

# THE IMPACTS OF A GROWING OIL AND GAS SECTOR ON GUYANA'S MARINE VESSEL TRAFFIC FROM 2015 TO 2020

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## Glossary

AIS	Automatic Identification System
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency (Guyana)
FOC	Flag of Convenience
FPSO	Floating Production Storage and Offloading Unit
GFW	Global Fishing Watch
GMCS	Guyana Marine Conservation Society
IMO	International Maritime Organization
ITF	International Transport Workers' Federation
IUU	Illegal, Unreported and Unregulated (IUU) fishing
MARAD	Maritime Administrative Department
MMSI	Maritime Mobile Service Identity
UNCLOS	United Nations Convention on the Law of the Sea
WWF	World Wildlife Fund

## Purpose of this report

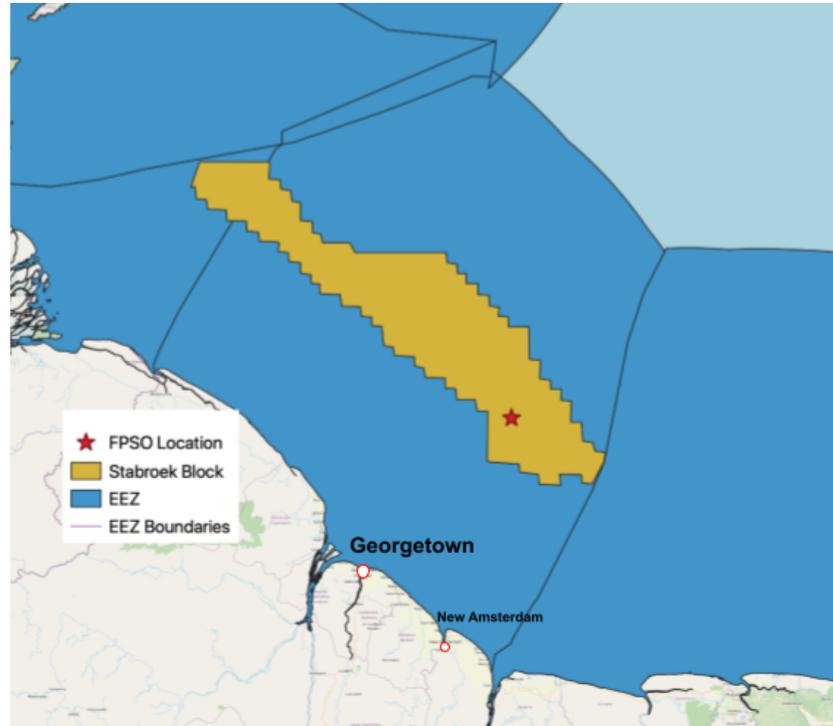
The work presented in this report offers a first overview and analysis of ship traffic based on AIS vessel tracking data in Guyanese waters between the years 2015 to 2020, with special consideration of the oil and gas exploration. It is intended to provide a multi-year baseline of changes in shipping traffic and activity that hopefully will serve to support further research and management of Guyana's marine space.

## Introduction

Guyana's maritime exclusive economic zone (EEZ) covers 138,240 km<sup>2</sup> and 200 nautical miles of coastline. Like many coastal nations, Guyana has long relied on the coastline for shipping, and the maritime industry has evolved over the years from colonial trade to a developing fisheries sector and the most recent oil and gas discovery starting in 2015. The latter underscored the general lack of information available about the marine environment and the urgent need for research to inform and adjust management.

The local authority for managing the maritime industries, shipping and other related activities in the EEZ is the Maritime Administrative Department (MARAD). Established in 2003, MARAD is the key agency that directs and executes the laws relative to maritime affairs under the International Maritime Organisation (IMO). Additionally, under the Ministry of Agriculture, the local Department of Fisheries is responsible for managing and promoting the sustainable development of Guyana's fishery resources.

Guyana's oil and gas discovery began within the Liza Field in 2015 and production began in 2019. This oil field is located in the eastern half of the Stabroek Block approximately 190 km offshore Georgetown (Figure 1). Oil deposits are about 3,600 m below seabed with an estimate of 3.2 billion in excess oil-equivalent barrels. Operations are estimated to be ongoing for at least 20 years starting in 2020. The main port for service vessels to the oil fields is in Georgetown, but other ports and shore base facilities are being developed in Berbice and the West Coast to cater to the oil and gas industry and other service needs.



*Figure 1 The Floating Production Storage and Offloading (FPSO) unit in the Stabroek Block of Guyana's Exclusive Economic Zone (EEZ). Source: Guyana Marine Conservation Society and Dr. K. Boerder.*

According to Pirotta (2018), shipping routes in the ocean can be compared to terrestrial roads, meaning that they are frequently traversed passages concentrating the movement of vessels between multiple locations. Shipping routes can then be seen as “marine roads”, connecting locations and concentrating vessel movements (Coffin, 2007). Although marine roads provide transport for global trade, the increase in vessel traffic is known to adversely affect the marine environment: Marine vessels are an emission source of air pollutants, underwater sound (Duarte et al., 2021), and other drivers of climate change (Transportation Research Board, 2016). Maritime traffic also has effects on biodiversity: cetaceans like whales and dolphins can be impacted by vessel strikes, water pollution from leaks and spills impacts water quality and the hulls and ballast water can introduce invasive species (Ameer, 2008). Although information about marine biodiversity, and especially cetaceans, in Guyanese waters is limited and under-recorded, there is evidence from marine mammal strandings and fatalities (Figure 2) to identify critical areas for marine biodiversity conservation (De Boer, 2015).

