Global Fishing Watch

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Fishing activity and vessel traffic near Tristan da Cunha

A use case of Global Fishing Watch Marine Manager

Global Fishing Watch

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Caveats and disclaimer

The designations employed in this publication and the presentation of material therein do not imply the expression of any opinion whatsoever on the part of Global Fishing Watch concerning the legal status of any country, area or territory or of its authorities.

Definition of apparent fishing effort: Any and all references to "fishing" should be understood in the context of Global Fishing Watch's fishing detection algorithm, which is a best effort to determine "apparent fishing effort" based on data from the automatic identification system (AIS) collected via satellites and terrestrial receivers. As AIS data varies in completeness, accuracy and quality, it is possible that some fishing effort is not identified and conversely, that some fishing effort identified is not fishing. For these reasons, Global Fishing Watch qualifies all designations of vessel fishing effort, including synonyms of the term "fishing effort," such as "fishing" or "fishing activity," as "apparent," rather than certain.

AIS Methodology: The AIS broadcasts a ship's position so that other ships are aware of its location, in order to avoid collision. The International Maritime Organization (IMO) started to mandate the use of AIS on vessels larger than 300 gross tonnes that travel internationally under the 2002 International Convention for the Safety of Life at Sea.

The key factors that affect the completeness and accuracy of footprints derived from AIS analysis are its use and reception. AIS must be installed and broadcast in order to be detected. AIS reception is a measure of how likely it is for a vessel's AIS message to be received correctly by the existing network of satellites and terrestrial antennas placed along the world's coastlines. In regions of the world with high maritime traffic, AIS signals can interfere with each other, which reduces reliable satellite reception.

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Executive Summary

The archipelago of Tristan da Cunha, in the middle of the South Atlantic Ocean, is home to the world's most remote community and a rich diversity of marine species. In November 2020, the government of Tristan da Cunha announced the establishment of a marine protection zone (MPZ), excluding fishing activity from 90 percent of its exclusive economic zone (EEZ), and creating the largest fully protected MPZ in the Atlantic.

Management of the MPZ is not without challenges. Trans-Atlantic shipping lanes pass through Tristan's EEZ, and while fishing vessels are now excluded from the MPZ, high densities of longline vessels fish in adjacent waters. Global Fishing Watch Marine Manager is a dynamic technology portal designed to make actionable information on human activity and environmental data available to managers of marine protected areas. In this report we aimed to demonstrate the utility of the marine manager portal by applying Global Fishing Watch data to three management use cases for Tristan da Cunha.

Due to its remoteness and proximity to shipping lanes, Tristan da Cunha is particularly vulnerable to the environmental impacts of ships running aground, as the MS Oliva did in 2011, and the subsequent pollution that this can cause. In April 2020, the areas to be avoided (ATBA) were established as a 25 nautical mile recommended exclusion zone around each island for vessels transiting through the area. Between April 1, 2020 and June 30, 2021, a total of 123 vessels were detected making 125 transits through the ATBA using automatic identification system (AIS) vessel detections. These vessels, made up of mostly cargo vessels or squid jigger fishing vessels, were associated with 19 flags; China, Liberia, and Panama being the most common. To aid communication of the presence of the ATBA to relevant vessel operators, we identified the most common ports of origin and destination for transiting vessels, with Singapore and Puerto Ingeniero White, Argentina, most frequently visited. We also identified notable gaps in AIS transmission by fishing vessels in the area, to provide an insight into potential transits through the ATBA that may have gone undetected.

Tristan da Cunha is home to tens of millions of seabirds, the conservation of which, with support from the Royal Society for the Protection of Birds, is a key management priority. The critically endangered Tristan albatross, endemic to Gough Island, are in decline as a consequence of bycatch in longline fisheries and predation by invasive mice. Longline fishing vessels are required by the International Commission for the Conservation of Atlantic Tuna (ICCAT) to use bycatch mitigation measures while operating near Tristan da Cunha, and vessels registered with the Commission for the Conservation of Southern Bluefin Tuna (CCSBT) are also required to adhere to these requirements while operating within the ICCAT area. However, monitoring how effectively these measures are being deployed is challenging due to the long periods spent at sea by longline vessels. One of the most effective mitigation measures for albatross species is setting longlines at night, when albatross are less active. In this report, we applied a dataset developed by Global Fishing Watch to identify where and when longlines were set to explore if and how effectively night-setting has been used as a mitigation measure. We found that longline fishing vessels operating near Tristan da Cunha, including the vessels fishing closest to Gough Island, predominantly set longlines during the day. Furthermore, the majority of sets occurred over dawn, when albatross are most active and bycatch risk is highest. In compliance with ICCAT and CCSBT requirements, these vessels should therefore be using alternative mitigation measures, including weighted lines, bird-scaring lines, or hook-shielding devices, as night-setting has not been effectively used to date to reduce albatross bycatch risk near Tristan da Cunha.

Longline fisheries have the largest global footprint of any fishing activity, and these vessels are extremely active near Tristan da Cunha's EEZ, targeting a range of species including southern bluefin tuna. Globally, fisheries catches are predicted to shift polewards this century as a result of climate change, and high seas fishing activity is likely to follow. The waters around Tristan da Cunha are predicted to remain most suitable for southern bluefin tuna, while habitat suitability for other tuna species is predicted to increase only slightly. To understand the scale and distribution of longline fishing activity near Tristan da Cunha, and how this might change in the future, we analyzed the last six years of Global Fishing Watch data to identify recent trends in longline activity to the north and south of Tristan. Fishing activity to the north includes a larger number of vessels and flags, while fishing to the south is carried out by a smaller number of mostly Japanese and Korean-flagged fishing vessels. There is a clearly defined seasonality in both areas, with fishing activity peaking between April and July each year, which coincides with declining sea temperatures. Declining activity in the southern fishing area is closely mirrored by a reported decline in southern bluefin tuna catch, as per CCSBT. Tristan da Cunha represents an important conservation area for the near threatened blue shark. Spanish-flagged longline vessels reportedly catch more blue sharks than any other species, according to ICCAT-reported catch data, but there is no sign of these vessels fishing closer to Tristan, and fishing activity by Spanish-flagged vessels has generally declined to the north of Tristan's waters.

