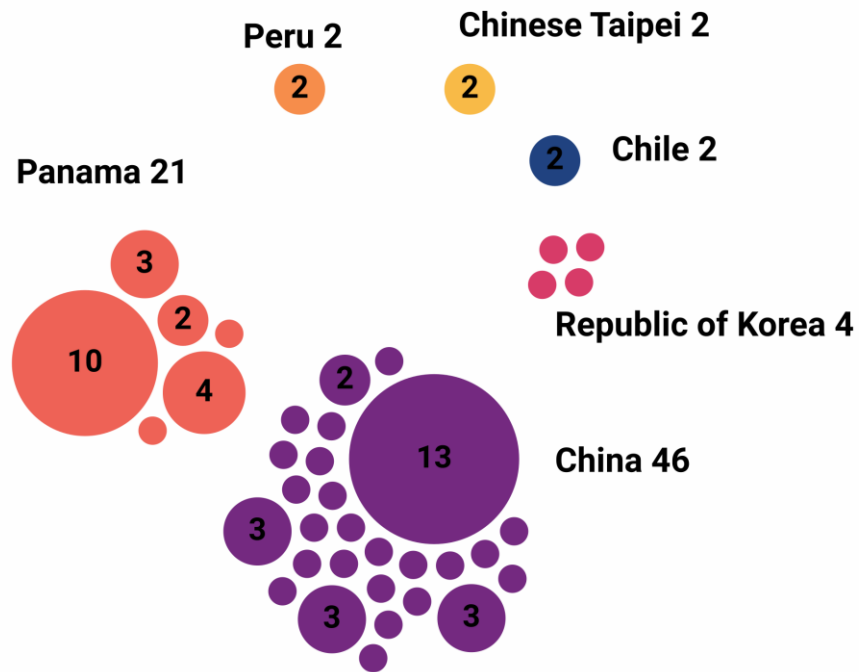
Table 5: Port visits by carriers after the encounter with squid fishing vessels

Count of port visits by carriers after encountering a squid vessel inside the study AOI, ports are listed by name and port State.

Port	Country	Number of port visits
Zhoushan	China	25
Balboa	Panama	21
Weihai	China	12
Busan	Republic of Korea	4
Fuzhou	China	3
Punta Arenas	Chile	2
Taizhou	China	2
Callao	Peru	2
Kaohsiung	Chinese Taipei	2
Zhuhai	China	1
Guangzhou	China	1
Dalian	China	1
Qingdao	China	1

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Figure 20: Summary of port visits, aggregated by port State



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Figure 21: Port visits following encounters with squid vessels

Carrier vessel port visits following encounters in 2020 with squid jiggers.



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6 Looking at the ‘Dark Fleet’

Analysis using AIS tracking is effective in providing a whole range of new insights and transparency on the activities of fleets like the high seas squid fleet. The challenge however remains that vessels are able to switch off AIS transmissions, rendering the vessel ‘dark’. It has also been shown that [cases](#) of IUU fishing often includes the switching off of AIS. Satellite based remote sensing imagery can provide an additional source of information on the activity of fishing vessels that does not rely on tracking devices being switched on.

6.1 VIIRS image analysis

The Suomi National Polar-orbiting Partnership (NPP) satellite has a sensor with a spatial resolution of approximately 0.74 km², capable of detecting low light signals from the Earth. Called the Visible Infrared Imaging Radiometer Suite (VIIRS) it is able to detect fishing vessels that use bright lights to attract target species to the surface such as the squid fishery in the eastern equatorial Pacific. VIIRS imagery requires the sky to be relatively clear to detect vessels but provides good coverage, one daily global scene, and is available in near real time. Global Fishing Watch uses this data to produce a night light vessel detection layer on its public [map](#).

The distribution of daily VIIRS vessel detections over the Southeast Pacific Ocean for 2020 showed a seasonal pattern of the fishing points of the squid fleet that supports the AIS analysis. During the first quarter of 2020, the fleet was located along eastern equatorial Pacific (yellow points in Figure 22). After that, the fleet around east of the Galapagos Islands started to transit to the south of Peru’s EEZ’s limit in April, and moved to international waters between the Galapagos Islands’ EEZ and Ecuador’s EEZ in June.

For the third quarter, the squid fleet mainly extended along the south of Galapagos Islands EEZ limit (red points in Figure 22), and by the end of the third quarter started to move along to the south of Peru’s EEZ. And, in the last quarter of 2020, the fleet was concentrated between degrees 13° and 19° of latitude next to Peru’s EEZ (cyan points in Figure 22). Finally, in December, 21% of the fleet returned to the high seas adjacent to Argentina’s EEZ and the other 79% returned to the eastern equatorial Pacific fishing area in the eastern part of the study AOI.

Matching VIIRS detections with AIS transmissions creates an estimate of how many vessels in a fleet with AIS tracks. For each AIS vessel track in the area of the detection the course and speed required to be in the location of the VIIRS detection at the same time are calculated. Using the speed and course the likelihood is then estimated for whether a VIIRS detection is matched with a AIS vessel track. The likelihood distributions were pre-calculated by GFW based on a large-scale review of historical AIS data. Finally, for a match to happen the VIIRS-AIS pairs need to have a likelihood score greater than a threshold and in the case of multiple matches the highest score above the threshold is chosen.

When this analysis is applied to the squid fleet in three distinct areas inside the study AOI it appears to show a high proportion of squid vessels operating with AIS switched on. Figure 23 shows the number of VIIRS detections as a bar graph for three areas of the study AOI, the bars are split by detections. The line graph overlaid represents the daily count of squid vessels transmitting on AIS, if the bars were greater than the bar chart it would indicate the existence of a ‘dark fleet’. For these three regions the bars are less than the daily AIS count of squid vessels suggesting a high proportion of the fleet is using AIS. In the case of the high seas area around 1000nm west of Ecuador EEZ (Galapagos) (Equatorial Pacific HS) and high seas are adjacent to the Peruvian EEZ (HS adjacent to Peru) the daily AIS count of squid vessels is actually higher than the VIIRS detections. This is likely a result of clouds obscuring the images or a very tightly packed fleet

where multiple vessels are closer than the image resolution of 0.74 km² and counted as a single vessel detection.

Key Finding 9: Analysis of AIS data shows no distant water vessels operating within any of the coastal State waters inside the study AOI in 2020. To supplement the AIS analysis VIIRS vessel detections were used to identify potential nighttime fishing incursions into the EEZs by large industrial squid vessels.

A review of all the VIIRS detections for 2020 identified two vessel detections on June 20 within Peruvian waters (Figure 24). To confirm those detections, we analyze the NPP-VIIRS nighttime satellite imagery directly from the NOAA repository) and the vessel detections appear to match the light intensity of the squid fleet operating on the adjacent high seas. The VIIRS detections inside the Peruvian EEZ could not be matched to an AIS vessel track. Instead a manual analysis of AIS tracks by vessels operating on the high seas close by identified three Chinese-flagged vessels, [HAN YIN 3](#), [HENG XING 15](#), and [MING XIAN 816](#) that all had AIS gaps long enough to allow for fishing inside the EEZ (Figure 24).