In Guyana, marine research has mostly focused on coastal zone management, fisheries and marine wildlife by the World Wildlife Fund Guianas (WWF Guianas) and the Guyana Marine

Conservation Society (GMCS). Some research was conducted in areas where oil deposits are located but focused solely to support the Environmental Impact Assessments (EIA) conducted by Esso Exploration and Production Guyana Limited. This EIA has been criticised<sup>1</sup> not only for being below international standards but even below ExxonMobil's standards when compared to the EIAs that the company prepared for operations in other countries. A source from the local Environmental Protection Agency (EPA) shared that the EPA did find the assessment to be "less than adequate" but felt obliged to grant the permit based on the posture of the government on the issue (Kaieteur News, 2017)<sup>2</sup>. Additionally, the research that was supposedly generated and used to guide the EIAs have not been published and are currently inaccessible to the Guyanese public. Due to the lack of transparency surrounding the environmental permit, Exxon was allowed to flare excessively from their offshore oil operations for a significant amount of time before facing fines. Therefore civil society groups like GMCS are advocating for better marine science research, monitoring and management as it is essential to prevent or mitigate potential negative impacts on Guyana's marine environment (Figure 2).



*Figure 2 Sea turtle and sperm whale found dead on Guyana's seawall, the cause of death for the turtle was difficult to determine due to the state of decomposition and entanglement for the whale. Source: Guyana Marine Conservation Society*

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<sup>1</sup> <https://guyanachronicle.com/2020/10/30/447173/>

<sup>2</sup> [ExxonMobil submits poor EIA to Guyana, but still gets permit](#)

With the help of vessel tracking data, the routes and extent of vessel traffic to and from the oil fields can be better understood to establish marine management plans with oil and gas traffic in mind. Monitoring the vessels that are frequenting the EEZ is valuable to ensure transparency on a national level. Satellite-based vessel monitoring tools such as the Automatic Identification System (AIS) enable tracking vessel movements even far from shore (Kroodsma et al. 2018). AIS was initially developed to avoid vessel collisions but is now mandated by the IMO for vessels larger than 300 gross tonnes on international voyages. AIS data on ship movements can be freely accessed through Global Fishing Watch Marine Manager ([www.globalfishingwatch.org/marine-manager](http://www.globalfishingwatch.org/marine-manager)).

In addition to AIS for international voyages, vessels are mandated to fly the flag of the country it is registered with when sailing. Some vessel owners have taken to registering their vessels in countries that have less regulation, lower administration fees and ease of registration. The flags of these countries have become known as “Flags of Convenience (FOCs)”, and tend to be associated with varying levels of illegal activity, pollution incidents and subpar working conditions for employees (International Transport Workers Federation). Many shipowners are allowed to remain anonymous when registering their vessels in FOC nations, thus making it difficult to hold owners accountable for marine infractions and to impose enforcement actions.

The minimal data on the biodiversity of Guyana's marine environment does not stem from a lack of interest but rather from a lack of funding, equipment and opportunity. Anticipating the projected success of Guyana's offshore oil and gas industry and the large quantities of crude oil that need to be transported to production sites, refineries and consumption points, there is an urgent need to consider the implications of what an increase in marine vessels means for Guyana. As a result of a lack of transparency in the offshore operations provided to the Guyanese people and the limited ability to conduct field research, one way to fill some of the knowledge gaps on biodiversity and marine mammals is through an analysis of remote sensing data such as the AIS tracks of marine vessels that have entered Guyana's EEZ from 2015 to 2020.

For this report, the GMCS accessed free vessel tracking and oceanographic data from Global Fishing Watch (GFW) to assess vessel activity connected to the oil and gas sector. Using the recently launched Global Fishing Watch Marine Manager, datasets for human activity, biological data, oceanographic data and maritime zoning are now freely available to partners such as GMCS. This project has relied on free access to fishing and shipping

activity to create baselines for vessel traffic data. The findings in this report can be used to support ocean governance, management and marine protection in light of increasing oil and gas vessel activity for Guyana

## Objectives of this study

The objective of this work is to provide the first overview and analysis of the extent and intensity of the growing oil and gas sector through an assessment of the marine vessel traffic in Guyana's Exclusive Economic Zone (EEZ) from 2015 to 2020.

Our aims are to:

1. assess the patterns of marine vessel traffic according to ship type, the number of ships, time spent per year, and flag.
2. assess the patterns of marine vessels involved in the oil and gas sector, especially supply vessels.
3. determine the frequently used shipping routes and map their changes over time.

This work will hopefully provide a basis for the collection of long-term baseline data and support marine monitoring and management in Guyanese waters going forward.

## Data and methods

The management authorities MARAD and the Fisheries Department were approached for data on the total number of vessels traversing and corresponding IMO registration numbers, the total number of vessels conducting seismic surveys and vessel routes and GPS locations. However, this information was not readily available so secondary data was collected from MARAD's website where regular *Notice to Mariners*<sup>3</sup> are published with vessel names and their intended operations. These turned out to be not exhaustive lists and by themselves insufficient for the analysis at hand.

Subsequently, the following data sets were obtained from Global Fishing Watch (GFW) and Dalhousie University:

1. A list of 16,017 unique vessels equipped with AIS that entered Guyana's EEZ from 2015 to 2020.
2. Vessel movement and activity data for all vessels active in the Guyanese EEZ from 2015 to 2020.

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<sup>3</sup> <https://marad.gov.gy/notice-to-mariners/>

3. GIS shapefiles for the Stabroek Block, the floating production storage and offloading (FPSO) unit location, and Guyana's maritime boundary.

All vessel information available was collated: name, call sign, Maritime Mobile Service Identity (MMSI), IMO number, ship type, flag, owner. The data was then divided by year whereby:

- The original 31 vessel classes provided by GFW were reclassified and condensed to 11 vessel classes (Table 1).
- Vessels were randomly spot-checked to make sure the data was correct and gaps were filled where there was no data (NA), using Google search, IMO and vessel tracking websites such as Marinetraffic, VesselFinder, Shipfinder and FleetMon.
- A subset of all vessels deemed involved in the oil business was created (Table 1).
- The activity hours were summed by year on a 0.1-degree grid for all vessels and the subset of oil vessels.
- A list of Flags of Convenience (FOCs) was created as identified according to the International Transport Workers' Federation list of declared FOC countries<sup>4</sup>.

Table 1: Overview and reclassification of vessel categories used in this report.