While the marine manager portal allows managers to analyse long-term trends in fishing activity and environmental data, in some cases the portal can also highlight potential incidences of illegal, unreported, and unregulated fishing. In this case, the portal was used to highlight seven squid jigger fishing vessels which entered Tristan da Cunha's EEZ on May 21, 2021, while transiting across the South Atlantic. Overnight, while inside Tristan's EEZ, these vessels appeared to slow and drift in unison. This activity was identified as potential fishing activity by the Global Fishing Watch fishing detection algorithms, and furthermore, based on satellite imagery, these vessels appeared to use bright lights at night, typical of fishing for squid. This information was communicated to the UK Marine Management Organisation, which has continued the investigation.

Introduction

The British overseas territory of Tristan da Cunha is situated in the South Atlantic Ocean, more than 2,400 km from its nearest neighbour, Saint Helena, and over 2,700 km west of Cape Town, South Africa. Travel to this small group of volcanic islands is only possible by sea, with passage from South Africa taking several days.

The archipelago is home to important populations of seabirds, including the endangered northern rockhopper penguins (*Eudyptes crestatus*), where 99 percent of the global population breed, and the critically endangered Tristan albatross (*Diomedea dabbenena*), which are endemic to Gough Island. The surrounding waters include dense kelp forests and have been recognised as important habitats for several shark species, including the near threatened blue shark (*Prionace glauca*). Residents of Tristan da Cunha operate a Marine Stewardship Council-certified fishery for Tristan rock lobster (*Jasus tristani*) which is exported around the world.

In November 2020, the government of Tristan da Cunha announced the establishment of the marine protection zone (MPZ) as part of the UK's [Blue Belt Programme](), which aims to protect more than 4 million square km of the world's oceans. The MPZ, covering 90 percent of Tristan da Cunha's exclusive economic zone and an area more than 687,000 square km, represents the [largest fully protected marine reserve]() in the Atlantic (figure 1). With the exception of a small area reserved for the residents of Tristan da Cunha to fish for lobster, all fishing is prohibited within the MPZ.

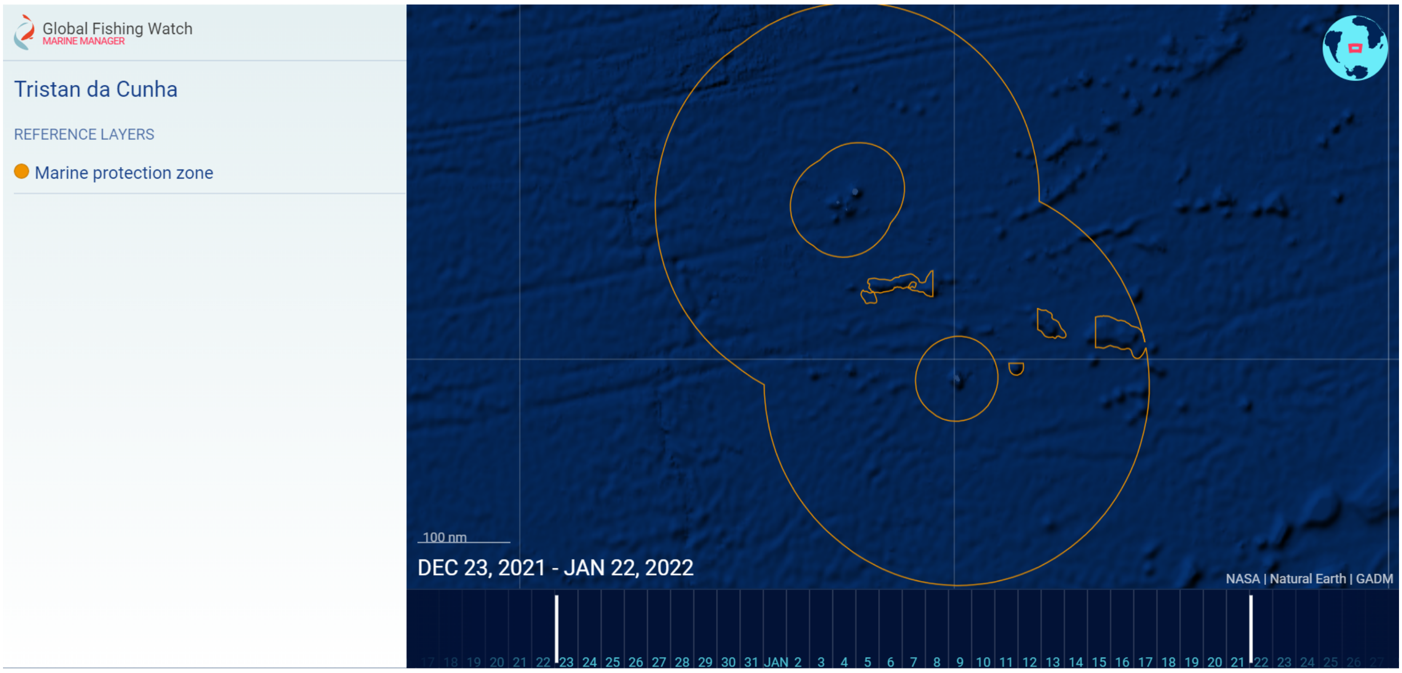

Figure 1: The marine protection zone (orange) of Tristan da Cunha. Link to marine manager workspace [here]().