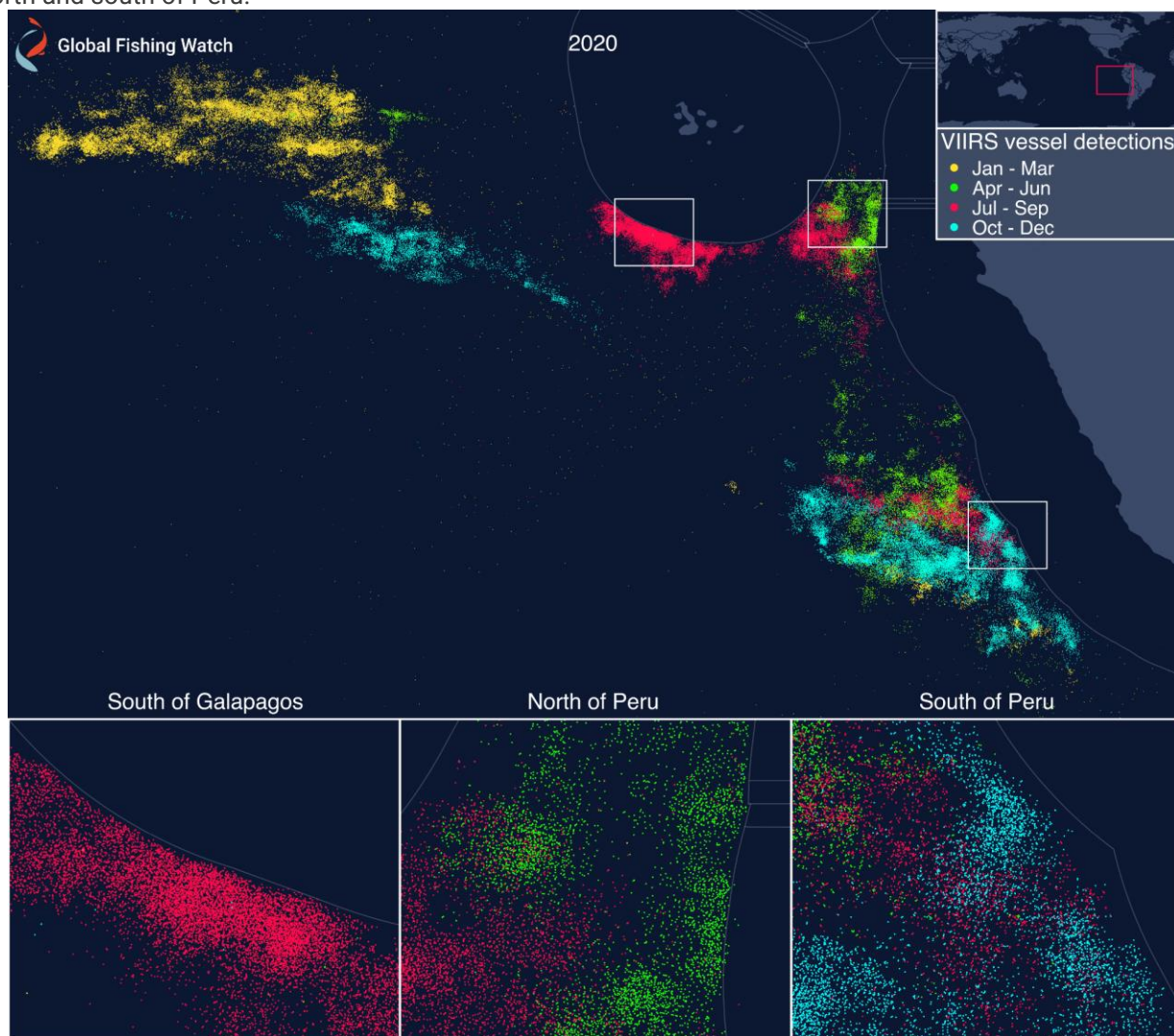
Recommendation 9:

9a: The movements of these three vessels during the AIS gaps is unknown and investigation of VMS data by the flag State and SPRFMO Compliance Committee is recommended for confirmation regarding these 3 vessels movements.

9b: The VIIRS vessel detections in this region closely match the operations of the larger high seas squid vessels through 2020 and provides a good proxy for monitoring the fleet and potentially vessels operating without AIS that warrant investigation by patrols at sea. Coastal States should incorporate the data source into their fisheries enforcement and maritime security regimes to prioritize targeting of dark vessels identified inside EEZs.

Figure 22: Annual VIIRS detection by each quarter, 2020

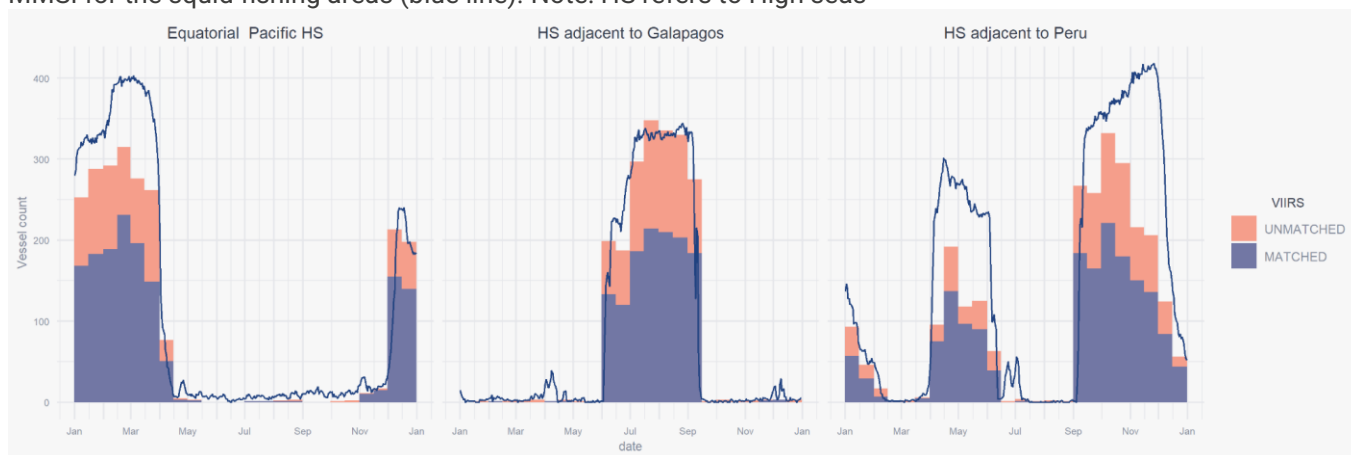
Annual VIIRS detection by each quarter for 2020. And a zoom over the main fishing squid areas, south of Galapagos and north and south of Peru.



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Figure 23: Daily count of VIIRS detection matched/unmatched to ais vessels and daily count of MMSI for the squid fishing areas

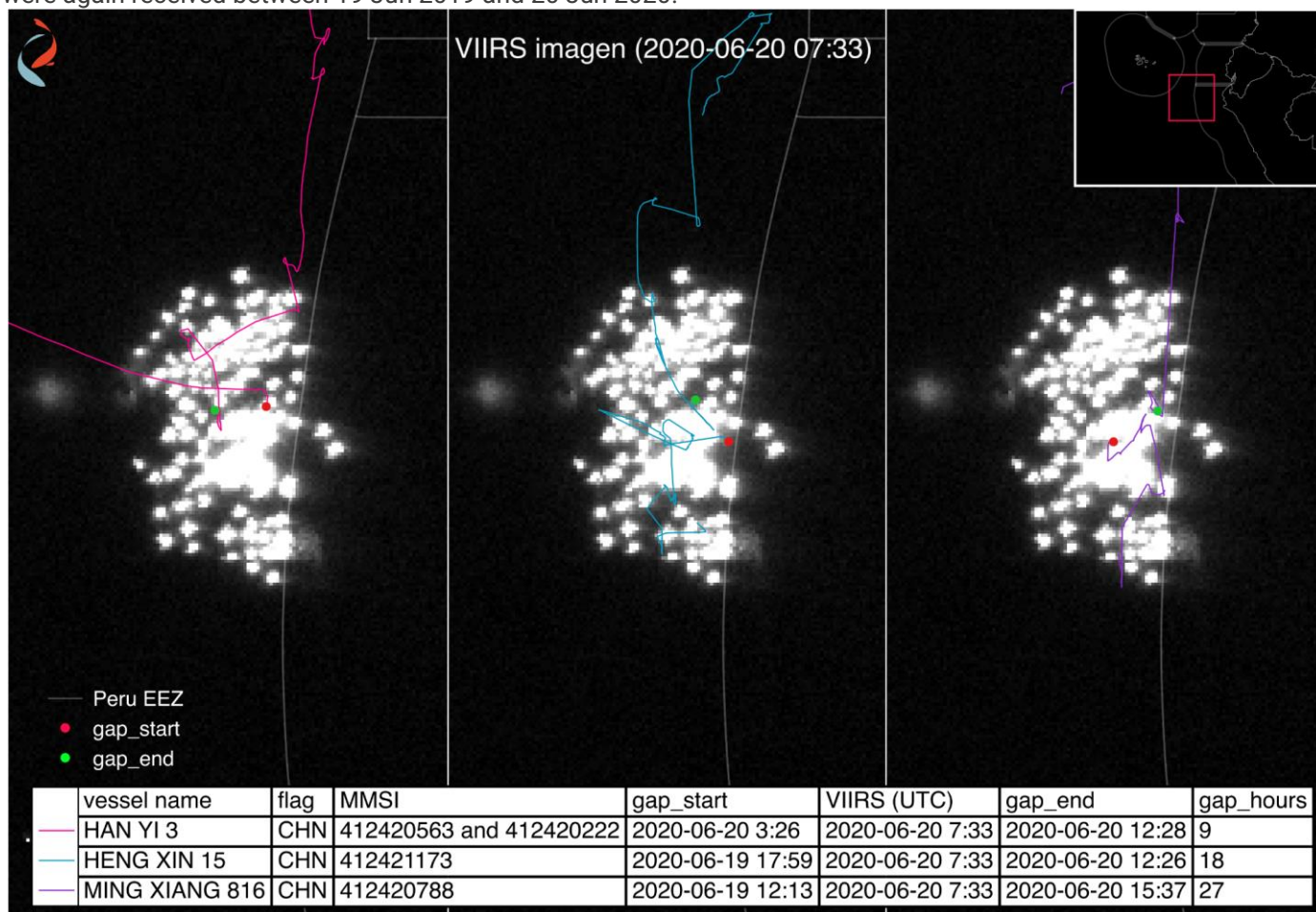
Daily count of VIIRS detection matched/unmatched to AIS vessels (blue/pink bar respectively) and daily count of MMSI for the squid fishing areas (blue line). Note: HS refers to High seas