Main Categories (as derived from GFW)	Sub Categories (condensed for this study)	Suspected involvement in oil business (Y/N)
1. bunker	bunker	Y
2. cargo	cargo_or_reefer	N
3. cargo_or_tanker	bunker_or_tanker	Y
	container_reefer	N
4. fishing	drifting_longlines	N
	fixed_gear	N
	pots_and_traps	N
	set_gillnets	N
	set_longlines	N

<sup>4</sup> <https://www.itfglobal.org/en/sector/seafarers/flags-of-convenience>

	trawlers	N
	tuna_purse_seines	N
5. gear	Removed	N
6. NA	NA	N
7. other_not_fishing	dive_vessel	Y
	dredge_non_fishing	Y
	non_fishing	N
	passenger	N
	patrol_vessel	N
	tug	N
	well_boat	N
8. reefer	specialized_reefer	N
9. research	research	N
10. seismic_vessel	seismic_vessel	Y
11. supply_vessel	supply_vessel	Y
12. tanker	tanker	Y

The activity of vessels visiting the FPSO was tracked and recorded separately. This data was checked and filled for gaps. Vessels classified as 'dive' vessels were separated and their identity was checked manually as described above.

Using the vessel movements and activity for all vessels from 2015 to 2020, individual activity maps were created to show the time and location of vessels per year, relative to the FPSO and the Stabroek block.

## Results

### Vessel traffic in the Guyanese EEZ

This project analysed the marine traffic within the boundaries of the Guyanese EEZ between 2015 and 2020. Marine traffic includes all of the ships at sea and is commonly monitored with vessel-tracking data such as AIS to provide information on vessel movements. The total number of AIS equipped vessels recorded in this report was 16,017 vessels, spending a total of 2,172,724 hours in the Guyanese EEZ over five years (2015-2020).

Vessel activity during this 5-year period showed a general increase that peaked in 2019 and dropped in 2020 for both the number of vessels (2,941 vessels, Figure 3) and the number of hours (570,335 hours, Figure 4). The top three overall categories with the highest number of vessels were *cargo*, *tanker* and *other not fishing* vessels, which made up 93% of all vessels. Vessels potentially connected to the oil and gas business made up 36% of the total number of vessels.

The number of vessels varied over the years but peaked in 2019 before reaching a low in 2020 (Figure 3). The overall percentage change from 2015 to 2019 was 13% while the average percentage change over the 4 years was 3%. There were 33% fewer vessels seen in 2020 as compared to 2019.

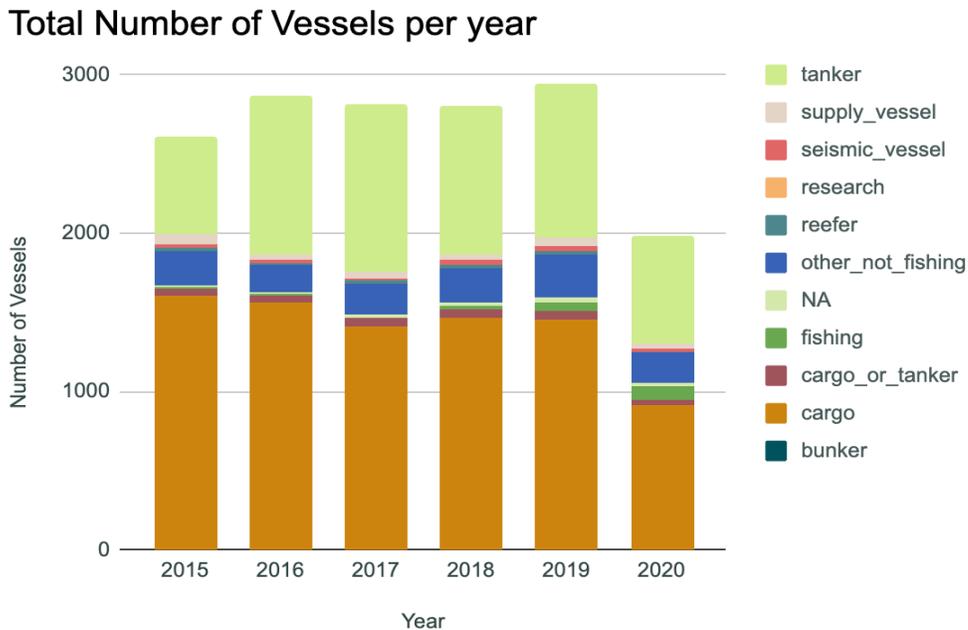


Figure 3 Total number of AIS equipped vessels by class within the Guyanese EEZ per year. Data from Global Fishing Watch.

Hours spent by vessels within the Guyanese EEZ remained fairly constant between 2015 and 2018 at about 314,286 hours (Figure 4). 2019 brought a steep increase of 82% in hours compared to 2015, before a sharp drop of 40% in 2020 to resemble previous levels. The amount of time spent by oil and gas vessels was highest in 2020 accounting for 42% of the total hours spent by all vessels that year, with a 1% increase compared to 2019. Notable increases in the number of hours were seen in most of the vessel categories in 2019 (Figure 4).

Although 2020 showed a reduction of hours, some categories that decreased were still at levels greater than the previous years, such as *fishing* increasing by 78% from 2019, *other not fishing* increasing by 23% from 2018, and *supply vessels* increasing by 55% from 2018 (Figure 4).