Management of such a remote area is not without challenges. Despite its remote location, the archipelago is adjacent to major shipping lanes for vessels transiting across the South Atlantic, and high densities of cargo vessels pass close to each of the islands. This creates a risk of vessels running aground, and the remoteness of the archipelago makes containing the pollution caused by a grounded ship extremely challenging logistically. When the MS Oliva ran aground on Nightingale Island in 2011, more than 300,000 gallons of oil were spilled and thousands of rockhopper penguins were affected. This event highlighted the unique vulnerability of Tristan da Cunha's marine life to pollution such as this. As commercial shipping continues to grow, managing marine traffic in such a remote territory presents a unique challenge.

The endemic population of Tristan albatross is in decline, primarily due to predation by invasive species of mice and bycatch in longline fisheries. Bycatch in longline fisheries is recognised as a major threat to seabird species worldwide, and albatross species, which are long-lived and relatively slow to reproduce, have proven to be particularly vulnerable (Phillips et al., 2016). While longline fishing is prohibited within Tristan da Cunha's MPZ, albatross are far-ranging seabirds and longline fishing is widespread throughout the Southern Atlantic. Many regional fisheries management organisations require vessels to use bycatch mitigation measures to reduce the risk of seabird bycatch, but monitoring compliance is challenging. Understanding how effectively these mitigation measures are being implemented and where and when albatross are likely to interact with vessels is key to understanding the pressure that bycatch may currently be placing on Tristan albatross.

Many of these longline vessels target tuna. The waters around Tristan da Cunha are suitable for a number of tuna species, especially southern bluefin (Townhill et al., 2021). However, as climate change leads to warmer sea temperatures, the global distribution of fish species is predicted to shift polewards (Erauskin-Extramiana et al., 2019; Poloczanska et al., 2013). Understanding the scale and recent trends in longline fishing activity near Tristan da Cunha's MPZ is key to understanding how this activity might change in the future, particularly as it relates to bycatch of species such as the Tristan albatross, and the importance of the MPZ as a refuge for targeted marine species.

Addressing these management challenges requires access to leading edge environmental and human activity data, to enable managers to make the most informed decisions possible. Global Fishing Watch Marine Manager is a dynamic technology portal created to help transform the management of marine protected areas (MPAs), from data collection through implementation. The portal aims to make diverse ocean datasets accessible and translated into actionable information for decision-making. The marine manager portal is designed to empower managers and stakeholders to rapidly collate, assess, and analyse scientific data integral to the governance of marine reserves, along with other management frameworks including MPAs and other area-based conservation measures.

In this report we aim to demonstrate the utility of the marine manager portal to Tristan da Cunha by using Global Fishing Watch data to provide new insights into three management use cases. Namely, these analyses will focus on:

1. Vessel traffic through the designated areas to be avoided around Tristan da Cunha
2. The use of night-setting in longliners as a mitigation measure for bycatch of Tristan albatross
3. Trends in the distribution and activity of longliner vessels operating near Tristan da Cunha

Each analysis will provide actionable information for the managers of Tristan da Cunha's waters, and though not the primary purpose of the marine manager portal, we will also demonstrate the potential of marine manager to promote ocean transparency and in some cases detect potential incidences of illegal, unregulated, or unreported fishing activity.

1. Compliance with Tristan da Cunha's Areas to be Avoided

Background

On March 16, 2011, the bulk carrier MS Oliva, en route from Brazil to Singapore, ran aground at Spinners Point on Nightingale Island. Soon afterwards, the vessel broke apart, spilling more than 300,000 gallons of oil and contaminating thousands of northern rockhopper penguins. The remoteness of Tristan da Cunha made mounting a rapid, large-scale containment logistically impossible. This event highlighted the elevated risk of environmental incidents due to the remoteness of Tristan da Cunha and its proximity to major shipping channels across the South Atlantic. To reduce the risk of another ship running aground, in April 2020 the government implemented a 25 nautical mile suggested exclusion zone around each island within the archipelago, and designated these as areas to be avoided (ATBA). Vessels greater than 400 gross tonnage (gt) are requested to avoid the ATBA while transiting through the area.

The Blue Belt Programme is an initiative by the UK government to support British Overseas Territories with the protection and sustainable management of their marine environments. As part of this program, the UK Marine Management Organisation (MMO) has been providing support to Tristan da Cunha by detecting transits through the ATBA and coordinating efforts to communicate the presence of the ATBA to relevant flag states and vessel operators.

Through consultation with the MMO, we identified a number of complementary analyses that could add value to the ongoing monitoring of the ATBA. To that end, we analysed a global dataset of automatic identification system (AIS) transmissions to:

1. Quantify transits through the ATBA
2. Provide a port-to-port track analysis of transiting vessels to identify which port authorities to prioritise in communicating the ATBA
3. Identify gaps in AIS transmission by fishing vessels potentially related to suspected disabling of AIS devices during transits

Methods

Transits through the areas to be avoided

For this analysis we included all AIS-transmitted vessel locations between -20° and 0° longitude, -50° and -30° latitude, from Jan. 1, 2019 to June 30, 2021 (figure 2). This time range included comparable periods of 15 months before and after the implementation of the ATBA.

We defined a transit as a vessel moving through the ATBA without slowing below 0.2 knots. This low, non-zero, speed threshold is used to identify vessels that have likely stopped, but may be not perfectly stationary, as the vessel may swing on an anchorage for example. If a vessel exited and re-entered the ATBA seven or more days later, then each entry was counted as a separate transit. Only transits with at least one location transmitted from within the ATBA were included in the analysis.