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Figure 24: VIIRS detection from June 20, 2020

VIIRS images from 20 June 2020 at 7:33 (UTC). Three Chinese flagged squid vessels with AIS gaps at the limit of Peru's EEZ. The red circles represent the moment AIS reception ended and green circles signal when AIS positions were again received between 19 Jun 2019 and 20 Jun 2020.



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6.2 SAR image analysis

Global Fishing Watch primarily tracks fishing activity through AIS position broadcasts. However individual fishing vessels may choose not to broadcast AIS or to broadcast only intermittently. So, to detect non-AIS broadcasting vessels, commonly referred to as “dark vessels,” other imagery sources are used. Synthetic Aperture Radar (SAR) can provide very precise vessel presence detection for large industrial vessels both at night and through cloudy conditions.

Fisheries and Oceans Canada (DFO) and the Canadian satellite company MDA provided vessel detections from RADARSAT 2 SAR images for the squid fishing areas within the study AOI in June and July 2020. A total of 113 images provided 616 vessel detections for the area. Detections matched with the squid fleet but did not indicate activity inside the coastal State EEZs. Detections inside the EEZs either matched with AIS as a non-fishing vessel or were operating far from the squid fleet and likely domestic fishing vessels not broadcasting AIS.

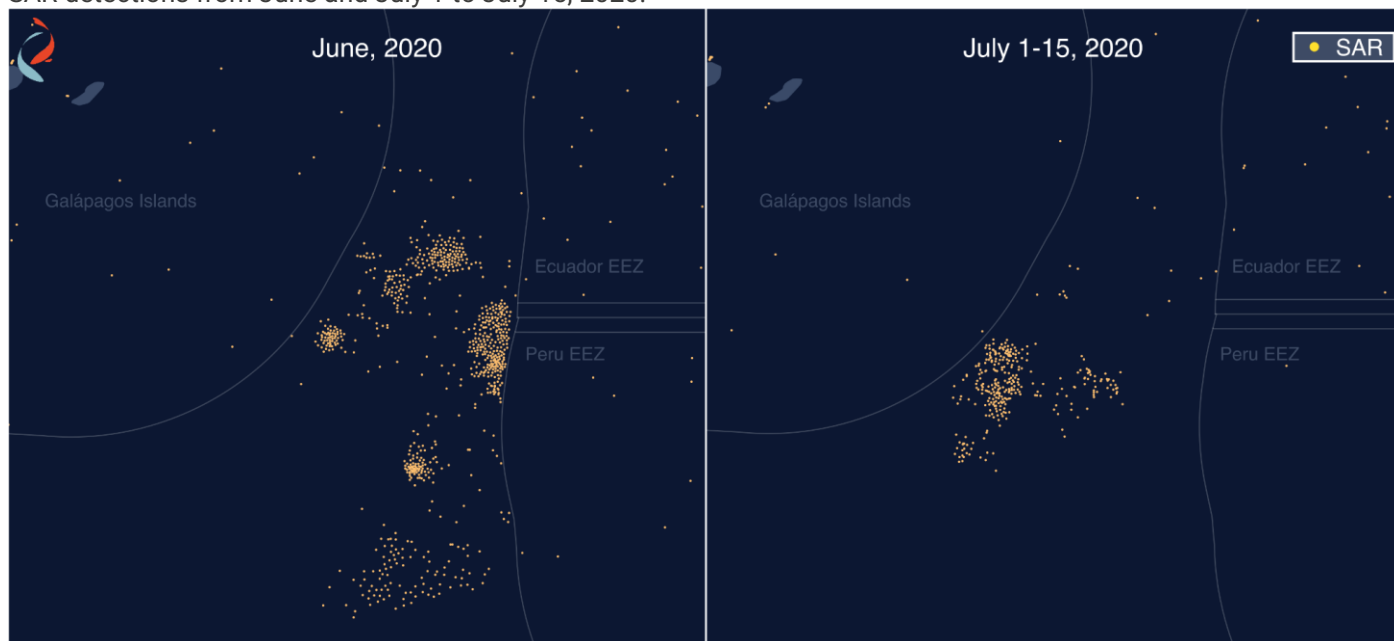
One SAR image taken on Jul 09 identified one large vessel close to where the squid fleet was operating on the high seas but inside the Ecuador EEZ (Galapagos) (Figure 25). Due to the size of the vessel detected it is possible this was a Ecuadorian naval vessel however, further investigation by the coastal State would be needed to try and confirm its identity.

Key Finding 10: The potential identification of two squid vessels operating inside the Peruvian EEZ in 2020 from daily VIIRS imagery analysis and 113 SAR images suggests that in 2020 there was good compliance with EEZ limits boundaries by the high seas squid fleet. The fleet does operate right up to the EEZ limit, often in high concentration but they do not appear to routinely encroach into the EEZs.

Recommendation 10: It is recommended that remote sensing analysis of this nature is continued by the coastal States and their partners with the result being available publicly and to SPRFMO meetings. Continued and public monitoring of this nature supported by at sea operations by coastal State maritime security agencies are the strong deterrent to the risk of unauthorized IUU fishing inside their waters.

Figure 25: SAR detections

SAR detections from June and July 1 to July 15, 2020.



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Table 6: RADARSAT 2, SAR acquisition from MDA on July 9, 2020