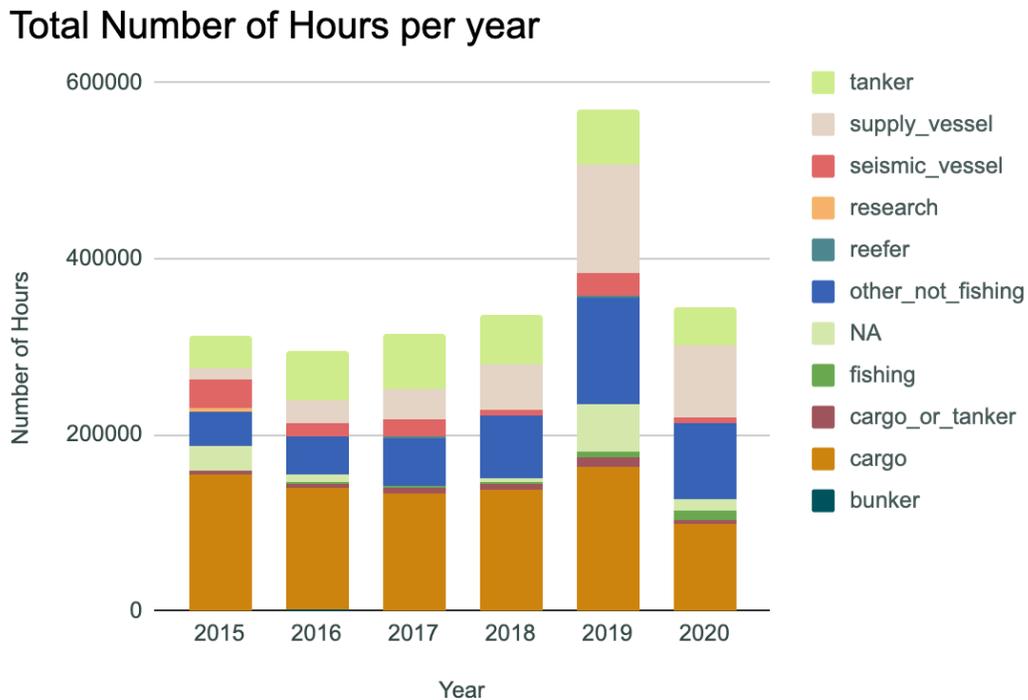


Figure 4. The total number of hours spent by AIS-equipped vessels within the Guyanese EEZ from 2015-2020. Data from Global Fishing Watch.

Cargo vessels displayed a close link between the number of vessels and their activity accounting for 52% of the total number of vessels and 38% of the total number of hours

spent in Guyana's EEZ (Figure 5). The vessel class *other not fishing* made up 8% of the total number of vessels and 19% of the total activity hours. *Supply vessels* accounted for 2% of the total number of vessels but 15% of the total hours spent within the EEZ. *Tankers* accounted for 33% of the number of vessels but only for 15% of the total hours spent (Figure 5).

Total Hours in Operation and Number of Vessels

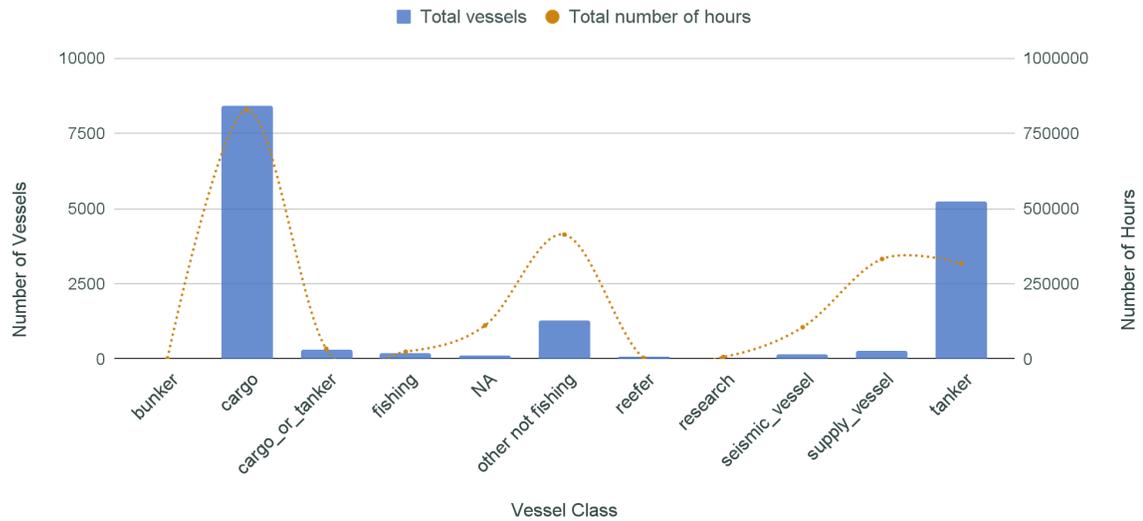


Figure 5: Number of vessels by vessel class, relative to the number of hours spent by each category within the Guyanese EEZ between 2015 and 2020. Data from Global Fishing Watch.

### Flags of Convenience (FOCs)

The number of vessels flagged as FOCs was constant with slight fluctuations up to 2019 before a drop in 2020 (Figure 6 A). As evident from Figure 6 B, hours spent in the EEZ slowly increased from 2015-2018 and then sharply rose in 2019.

FOCs accounted for 56% of the number of vessels in the EEZ, of which 27% were flagged to Panama, 24% to the Marshall Islands, 18% to Liberia, 10% to Malta, and 8% to the Bahamas. The largest number of FOC vessels active in Guyanese waters was seen in 2016 of 1,638 vessels.