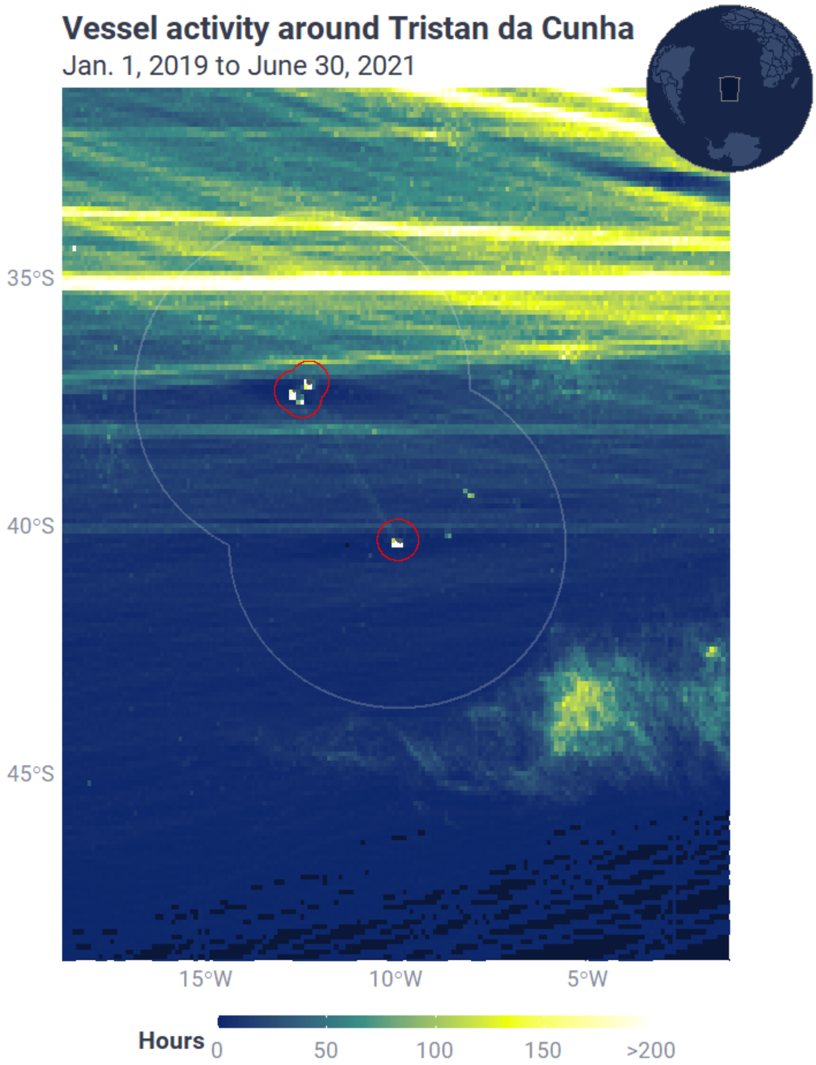

Figure 2: Vessel activity around Tristan da Cunha from Jan. 01, 2019 to June 30, 2021. Lighter areas indicated higher densities of vessel activity.

Port to port tracking

In order to effectively communicate the presence of the ATBA to relevant vessel operators, it is useful to know which ports the vessels were most frequently travelling from and to when they transited through the ATBA. To this end, we analysed the port to port tracks of transiting vessels, and identified the port of origin and destination of each vessel as it transited through the ATBA.

Global Fishing Watch have developed a global dataset of port locations by first identifying every anchorage location on a global grid (approximately 0.5 km^2 resolution) where at least 20 individual vessels remained stationary between 2012 and 2020 (see Kroodsma et al. 2018). Each of these locations is named from a combination of the World Port Index, Geonames 1000 database—the most commonly listed destination field according to AIS—or manual review. Where multiple ports shared the same name but had multiple sets of latitude and longitude coordinates (a result of multiple anchorage locations clustered together), these locations were considered a single port and the latitude and longitude coordinates were averaged.

We considered a vessel to have visited a port if the vessel:

1. Entered port (vessel within 3 km of port)

2. Was stationary (speed less than 0.2 knots) or stopped transmitting its location for more than 4 hours
3. Exited port (vessel more than 4 km from port)

The use of different distance thresholds for identifying a port entry and exit prevents vessels anchored at a single point of entry/exit from being labelled as repeatedly entering and exiting a port. Only port visits including each of these events in the correct order were included in the analysis. It is important to consider that this is a relatively conservative method of identifying port visits as, for example, port visits from vessels that stop transmitting long before entering port may not be detected. However, loosening these criteria increases the risk of falsely identifying port visits where vessels have merely transited nearby.

Gaps in AIS transmission

Detecting transits through the ATBA is largely dependent on vessels regularly transmitting their locations. To understand how gaps in AIS transmission may affect our ability to detect transiting vessels, we used a dataset of suspected AIS disabling events. The methodology is currently under peer review, but in short, this dataset applies a classification model to gap events longer than 12 hours to identify suspected disabling of AIS devices. Gap events shorter than 12 hours were excluded as satellite coverage can vary substantially over shorter periods of time. This model accounts for the quality of satellite reception, the location and duration of a gap event, and the rate of AIS transmission before and after the gap occurred.

For Tristan da Cunha, we looked at AIS gap events of 12 hours or more by fishing vessels within the area between -25° and 5° longitude, and -25° and -50° latitude. As the model was developed for detecting deliberate AIS disabling by fishing vessels, this dataset currently excludes non-fishing vessels.