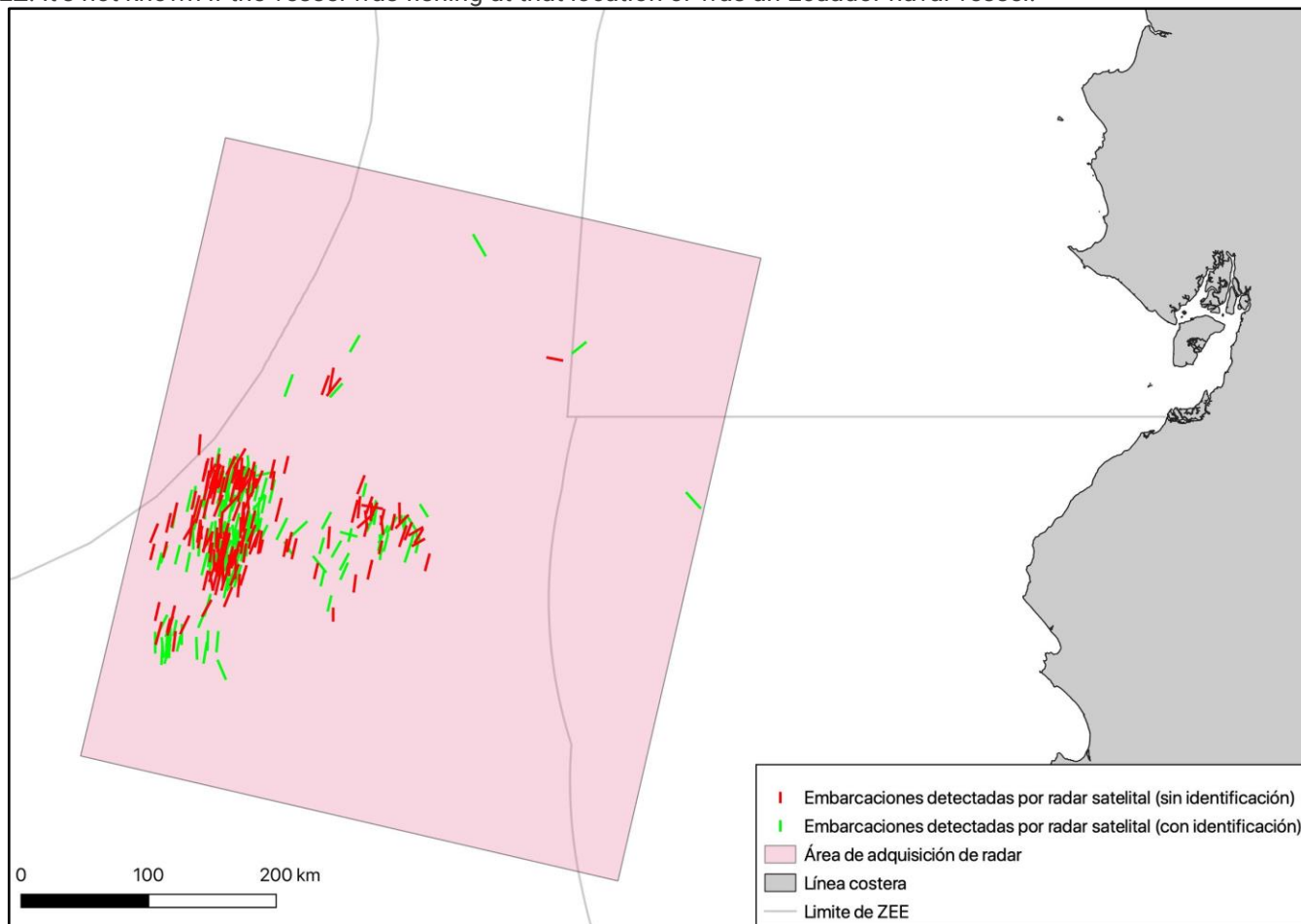
One SAR acquisition from MDA on July 9, 2020 captured the predominantly Chinese flagged squid fleet fishing between the mainland Ecuador and Galapagos’ EEZs

Acquisition time UTC	Ecuador local time (GMT-5)	SAR detected vessels	AIS correlated SAR detections	Total AIS vessel present	Number squid jiggers from AIS
2020-07-09 11:14:31	2020-07-09 6:14:31	310	151	341	319

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Figure 26: Vessel detections from SAR acquired from MDA Ltd.

Vessel detections from SAR acquired by MDA Ltd. on July 9, 2020. A total of 306 vessels were detected of which 190 could be matched to AIS (green). Unidentified vessels are shown in red. Again, vessels in the squid fleet appear with similar orientations (here about 190°). A single unidentified vessel with this orientation appears within the Galapagos' EEZ. It's not known if the vessel was fishing at that location or was an Ecuador naval vessel.



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7 Vessel History - Links to IUU Fishing

A review of historic media reports, IUU vessel lists and national IUU fishing reports, identified 10 vessels authorized via the SPRFMO record of vessels and seen operating in the Convention Area in 2020 that have been linked to possible IUU fishing cases from 2014 to 2020 (Table 5). Eight of these reports correspond to Chinese squid vessels within Argentina's EEZ, one fishing within Peru's EEZ, and one fishing in both of them. These reports have not been verified with the flag State and details of any resulting enforcement action or sanctions are not public. The link between these vessels operating within the SPRFMO Convention Area and possible historic IUU cases can support a risk assessment of the fleet so coastal and port States can prioritize boardings and inspections appropriately.

HUA LI 8 had been the subject of an INTERPOL [Purple Notice](#) for suspected IUU fishing in February 2016. It was not broadcasting AIS when it was intercepted by a routine patrol of the Argentine navy, which claimed it caught the vessel fishing within Argentina's EEZ. After that, while sailing to China, the HUA LI 8 was arrested by the [Indonesian Navy](#) on March 21, 2016, where crew were found to be victims of human trafficking. Two years later, the HUA LI 8's owner, [Zhoushan](#)

[Huali Ocean Fisheries Company](#), was able to register in the [SPRFMO](#), despite the history of illegal fishing and human rights abuses. The vessel has been authorized to operate in the SPRFMO's area from February 8, 2018 to date. During 2020, it has been fishing along the border of Peru's EEZ, and entered two times at Peruvian ports (Fig. 26).

RUN DA 608 was [intervened by the authorities](#) of Peru for catching 19 tons of squid inside Peru's EEZ without authorization in October 2018. In 2019, the squid vessel has not been added to any IUU lists and continues to operate along the Peru EEZ and use Peruvian ports.

Figure 27: Example of vessels with historical IUU events

Two squid vessels with historical IUU events. The Chinese flagged HUA LI 8 and RUN DA 608 tracks inside the study AOI in 2020.



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Table 7: Vessels identified with links to historic IUU fishing cases

List for 10 vessels registered and authorized by the SPRFMO in 2020 with links to IUU fishing activities between 2014 and 2020. The list was compiled in collaboration with the Sustainable Fisheries Partnership.

ID	Vessel Name	MMSI	IMO	Flag	Type of fishery	SPRFMO List 2020	Date	Media report	AIS positions 2020
1	HONGPU16	412549092	9890551	China	Squid	Authorised	4/28/2020	Argentina	53426
2	HUA LI 8	412420941	8779774	China	Squid	Authorised	3/16/2020	Argentina	106926
3	HUA XIANG 801	412421062	9822695	China	Squid	Authorised	3/19/2020	Argentina	1702
4	LU RONG YUAN YU 606	412334077	9847528	China	Squid	Authorised	4/28/2020	Argentina	2014
5	LU RONG YUAN YU 688	412331078	8775883	China	Squid	Authorised	5/1/2020	Argentina	1380
6	LU RONG YUAN YU 881	412331175	8775352	China	Squid	Authorised	5/1/2020	Argentina	27782
7	RUN DA 608	412420649	8778770	China	Squid	Authorised	1/10/2018	Peru	8116
8	JING YUANG 626	412331089	9784568	China	Squid	Authorised	2/21/2018	Argentina	60682
9	FU YUAN YU 873	412440149	8685325	China	Squid	Authorised	1/1/2013	Argentina	20007
10	LU YAN YUAN YU 016	412331076	8708256	China	Squid	Authorised	5/1/2020	Argentina-Peru	19668

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Key Finding 11: SPRFMO CMM 04-2020 - *Conservation and Management Measure Establishing a List of Vessels Presumed to Have Carried Out Illegal, Unreported and Unregulated Fishing Activities in the SPRFMO Convention Area* defines IUU fishing activities in relation to SPRFMO CMMs and a review of CMMs and the [Convention](#) does not show any recognition of IUU vessel lists compiled by other RFMOs or consideration of vessels activity outside of the Convention Area.

Recommendation 11: SPRFMO members adopt a stronger IUU listing process that incorporates other IUU lists and accepts evidence of IUU fishing activity against its authorized vessels from non-members or non-CNCs and from activity outside of the Convention Area. This is vital to ensure IUU fishing activity by the global high seas squid fleet can be effectively sanctioned and IUU vessels are not able to evade sanctions by moving to new regions.

8 Conclusions

Global Fishing Watch analysis of the fleet using open data and SPRFMO reports has made 11 key findings that warrant action in order to improve the monitoring and control of this fleet and demonstrates that open data provides a level of understanding for the activity of the distant water squid fleet that is not otherwise available publicly through flag State or SPRFMO reported data.