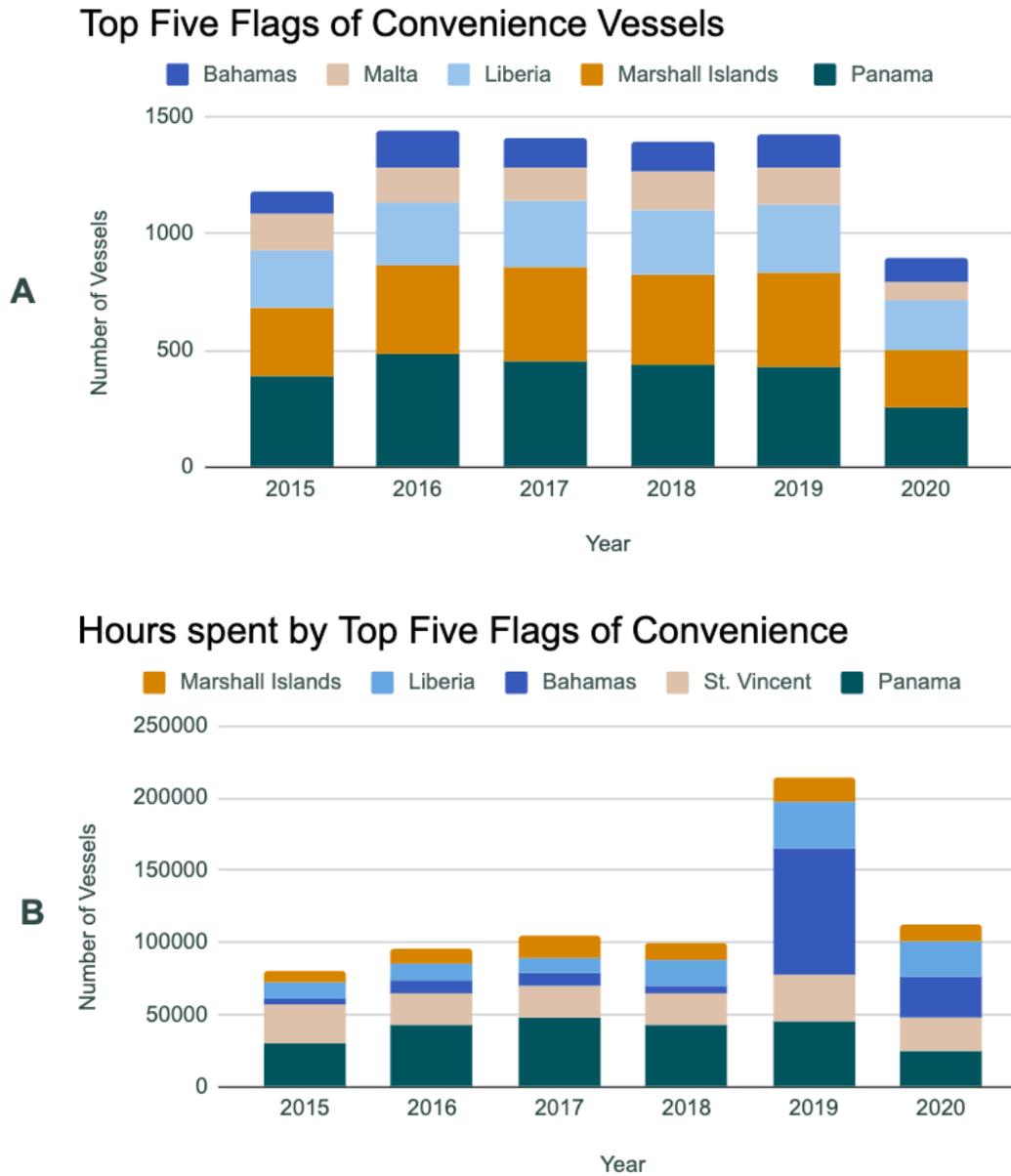


Figure 6 Activity of vessels flying Flags of Convenience (FOCs): Top five FOCs active in the Guyanese EEZ between 2015 and 2020 (A) and top five highest number of hours spent by FOCs (B). Data from Global Fishing Watch.

The five highest FOCs by vessel numbers are mostly reflected in the five FOCs that spent the most hours in Guyana's waters. FOCs accounted for 45% of the number of hours spent in the EEZ, of which 24% were flagged to Panama, 15% to St. Vincent, 14% to the Bahamas, 11% to Liberia and 8% to the Marshall Islands.

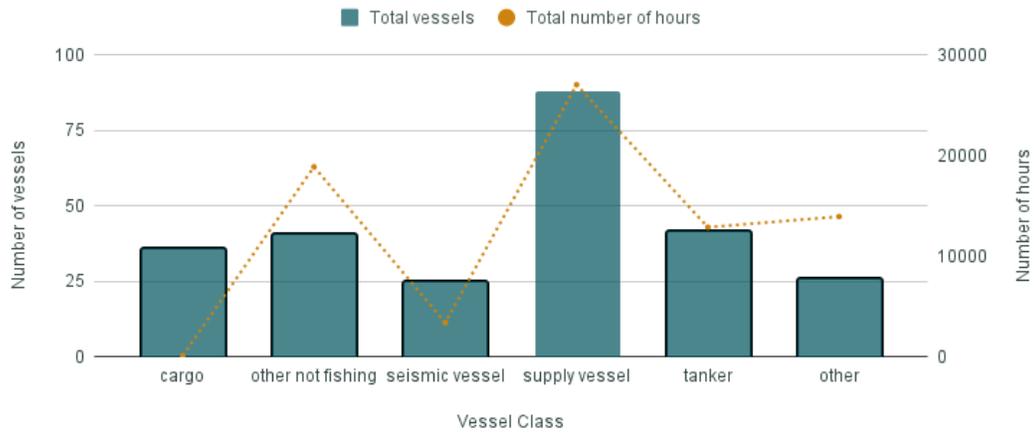
The year when FOCs spent the greatest amount of time was in 2019 with 274,217 hours, which is a 105% increase from the hours spent in 2018.

## Vessel Traffic to and from the FPSO

A subset of vessels was found to regularly visit and service the FPSO located offshore in the Stabroek block (Figure 1). These vessels included the categories *cargo*, *seismic*, *supply* and *tanker*. The categories *other not fishing* and *other* were also observed in the vicinity of the FPSO and were subsequently added to this analysis as some vessel types might have been misclassified (see Table 1 for overview).