Results

Transits through the areas to be avoided

Following the implementation of the ATBA in April 2020, there was an immediate decrease in activity by vessels greater than 400 gross tons within the area, which increased again in September 2020 (figure 3). A similar trend can be seen the previous year, with vessel traffic at its lowest between April and August before again increasing in September 2019 (figure 3).

In the 12 months before the implementation of the ATBA, from April 1, 2019 to Mar 31, 2020, 305 vessels greater than 400 gross tons made a total of 328 transits through the area. In the 12 months after the ATBA was implemented, from April 1, 2020 to Mar 31, 2021, these numbers declined to 104 vessels making 104 transits. As can be seen in figure 4, some transiting vessels passed close to shore, with two vessels passing less than 5km from shore at their closest point, and one vessel passing within approximately 5km of the site where the MS Oliva ran aground.

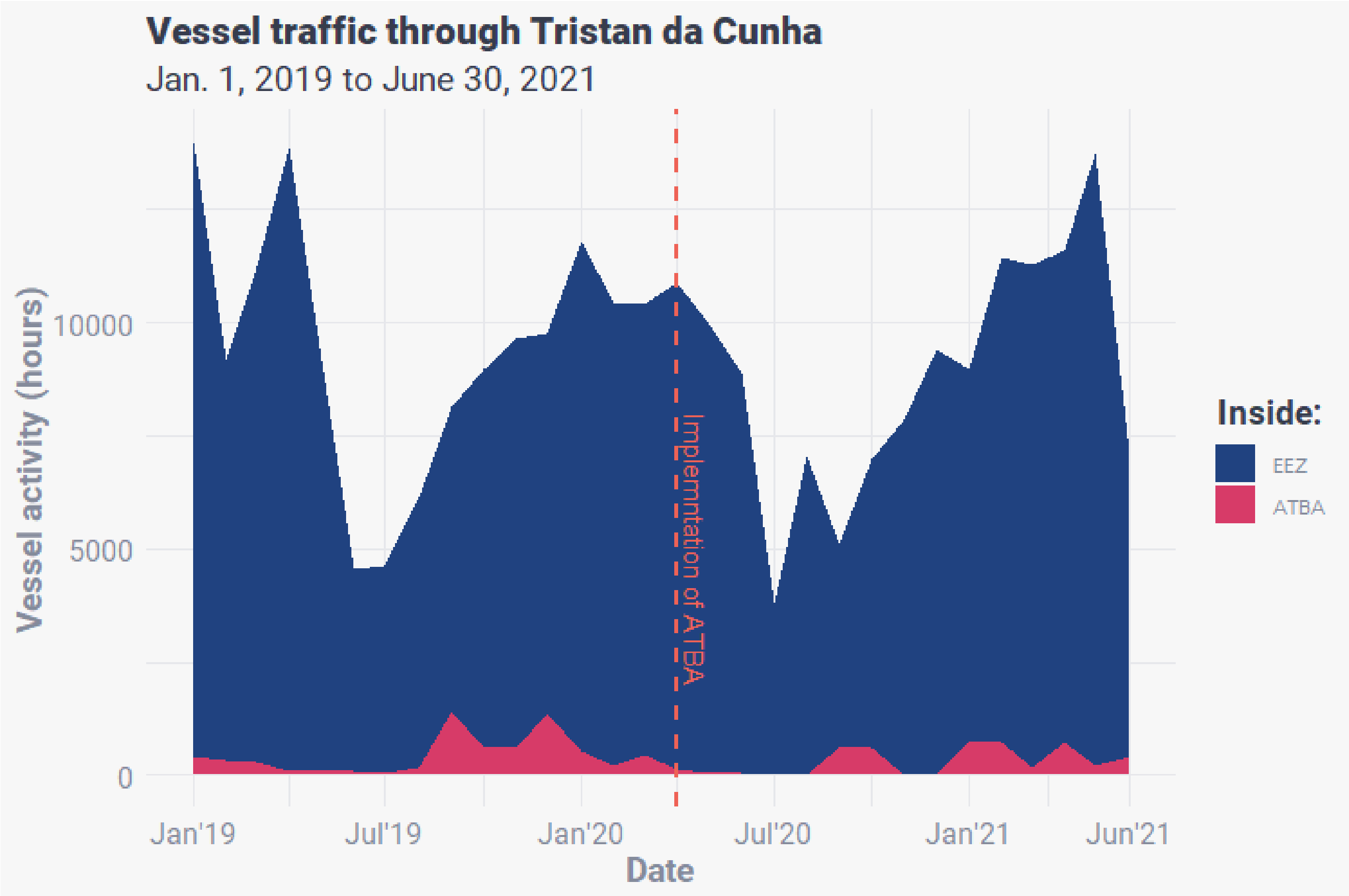

Figure 3: Hours spent by vessels greater than 400 gross tonnage inside the exclusive economic zone (EEZ) and areas to be avoided (ATBA) between Jan. 1, 2019 and June 30, 2021.