The growth of the distant water squid fishery within the SPRFMO Convention Area has been rapid; the introduction of newer, larger vessels has more than doubled the catch capacity since 2014. Given the size of the fleet and tendency to operate close together and right up to EEZ limits it is not surprising that in recent years the fleet has gained a lot of attention by both the coastal States and international community. One of the concerns [raised](#) is the risk of IUU fishing by the squid fleet in close proximity to a UNESCO World Heritage Site and impacting socio-economically important coastal State fisheries.

Using open-sourced data this report addresses gaps in transparency and governance that are blocking the sustainable and equitable management of the jumbo flying squid fishery.

Open-source data can play an important role in highlighting risk of IUU fishing and 'tip and queue' enforcement bodies to investigate those observations, collect evidence, and apply the appropriate penalty where relevant.

A major concern of coastal States is the risk of illegal fishing inside their waters by the high seas fleets. Analysis of remote sensing images identified only two instances of large-scale squid vessels fishing inside the Peruvian EEZ, and indicates a tendency for the fleet to comply with EEZ limits in this region. Continued presence of coastal State's patrol vessels and remote sensing monitoring of the fleet are a likely deterrent and is recommended that this surveillance is maintained.

Compared to squid fisheries in the north Pacific, Indian Ocean, and Atlantic the fishery inside the SPRFMO Convention Area has the most developed regulatory framework covering vessel authorization however, implementing the relevant CMMs across a fleet of this scale operating on the high seas is challenging without cooperation between enforcement bodies and more transparency of the fishing operations. The analysis identified 14 vessels that could not be matched to a SPRFMO authorization which, if confirmed, would indicate a degree of unregulated squid fishing, albeit small. This does not, however, eliminate the risk of unregulated fishing and more transparency is required regarding either incidental or targeted catching of shark or tuna and tuna like species by these vessels, or vessels associated with the fleet. To further strengthen the control of unregulated fishing, member States where possible, should make greater efforts to utilize CMM 11-2015 *Conservation and Management Measure Relating to Boarding and Inspection Procedures in the SPRFMO Convention Area* to carry out at sea boarding and inspections.

Around 10% of the distant water squid fleet was identified on AIS as active inside the study AOI but not reported on the Secretariat's lists of vessels which have participated in fishing activities in the Convention Area. There is a risk that these vessels are landing unreported catch and member States and CNCPs should work to ensure catch is being properly reported, including any bycatch.

In addition to IUU fishing risks, the study identified a number of governance gaps related to transshipment. The AIS analysis is able to show the true scale of the support required to keep the fleet operational. A total of 41 carrier vessels and 18 bunkering vessels were observed on AIS

providing support to the fleet, considerably more vessels than were reported as active by SPRFMO. Weak controls regarding transshipment have potential consequences beyond the squid fishery, if a fleet of carriers of this scale is able to transship within the Inter-American Tropical Tuna Convention Area without any requirements for the flag States of the vessels to authorize the activity is compliant, creates a real challenge in controlling transshipment of either RFMOs species. It is strongly recommended that SPRFMO removes the exception that allows jumbo flying squid transshipments to be carried out without prior authorization from the flag States, put in place transshipment data sharing agreements with overlapping RFMOs and publish the location, time and identify of authorized transshipments.

Greater transparency of the active vessels in the area and their catch, including bycatch of non-squid species, transshipments and requiring vessels to continuously broadcast on AIS would go a long way in strengthening existing mechanisms for port controls and at sea boarding in the fight against IUU fishing in the southeast Pacific.

States in the region are leading globally in the adoption of transparency as a tool to drive greater ocean governance. Such ocean action significantly enhances our ability to analyze fishing vessel activity within the SPRFMO Convention Area. Several countries in Latin America—Belize, Brazil, Chile, Costa Rica, Ecuador, Panama and Peru—are committed to sharing or have already published their vessel tracking information on the Global Fishing Watch map. Considering the importance of the Southeast Pacific squid fishery to coastal States and distant water fishing nations, all flag States that have not made this vessel information publicly available should do so as a matter of priority.

APPENDIX 1 - Vessels using multiple MMSI numbers

The table below shows the nineteen squid vessels that were detected engaging in squid fishing operations during 2020. Most of these vessels used two MMSI numbers at the same time according to the AIS data.

Table A1.1: Vessels using multiple MMSI numbers at the same time.

N	Vessel information from the SPRFMO register					Multiple MMSI linked to the vessel			
	vessel name	imo	callsign	flag	status	MMSI	vessels	Flag	AIS positions
1	ZHOU YU 921	9888261	BZSU2	CHN	Authorized	232471989	ZHOU YU 921	UNK	10346
						412549085	ZHOUYU921	CHN	180352
2	FU YUAN YU 878	8685363	BZ7UX	CHN	Authorized	412440154	NA	CHN	2897
						412441054	FUYUANYU878	CHN	19044
3	SHUN ZE 805	8779994	BZ4VO	CHN	Authorized	412549176	SHUNZE805	CHN	7378
						412420535	PUYUAN825	CHN	3936
4	YONG XING 1	8776497	BZTV9	CHN	Authorized	412326889	YONGXING1	CHN	34611
						701006889	HONG RUI 198	ARG	11783
						440106889	HONG RUI 198	KOR	471
5	CHANG TAI 812	8775467	BZU6N	CHN	Authorized	412000812	NA	CHN	3890
						412354167	NA	CHN	3256
6	SHUNZE85	9909455	BZU1X	CHN	Authorized	412549158	JULONGJIAYA31	CHN	92588
						505050505	NA	---	5716
7	SHUNZE807	8524430	BZW9P	CHN	Authorized	412421101	HAIDELI706	CHN	14064
						412549244	NA	CHN	5324
8	LU RONG YUAN YU 279	8776356	BCFC5	CHN	Authorized	412555279	LURONGYUANYU279	CHN	844
						412331075	LURONGYUANYU279	CHN	2744
9	NINGTAI717	8778770	BZ4VJ	CHN	Authorized	412549269	NINGTAI717	CHN	9501
						412420649	RUNDA608	CHN	8116
10	ZHOU YU 916	9819612	BZW5E	CHN	Authorized	412420000	NA	CHN	9754
						412421037	ZHOUYU916	CHN	203436
						412672040	ZHOUYU689	CHN	4698
11	HUA YING 811	8776502	BZV5K	CHN	Authorized	412422696	HUAYING811	CHN	26222
						412421666	TAIPINGYANG5	CHN	57
12	PU YUAN 885	8780010	BZ2VP	CHN	Authorized	412120464	PUYUAN885	CHN	150
						412420464	PUYUAN885	CHN	12346
13	PU YUAN 719	8528826	BZYU4	CHN	Authorized	412549173	PUYUAN719	CHN	18568
						412421158	JULONGJIAYA19	CHN	1443
14	ZHOUYU906	9819571	BZW1E	CHN	Authorized	412421043	ZHOU YU 906	CHN	18701
						425656315	AIS TEST SHIP	IRQ	9615

15	HAI FENG 1	8774853	BZ5VC	CHN	Authorized	412439741	HAI FENG 1	CHN	10845
						900412888	ZHE DAI YU 12888	--	3882
16	No.101 AMOR	9041992	DTZJ	KOR	Authorized	440811000	No.101 AMOR	KOR	7141
						440540604	NA	KOR	14
17	HAN YI 8	8775998	BZ9VI	CHN	Authorized	412420561	HANYI8	CHN	10761
						412428561	ZHESHENGYU7568	CHN	105
18	ZHOU YU 908	9819595	BZW3E	CHN	Authorized	412421039	ZHOUYU908	CHN	49376
						412121039	ZHOUYU908	CHN	3963
19	HAN YI 3	8775986	BZ8VI	CHN	Authorized	412420563	HAN YI 3	CHN	47031
						412426663	ZHEDAIYU	CHN	1810
						412420222	NA	--	1822

*NA: vessel name unidentified82
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Individual cases for vessels using multiple MMSI numbers

ZHOU YU 921

The Chinese-flagged squid fishing vessel, ZHOU YU 921, authorized by SPRFMO since October 11, 2019 was using simultaneously two MMSI numbers during 2020. One of them, the 412549085 (associated to China) recorded on the SPRFMO registry, broadcasted a total of 180,352 AIS positions on the Southeast Pacific. Another, the MMSI number 232471989 associated with the United Kingdom flag broadcasted 10,346 positions. This last MMSI number is likely being used without the consent of the flag State it is associated with.