**A**

**Total Hours and Vessels to the FPSO by Class**



**B**

**Total Hours and Vessels to the FPSO by Year**

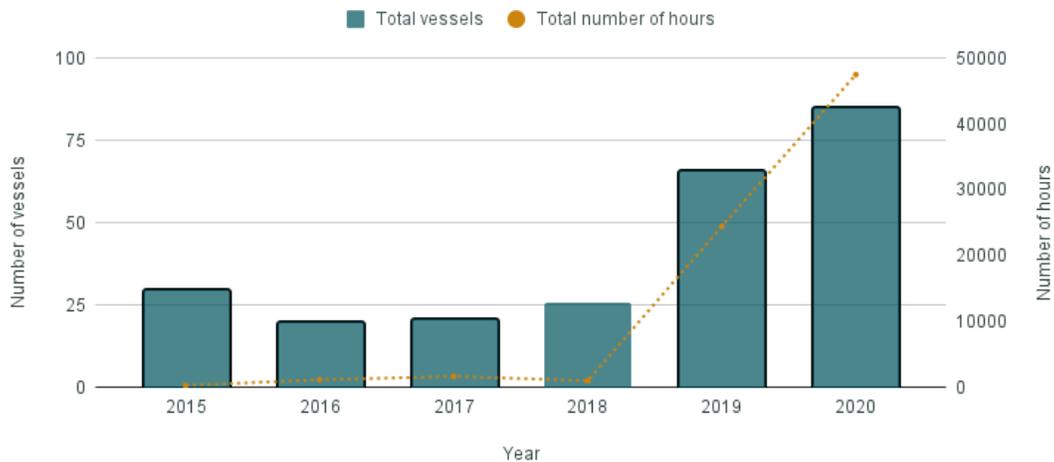


Figure 7 AIS-equipped vessels visiting the Floating Production Storage and Offloading (FPSO) unit: Number of vessels and number of hours spent visiting the FPSO unit according to vessel class type (A) and the number of vessels and number of hours spent visiting the FPSO unit by year (B). Data from Global Fishing Watch.

There was a gradual increase observable in the number of vessels visiting the FPSO from 2016 to 2018 before a rather steep increase of 227% between 2018 and 2020 (Figure 7 B) next to an average percentage increase of 38% in the number of vessels from 2015 to 2020. *Supply vessels* made up the majority of the vessels that visited the FPSO (34% of total). The number of *supply vessels* increased overall by an average of 46% from 2015 to 2020.

Vessels to and from the FPSO Area

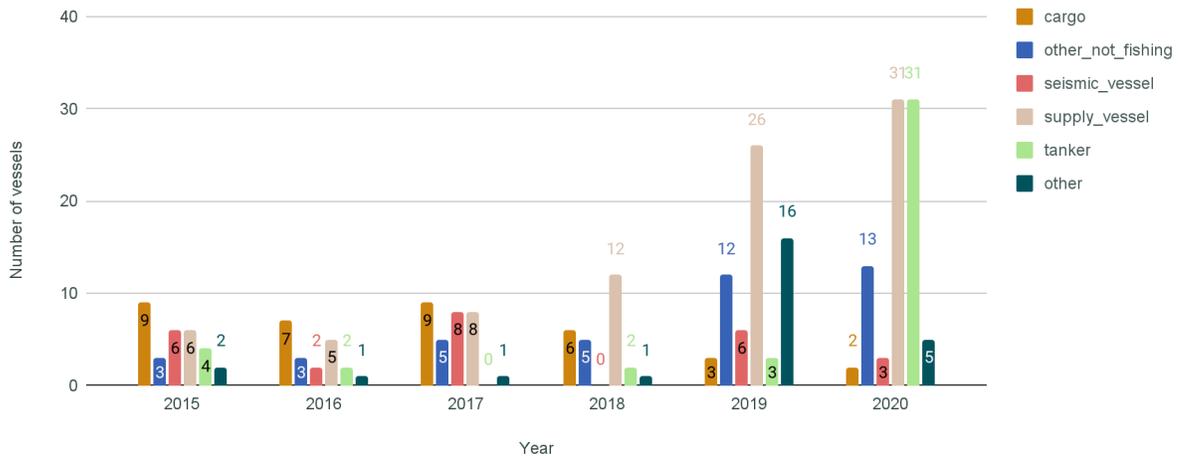


Figure 8 Total number of vessels frequenting the floating production storage and offloading (FPSO) unit from 2015 to 2020. Data from Global Fishing Watch.

### Traffic patterns in the Guyanese EEZ

Over the time period analysed for this report, patterns of vessel traffic and its intensity within the Guyanese EEZ have changed notably, peaking at 87,436 hours of vessel activity (Figure 9). The most obvious change was the increased traffic from Georgetown to the FPSO in the course of the evolving oil business. While barely frequented in 2015, the years 2016 and after, show subsequent increases in vessel traffic (as previously discussed) with a hotspot of vessel activity establishing around the FPSO. The southeastern zone of the Stabroek Block experienced the strongest increases in vessel traffic, while traffic also appeared to have increased further offshore along the perimeter of the EEZ as well as along the shipping routes closer to the coast, especially going northwest to Venezuela and southeast to Suriname.