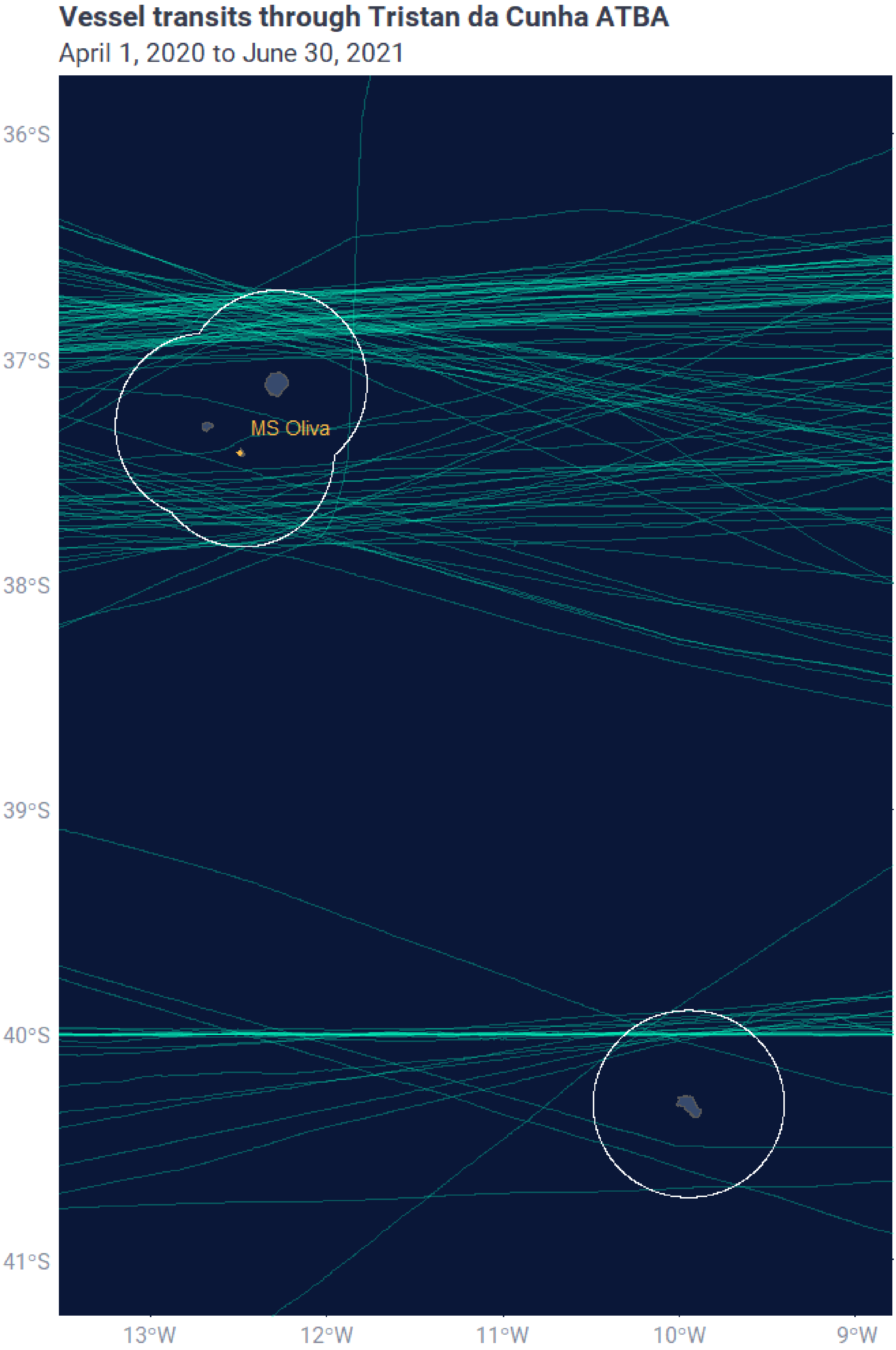

Figure 4: Tracks of vessels over 400 gross tonnage transiting through the Tristan da Cunha's Areas to be Avoided, without slowing below 0.2 knots, from 1 April 2020 to 30 June 2021, after the ATBA was implemented. The location where the MS Oliva ran aground is indicated by the orange point.

Between April 1, 2020, when the ATBA was first implemented, and June 30, 2021, 125 transits were detected by 123 vessels in total through the ATBA. Vessels flagged to China made the most transits with 31, followed by vessels flagged to Panama (23), Liberia (16), Hong Kong (14), and Malaysia (14; figure 5). Out of 125 transits, 90 were by vessels identified by Global Fishing Watch as cargo vessels, and 20 transits were by squid jigger fishing vessels. As figure 6 shows, squid jigger vessels flagged to China transited through the ATBA while moving between fishing grounds in the eastern Pacific off South America and the western Pacific. See Appendix A for a full list of vessels that transited through the ATBA.