Photo from [NPFC](#)

SHUN ZE 805

The vessel broadcasted both names; [SHUN ZE 805](#) and a previous name PU YUAN 825 with different MMSI numbers at the same time. While the vessel was transmitting with the name PU YUAN 825, it broadcasted a total of 3,936 AIS positions, while the SHUN ZE 805 broadcasted 7,378 AIS positions. It's unknown why this vessel kept both MMSI numbers.



Photo from [NPFC](#)

YONG XING 1

The Chinese-flagged squid fishing vessel YONG XING 1 was using three different MMSI numbers associated with three different country flag states during 2020. The vessel was not using simultaneously the three MMSI number, it would use a single MMSI at specific times, changing its AIS identity and flag State each time. The vessel operated in the high seas adjacent to Argentina and Peru using the MMSI 412326889 (number associated with China) until July 11, 2020.



Photo from [NPFC](#)

After that, the vessel changed its MMSI number to 440106889 (number associated with Korea) while fishing in the region between Galapagos Islands and Peru's EEZ only for three days between 11 July 2020 and 13 July 2020. Finally, the YONG XING 1 changed its MMSI number to 701006889 (three first digits associated with Argentina), and was transmitted between 13 July 2020 and 20 August 2020. The last MMSI number associated with the Argentinian flag was used only while the vessels operated along the Galapagos' EEZ boundary.

ZHOU YU 906 and HAI FENG 1

The Chinese-flagged squid fishing vessels, ZHOU YU 906 and HAI FENG 1, illustrate two cases where the second MMSI number was associated with a different flag state compared to the first MMSI number. The ZHOU YU 906, broadcasted 66 percent of its AIS positions (18,701 messages) through the MMSI 412421043. The second MMSI number used by the ZHOU YU 906 was the 425656315 belonging to Iraq, transmitted the vessel name as AIS TEST SHIP, but the AIS positions of both MMSI numbers showed it is the same vessel ([Click](#) to see on Global Fishing Watch map). The HAI FENG 1, using both MMSI numbers the 412439741 and 900412888 broadcasted 10,845 (74 percent) and 3,882 (26%) AIS positions respectively. The second MMSI number used by this vessel doesn't belong to any flag states and if someone looks at the vessel track it seems to be two vessels moving close to each other or one vessel active with two AIS devices making enforcement a challenge for this vessel ([Click](#) to see on Global Fishing Watch map).

NING TAI 717

The Chinese vessel broadcasted both its current name NING TAI 717 (MMSI 1: 412549269) and a previous name RUN DA 608 (MMSI 2: 412420649) with different MMSI during 2020. The second MMSI was broadcasted using the previous name of the vessels RUN DA 608 by the first quarter of 2020. And the first MMSI number for the last quarter of 2020 and using the new vessel name (NING TAI 717) registry at the SPRFMO. One thing to mention about RUN DA 608 is suspected of being involved in a IUU fishing event inside Peruvian waters in October of 2018. The RUN DA 608 was [intervened by the authorities](#) of Peru for fishing 19 tons of squid inside the Peru's EEZ without authorization. In 2019 and 2020, the squid vessel continued operating outside Peru's EEZ and using Peruvian ports.

APPENDIX 2 - One MMSI used by multiple vessels

The tables in APPENDIX 2 identify the vessels that broadcast and MMSI that was the same as another vessel. The tables have two vessels identified, the first (Vessel_1) is the vessel believed to be operating within the SPRFMO area, the second (Vessel_2) are the second which is operating elsewhere. The sections are broken up by where the second vessel was operating, either in Chinese waters, Arabian sea and Pacific Ocean.

Shared MMSI with vessels operating in Chinese waters

The review of the AIS shows substantial vessels operating simultaneously in both regions; high seas adjacent to Peru (around SPRFMO Convention Area) and the Chinese coast. Vessels were broadcasting their AIS information through the same MMSI number.

Table A2.1: List of some squid vessels using the same MMSI number and with activity around the southeastern Pacific Ocean (vessels_1) and inside Chinese waters (vessel_2).

	MMSI	Vessel_1	Flag	SPRFMO	Vessel_2	Flag
1	412421027	NINGTAI72	CHN	Authorized	YUEXUYU21027	CHN
2	412322090	CHANG AN 998	CHN	Authorized	YUEXUYU22090	CHN
3	412440691	FU YUAN YU7888	CHN	Authorized	XM PILOTBOAT 13	CHN
4	412440661	FU YUAN YU7871	CHN	Authorized	WANGBIAO2301	CHN
5	412440662	FU YUAN YU7872	CHN	Authorized	WANGBIAO2302	CHN
6	412326885	ZHEN FA 6	CHN	Authorized	LUDONGGANGYU67789	CHN
7	412420991	HAI DE LI 708	CHN	Authorized	ZHEDAIYU4278	CHN
8	412421087	JIN HAI 779	CHN	Authorized	ZHE XIANG YU 21087	CHN
9	412333345	LURONGYUANYU709	CHN	Authorized	HUAZHONGYOU5	CHN
10	412336869	LURONGYUANYU738	CHN	Authorized	LULAIZHAOYU66186	CHN
11	412206009	LIAO YU 6	CHN	Authorized	LIAODANYUYUN25061	CHN

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Qiongzhou Strait

The NING TAI 72 (412421027) and CHANG AN 998 (412322090) squid vessels flagged to China appear to be sharing their MMSI number with other Chinese vessels, the YUEXUYU21027 (412421027) and YUEXUYU22090 (412322090) respectively, the last vessels were located along Qiongzhou Strait in China and consistently broadcast on AIS during the season.

Zhangzhou coast

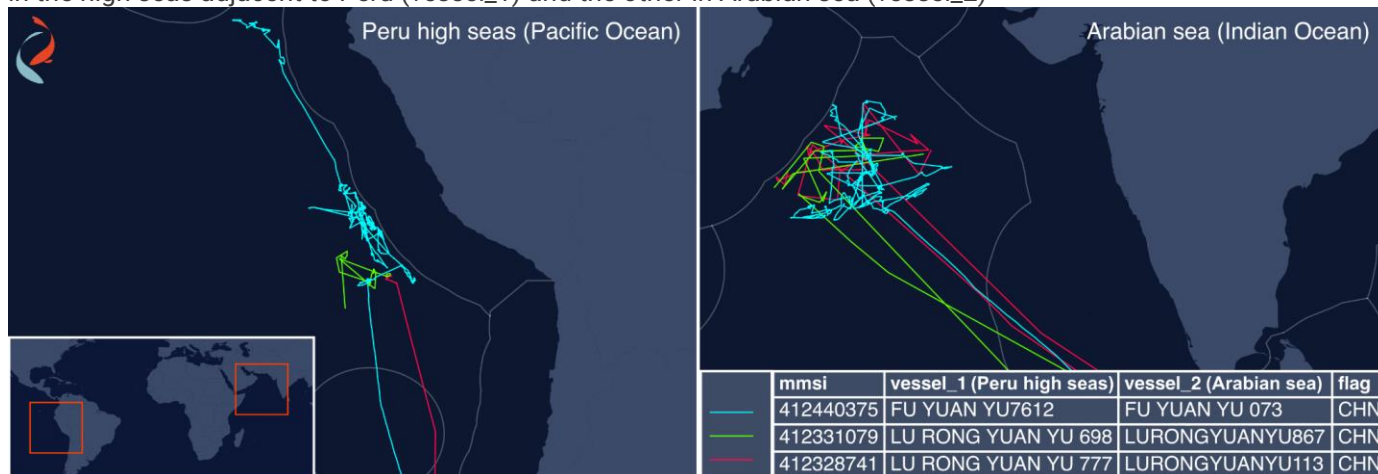
Vessels detected could belong to the same owner because the vessels have the same name in each region. For instance, the MMSI numbers 412440661 and 412440662 associated with the squid vessels FU YUAN YU 7871 and FU YUAN YU 7872 respectively, were also being used by other vessels, WANGBIAO2301 and WANGBIAO2302 respectively, the WANGBIA vessels had activity along Zhangzhou coast in China.