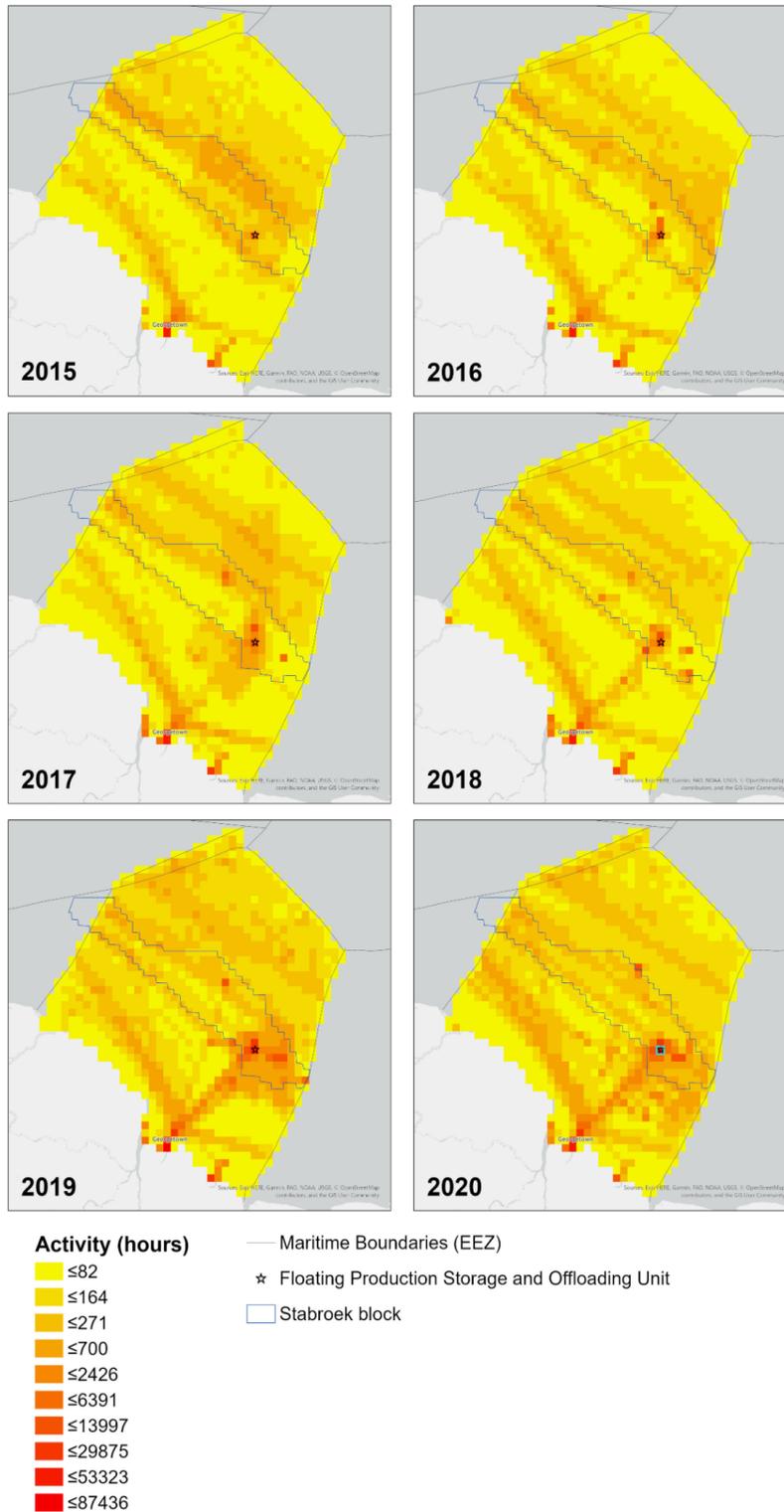


Figure 9: Activity of marine vessels in Guyana's EEZ from 2015 to 2020 on a 0.1 degree grid. The FPSO unit is marked with a star. Data from Global Fishing Watch.

## Discussion

Although Guyana's marine environment has been traversed by ships for centuries, this report provides the first comprehensive overview of recent vessel activity, especially with relation to the growing oil and gas industry in Guyana's EEZ since its discovery in 2015. Assessing 11 main categories of ship types, a general increase in the number of vessels in Guyanese waters was observable over time, peaking in 2019 and dropping in 2020 (Figure 3). The overall increase observed is in line with the developing oil and gas sector while the reduced activity observed in 2020 is very likely connected to travel restrictions due to the COVID-19 pandemic. A similar trend was also seen in the number of vessels and time spent by vessels flying Flags of Convenience (FOCs), peaking in 2019 and dropping by 44% in 2020 (Figure 6). The vessel traffic to the FPSO, however, steadily increased, matching the sudden increase in 2019, and continued the increase in 2020 despite the pandemic (Figure 7 B).

2019 saw an increase in all areas of interest to this report: vessel numbers, number of hours, vessels flying FOCs, oil and gas-related vessels, and traffic to and from the FPSO (Figure 3). It is likely this trend would have continued at similar or potentially intensified levels if not interrupted by the pandemic. While vessels present in the Guyanese EEZ only increased gradually, they were also observed to spend more time in Guyanese waters overall. Regarding this, it is notable that vessels from categories such as *fishing*, *reefer*, *seismic* and *supply vessels* more than doubled their amount of time in Guyanese waters from 2018-2019, an increase likely attributable to the increase in oil and gas vessels visiting the FPSO since production began at the end of 2019 (Figure 8).

However, the increase of 77% in vessels in the *fishing vessels* category from 2019 to 2020 is a point to be noted considering that, while Guyana's fishing industry is growing, the Guyana National Fisherfolk Organisation has revealed that Guyana's fishing industry took a hard hit when the pandemic began in March of 2020 with a 40% reduction reported in catches<sup>5</sup>. Additionally, most of Guyana's fishing vessels do not carry AIS, which means that this data is likely reflective of predominantly foreign fishing vessels and vessels misclassified as fishing vessels. Illegal, Unreported and Unregulated (IUU) fishing is identified as a major threat to world ocean health and multi-dimensional transnational crime problem (Ford et. al, 2018). Research shows links between supply vessels such as cargo vessels and their role in facilitating IUU fishing activities and human trafficking (Ford et al 2018). Whether this is done

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<sup>5</sup> <https://newsroom.gy/2021/06/30/fishermen-report-40-reduction-in-catches-due-to-covid-19/>

knowingly or unintentionally and to what extent is unclear as of yet. While identifying IUU fishing is outside the scope of this report, the growing number of vessels in the *fishing vessels* category warrants further examination for wrongly declared vessel types or actual illegal activity.

The vessels visiting the FPSO had an average overall increase of 40% in 2019 but, unlike the other areas, proceeded to increase by 29% in 2020 (Figure 7 B). This is an indication that, regardless of circumstances such as a global pandemic as well as drastically reduced oil prices in 2020<sup>6</sup>, the activity of Guyana's oil industry seemed to be less heavily impacted than other areas of maritime shipping and transport. Globally nearly 44%<sup>7</sup> of the global ocean showed a decrease in traffic density during April 2020, this was when the strictest confinement measures were implemented and caused a disruption in previous trends and future projections.

*Supply vessels* accounted for only 2% of the total number of vessels visiting Guyana but spent the second-longest amount of time in Guyanese waters (Figure 5), likely caused by loading procedures connected to the FPSO. Next to tanker and bunker ships, vessel types visiting the FPSO included vessels such as exploration and drilling vessels, support vessels, production vessels and construction/special purpose vessels. These offshore supply vessels provide support and are essential for the supply of materials for construction and repair as well as transport of goods and services such as restocking offshore vessels with food and other supplies, as well as catering to changing work shifts and fuel changes.

Additionally, *tankers* made up 32% of the total number of vessels visiting Guyana's EEZ and spent close to the same amount of time that supply vessels did (Figure 5). Tankers transport all kinds of liquified goods in bulk, therefore it can be assumed that the high number of tankers related to vessels transporting the 120,000 barrels produced per day as of March 2021<sup>8</sup>.