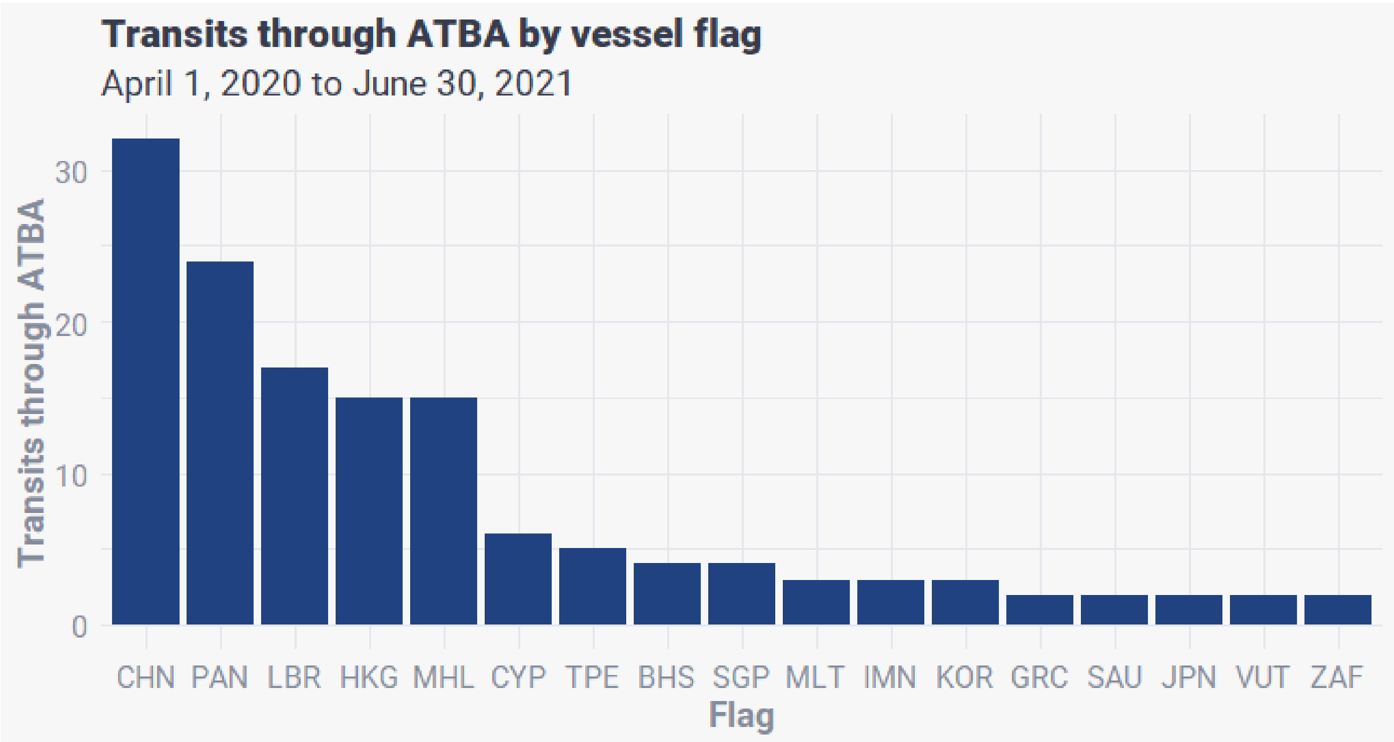

Figure 5: Number of transits through the ATBA by vessels greater than 400 gross tons per vessel flag between April 1, 2020 and June 30, 2021.

Figure 6: Examples of tracks from Chinese squid jigger vessels transiting through the ATBA between April 1, 2020 and June 30, 2021. Yellow points indicate locations of apparent fishing activity.

It is difficult to quantify the effect of the ATBA in reducing vessel traffic through the area as the implementation of the ATBA coincided with the onset of the COVID-19 pandemic, which led to an unprecedented decline in global shipping traffic (Millefiori et al., 2021). When comparing the 12 months before and after the implementation of the ATBA, the observed declines in vessel traffic through the ATBA are reflected in overall declines in traffic through the EEZ (table 1). While it is encouraging that vessel traffic through the ATBA has reduced since its implementation, further data collection and analysis will be required to determine the effectiveness of the regulation in reducing traffic through the area.

Table 1: Summary of total vessel traffic in hours and number of transits through the EEZ and ATBA of Tristan da Cunha in the 12 months before and after the ATBA was first implemented on April 1, 2020.

		1 April 2019 - 31 March 2020	1 April 2020 - 31 March 2021	Percentage change
Total vessel hours	EEZ	17924	7205	-57.9 %
	ATBA	5754	3107	-45.7 %
Number of transits	EEZ	344	112	-64.9 %
	ATBA	340	103	-67.5 %

Port to port tracking

Figure 7 shows the locations of all ports visited by vessels before and after transiting through the ATBA, and figure 8 lists the ten most visited ports in order of how many transits began and/or ended there (see Appendix B for a full list of ports visited by transiting vessels). Transiting vessels visited a total of 64 different ports before and after transiting through the ATBA. Many of these were located in South America and Asia (figure 7). Singapore was the most common port of destination and most frequently visited port overall, and Puerto Ingeniero White in Argentina was the most common port of origin and second-most frequently visited port overall (figure 8).