Shared MMSI with vessels operating in Arabian sea

The Arabian Sea is an interesting region that appeared to locate the second vessel around the high seas. In addition, both vessels broadcasted their AIS information through the same MMSI number and use names belonging to the same group of vessels (Figure 1).

Figure A2.1: Two MMSI numbers used by two different vessels at the same time

Cases where the MMSI number is used by two different vessels at the same time and in different places, one located in the high seas adjacent to Peru (vessel_1) and the other in Arabian sea (vessel_2)



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Table A2.2. List of some squid vessels using the same MMSI number and with activity around the southeastern Pacific Ocean (vessels_1) and other regions around the world (vessel_2).

MMSI	Vessel_1	Location_1	Flag	SPRFMO	Vessel_2	Location_2	Flag
1 412440375	FU YUAN YU7612	Peru HS	CHN	Authorized	FU YUAN YU 073	Arabian sea	CHN
2 412331079	LU RONG YUAN YU 698	Peru HS	CHN	Authorized	LURONGYUANYU867	Arabian sea	CHN
3 412328741	LU RONG YUAN YU 777	Peru HS	CHN	Authorized	LURONGYUANYU113	Arabian sea	CHN
4 412671870	Unidentified	Peru HS	CHN	Unknown	ZHOUYU810	NPFC	CHN
5 412422695	HUA YING 87	Galapagos HS	CHN	Authorized	HUA YING 809	High seas adjacent to Peru	CHN
6 412421111	JIN HAI 866	Peru HS	CHN	Authorized	TAI PING YANG 5	Kiribati's EEZ	CHN
7 412331076	LUYANYUANYU016	Peru HS	CHN	Authorized	LURONGYUANYU668	High seas adjacent to Argentina	CHN

NPFC: The North Pacific Fisheries Commission Convention Area. (*) The vessel also was using the MMSI number of 412549086.

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FU YUAN YU 7612 and FU YUAN YU 073

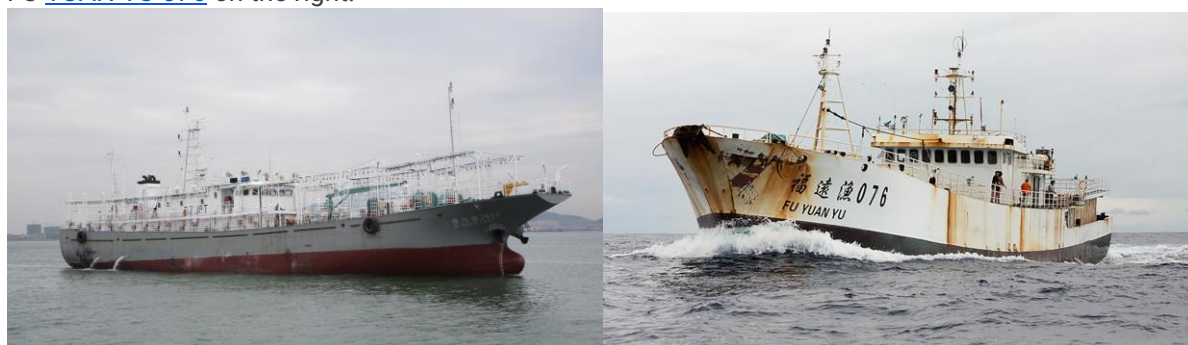
Both vessels broadcasted AIS data using the MMSI number 412440375 and belonging to the FU YUAN YU fleet, but the vessels were located in different places. The first vessel, the Chinese flagged squid fishing vessels FU YUAN YU 7612 was operating in the high seas adjacent to Peru and authorized by the SPRFMO. The second vessel, the FU YUAN YU 073 with a gear type of driftnets was operating in the high seas adjacent to the Arabian sea. When two vessels have the behavior of using the same MMSI number, it could be that one of the vessels seeks to hide itself within the MMSI number of the first vessel, and it could be the case of FU YUAN YU 073.

In January 2016, a vessel from the NGO Sea Shepherd, the Steve Irwin identified the Fu Yuan Yu fleet operating in the Indian Ocean. One of them, the FU YUAN YU 073 was identified operating an illegal driftnet in the Indian Ocean. After it was confirmed by the Chinese Fisheries Law, they took

the following punishment, [temporarily suspending the fishing license](#) of FU YUAN YU 073 and other vessels. Finally, the FU YUAN YU 073 appears to continue operating for 2020 and using a MMSI number (412440375) that is also used by the FU YUAN YU 7612. The true identity of the vessel operating inside the SPRFMO area in 2020 is unknown and should be determined by the flag State.

Figure A2.2: Photos of two Chinese vessels using the same MMSI number

Photos of two Chinese vessels using the same MMSI number '412440375', the [FU YUAN YU 7612](#) on the left and the [FU YUAN YU 076](#) on the right.



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The LU RONG YUAN YU 698 and LU RONG YUAN YU 867 flagged to China and from the same fleet LU RONG YUAN YU, both vessels transmitting their AIS data using the number of 412331079. One of them, a squid vessel LU RONG YUAN YU 698 active and fishing in the high seas adjacent to Peru's EEZ, and another the purse seiner Chinese vessel LU RONG YUAN YU 867 fishing in the high seas adjacent to the Arabian sea. The same pattern came from the couple of vessels LU RONG YUAN YU 777 and LU RONG YUAN YU 113, a squid Chinese vessel and purse seiner Chinese vessel respectively, fishing using the MMSI 412328741 in different areas (Figure 1).

Shared MMSI with vessels operating in the Pacific Ocean

Additionally, some cases where first and second vessels that were using the same MMSI number come from with vessels using the same gear type to catch squid in different locations and in the same fishing area, vessels fishing inside another RFMO area such as NPFC. Furthermore, the case where the first vessel with activity in the high seas adjacent to Peru was not identified and the authorization could not be corroborated with the SPRFMO, vessel apparently flagged to China and was using the MMSI number of 412671870.

The AIS tracking data from the MMSI number 412422695 (figure in the top right) described the case when two squid vessels were transmitted its AIS data using the same MMSI and around the same place, the Chinese flagged squid vessel HUA YING 87 and HUA YING 809. Both vessels have authorization from the SPRFMO, but the HUA YING 809 has another MMSI number (412422693) associated with their AIS tracking data. On the other hand, the AIS tracking data from the MMSI number 412421111 (figure in the bottom left) shows two vessels, the Chinese squid vessel JIN HAI 866 and the Chinese longline vessel TAI PING YANG 5 that was fishing inside Kiribati's EEZ.

ZHOU YU 922 and ZHOU YU 810

The AIS tracking data from the MMSI number 412671870 (violet track in figure 15) clearly shows that it is two vessels transmitting the same MMSI number. One of them, the vessel [ZHOU YU 922](#) authorized by the SPRFMO and located in the Galapagos and the high seas adjacent to Peru's EEZ was also using a other MMSI number 412549086 simultaneously with the 412671870 for 2020