The COVID-19 pandemic is linked to a global reduction in marine traffic, however, changes in maritime activities are also influenced by regulations, socioeconomic changes, piracy, environmental changes or cultural and political events (March 2021). For instance, the decreasing oil prices in early 2020 likely resulted in the observed decrease in tanker vessel

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<sup>6</sup> <https://markets.businessinsider.com/commodities/oil-price?type=wti>

<sup>7</sup> <https://www.researchsquare.com/article/rs-47243/v1>

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<https://oilnow.gy/featured/oil-production-will-soon-exceed-1-barrel-per-day-for-every-guyanese-in-country/>

traffic with the drop in oil demand due to the COVID-19 pandemic. Hence Guyana's marine vessel traffic from 2015 to 2020, especially the traffic visiting the FPSO and the outskirts of the EEZ steadily increased until 2019 (Figure 9). The traffic visiting the FPSO, predominantly consisting of supply vessels, was, however, largely unaffected and vessels spent extensive amounts of time traversing between the FPSO and the Georgetown port, a trend likely to continue increasing over time. With increasing numbers especially of oil-related vessels, proper surveillance and monitoring of the marine environment need to be a priority to assess potential impacts such as pollution, ship strikes, underwater noise, and marine mammal interactions.

Next to the oil-related vessel traffic the presence of vessels flagged to certain countries is of note. The International Transport Workers' Federation (ITF) has 35 listed countries that offer FOC registries and in the last five years combined, 22 FOCs made up 56% of the total number of vessels active and 45% of the total hours spent in Guyana's EEZ (Figure 6). Taking a closer look at the data shows the FOCs with the highest number of vessels resemble the FOCs spending the most time in Guyana's waters. Panama had the most number of vessels accounting for 27% of the total FOCs and represented 24% of the number of hours spent by FOCs in Guyana's EEZ (Figure 6). On the other hand, St Vincent had 165 vessels present in the EEZ from 2015 to 2020 but accumulated the second greatest number of hours spent by vessels flying a FOC (7% of the time spent by all vessels). The risks that FOCs present on the marine environment and to human rights violations have been recognised by multiple countries that have taken steps to address FOC registration issues (Lazenby, 1998). For example, Cambodia stopped foreign-owned ships from flying their flag after seeing Cambodian-flagged vessels implicated in illegal fishing activities and drugs and weapons busts in the early 2000s (Kotoski, 2016). The ITF believes there should be a genuine link between the real owner of a vessel and the flag the vessel flies, following the United Nations Convention on the Law of the Sea (UNCLOS). While not all vessels that fly a foreign flag are under a FOC scheme or necessarily involved in dubious activities, FOCs can be an indicator of unreliable marine activity with regards to both environmental safety and basic human and trade union rights (ITF). In the last five years, more than half of Guyana's vessel traffic was made up of FOCs out of which 9% were categorized as *unclassified* (NA) and *other not fishing* vessels. This is alarming since the majority of maritime pollution, particularly oil spills, is caused by tankers registered in open-registries most likely from FOCs (Wang, 2011). As Guyana's relationship with the international maritime community grows it is important to establish and maintain standards of operation for the activities permitted to occur in the Guyanese EEZ. This can include the creation of

lists of substandard flags and ships that will not be granted access to ports or marine space, as has been done in the United States (Hamad, 2016).

## Constraints

Several constraints may have affected this study and the quality of the output and should be noted. These include the inability to verify the AIS data with a local registry which may account for unusually high or low vessel numbers in some categories such as local fishing boats, which largely are not equipped with AIS. Vessels that do not carry AIS, in general, remain effectively unmonitored and unaccounted for, and there is the possibility of vessels turning off their AIS or providing false identities. Therefore, the results compiled may not accurately represent vessel traffic in its entirety (Kroodsmas et al., 2018). Similarly, the misrepresentation of vessels by incorrect classification could have skewed results. Lastly, the reduction in marine vessel traffic during the COVID-19 pandemic hindered the ability to make future projections and did not allow for a specific analysis of the relevant options for mitigating environmental impacts. With resuming vessel traffic in 2021 and beyond, this merits further study.

## Recommendations

Vessel traffic is a major anthropogenic influence on the marine environment and to better understand its impacts a robust monitoring system of vessels and their activity is needed. Greater collaboration and transparency between local agencies and those operating in the marine space is essential for data gathering and law enforcement. Information sharing between stakeholders should be prioritised and made available for public access, especially the research claimed to have been conducted and that will be conducted for the oil sector's EIAs. Through proactive planning for regulating marine traffic, Guyana has the chance to avoid the known detrimental impacts of marine vessels on the environment and local livelihoods.

Based on the results of this initial research further data analyses are needed to examine the vessel types associated with the FOCs spending the most time in Guyana's EEZ. FOC vessels and the practices associated with them need to be scrutinized by the relevant maritime authorities so that they are more aware of the threats that may be posed to our marine environment. Due to increasing vessel traffic at the borders of Guyana's EEZ more research is also needed to better understand which ships are traversing these routes, which

are spending time in the fishing grounds, and other critical areas to determine which areas need priority management, especially with regards to potential IUU fishing.

Lastly, expanded fisheries monitoring is required for the relevant fishery bodies to verify that the vessels classed as fishing vessels are legit and operating properly. Exploring reasons why fishing vessels increased in 2020 by looking at fish market trends and fish exports over time with existing local data is a potentially useful next step. Beginning to track movements and area use of vessels classed as fishing can also provide deeper insight to inform marine management. Furthermore, a greater understanding of the habitat use of fishes and marine mammals such as feeding and breeding areas is essential to create adequate protection for these sensitive habitats. This ultimately has the potential to not only preserve Guyana's marine biodiversity but also potentially positively influence fish catches in the long run. In the event of proven disturbance of these habitats by vessel traffic, this data will be helpful to advocate and plan for relocation or reduction of vessel traffic and the creation of marine protected areas and/or no-take zones.

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