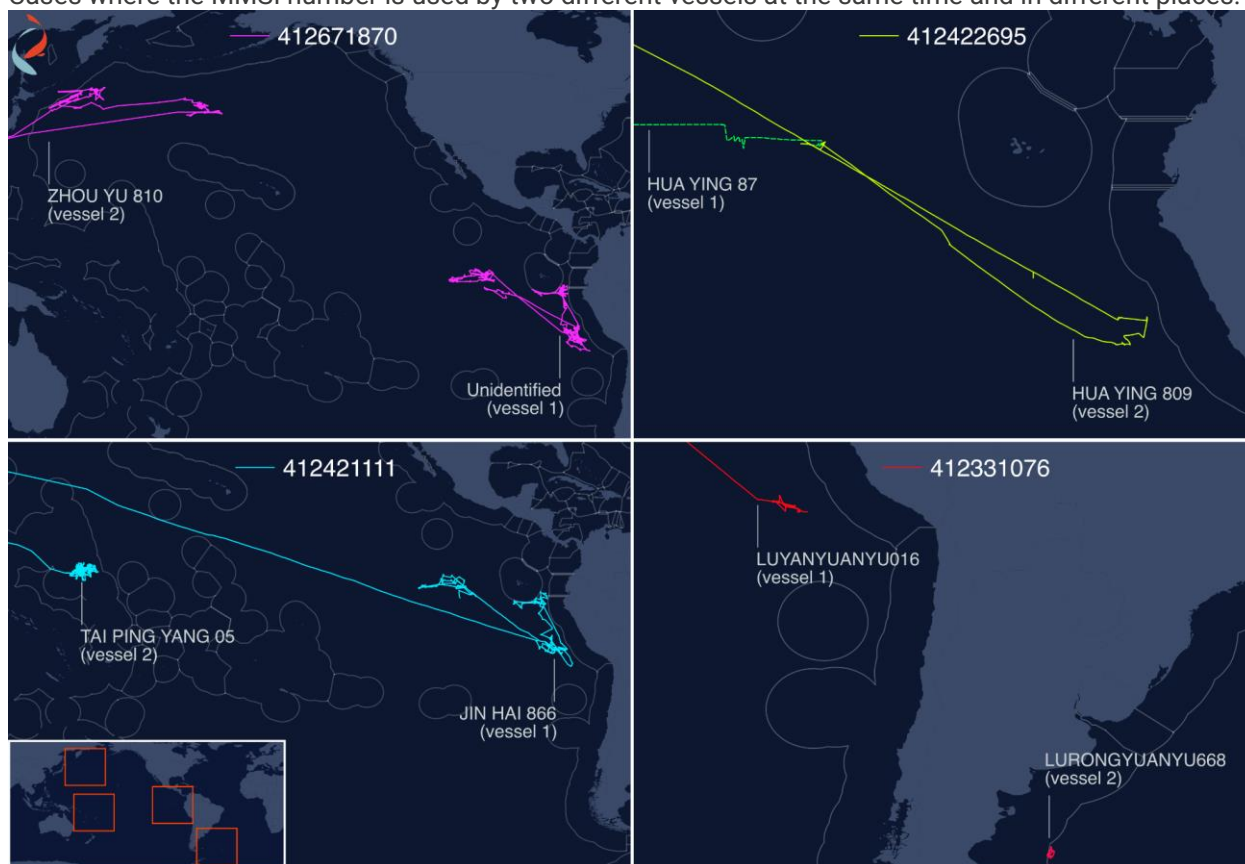
and the second vessel broadcasted in the high seas adjacent to Japan’s EEZ and inside the NPFC area was identified as [ZHOU YU 810](#), Chinese squid vessel with authorized by the NPFC.

LU YAN YUAN YU 016 and LU RONG YUAN YU 668

Both vessels were using MMSI number ‘412331076’ for 2020 (figure in the bottom right). The [LUYANYUANYU016](#) (vessel 1) was fishing near Peru. While the [LURONGYUANYU668](#) (vessel 2) was broadcasting a real location near Argentina. The LURONGYUANYU668, was sighted with full lights on catching squid on April 28 2020, in Argentina’s EEZ by the Coast Guard patrol “Prefecto Figue”, and was confirmed a [IUU fishing activity](#) by Argentine authorities.

Figure A2.3: Multiple vessels using the same MMSI

Cases where the MMSI number is used by two different vessels at the same time and in different places.



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APPENDIX 3 – Unidentified vessels

Detailed analysis of two vessels where no SPRFMO authorization could be found

ZHOU PU 818

The Chinese squid vessel was operating inside the NPFC area where the vessel has a fishing authorization, between April and October 2020. After that, on October 27, 2020, the vessel changed its course towards the southeast Pacific Ocean bound for the high seas adjacent to Argentina. But the vessel stopped for 15 days between November 15 and December 9, 2020, and where the squid fleet was fishing at the west of the Galapagos Islands. Finally, the ZHOU PU 818 continued its voyage toward the Atlantic Ocean arriving at the high seas adjacent to Argentina by the end of December 2020.

The ZHOU PU 818 did not have the authorization to carry out the fishing activity for the squid resource according to the SPRFMO for the year 2020. According to the SPRFMO Record of Vessels, the vessel was recently included in the SPRFMO record on May 06, 2021. So, the ZHOU PU 818 could be potentially involved in an unauthorized squid fishing activity in December 2020.

999999999 (Potentially the KUM YANG 103)

The Korean squid vessel, NO.103 KUMYANG authorized by the SPRFMO was operating close to the Peru EEZ boundary using the MMSI number of 440816000. A second MMSI 440616000, appeared over the same area claiming to be KUNYANG103, but the AIS tracking data from both MMSI numbers did not match. It is unknown if MMSI 440616000 was deliberately impersonating NO.103 KUMYANG or if this was some other issue with the AIS system.

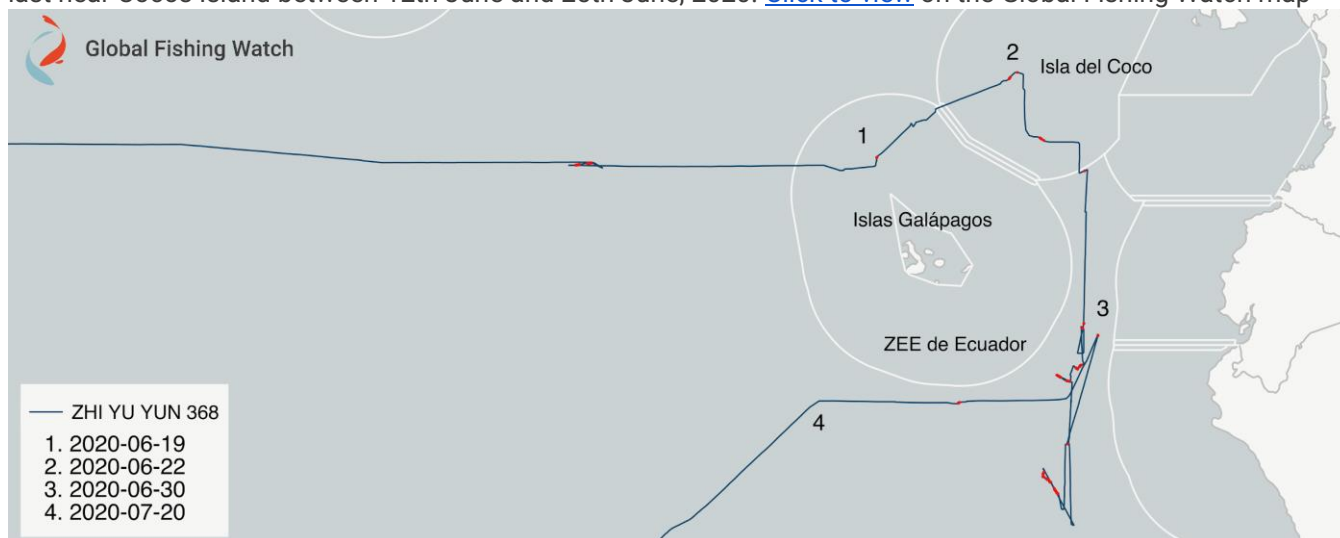
APPENDIX 4 – Support vessels case study

The vessel [MIN SHI YU 00368](#) flagged to China broadcasts its information to the AIS system using MMSI number 412353550 and reporting as a fishing vessel. It could not be confirmed if this is in fact a fishing vessel and there is a possibility it is acting as a carrier. The MIN SHI YU 00368 has also occasionally broadcast the name ZHI YU YUN 00368. A second fishing vessel also flagged to China, the [LIAOYINGYU56288](#) was using the same MMSI number 412353550, but has not left the Chinese coast. Neither vessel names (ZHI YU YUN 00368 or MIN SHI YU 00368) are recorded on the SPRFMO

On August 23, 2020, the identity of this vessel was confirmed as a carrier vessel, engaged in fishing activities, and supplying fuel and food to other fishing vessels at sea after it was captured by a [Papua New Guinea Navy vessel](#) near Kavieng, New Ireland. The unnamed vessel which police believe is linked to a [K1.47 billion](#) (NZ\$642 million) drug bust recently in Australian waters.

Figure A4.1: AIS track of MIN SHI YU 00368

The vessel shows three periods with possible vessel rendezvous, in the high seas, near the Galapagos Islands and the last near Cocos Island between 12th June and 25th June, 2020. [Click to view](#) on the Global Fishing Watch map




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