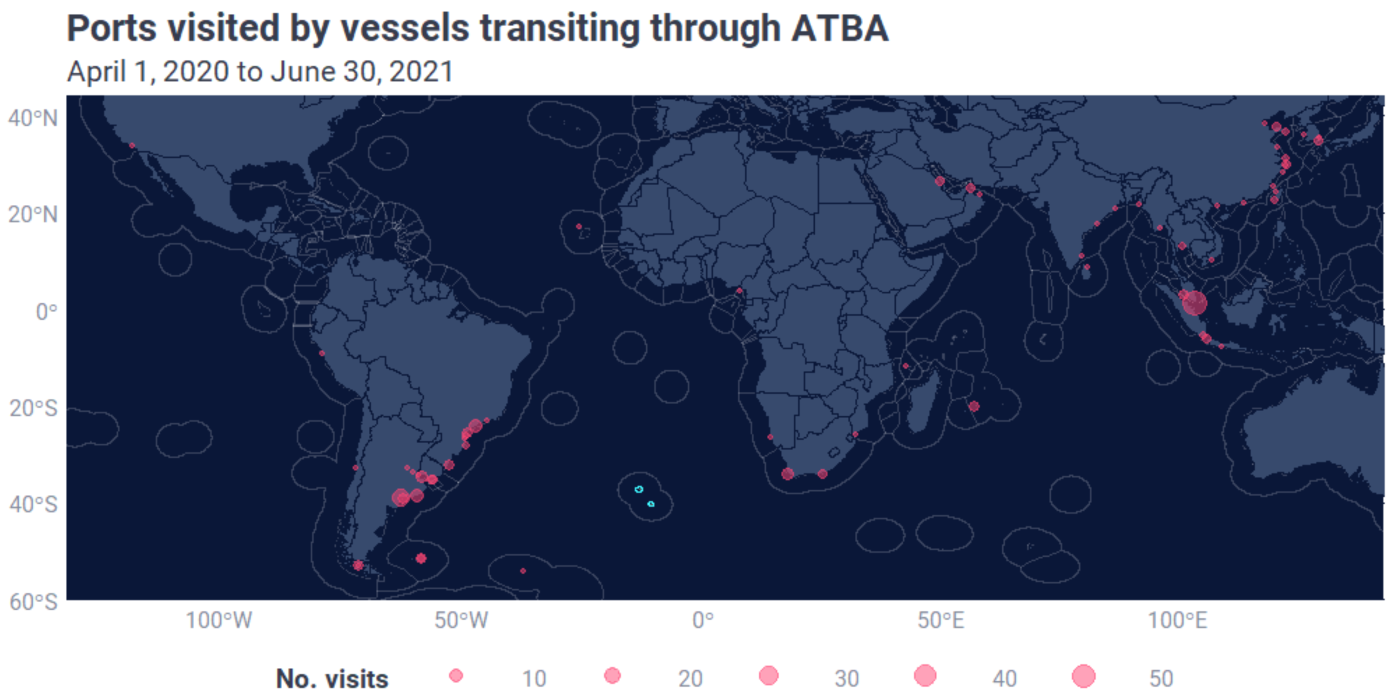

Figure 7: Map of ports visited by vessels before and after transiting through the ATBA (shown in light blue) between April 1, 2020 and June 30, 2021. Pink points indicate the location of ports visited and the size of points is scaled by the number of visits.

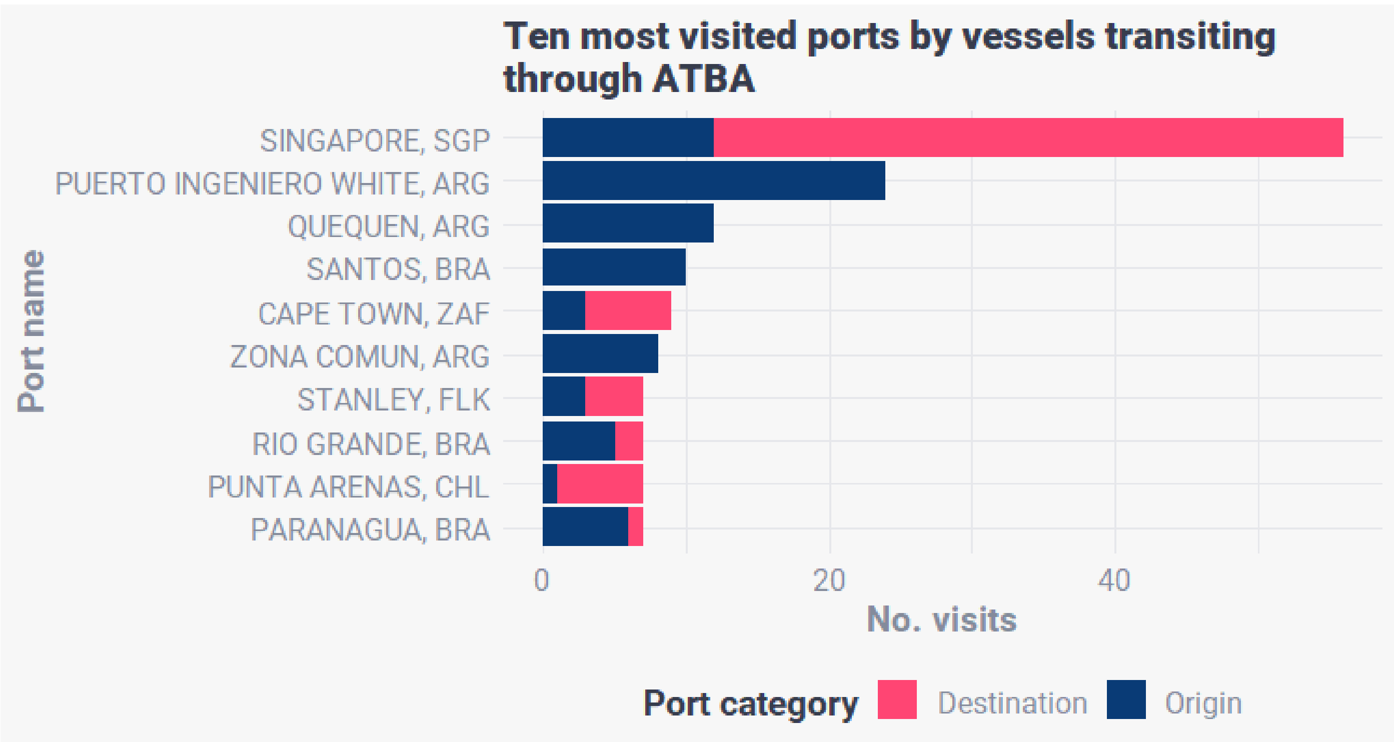

Figure 8: The ten ports visited most frequently by vessels before and after transiting through the ATBA of Tristan da Cunha between April 1, 2020 and June 30, 2021.

Gaps in AIS transmission

Between Jan. 1, 2019 and June 30, 2021, a total of 128 gap events by 41 fishing vessels were detected near Tristan da Cunha. The median duration of these gaps was 32 hours, and 16 gaps were longer than one week. The majority of gap events occurred on longliners flagged to Chinese Taipei and Spain (figure 9), most of which started and ended outside of Tristan's EEZ. A number of AIS gap events started or ended within Tristan's EEZ, or the straight line interpolation between start and end crossed the EEZ. These gaps belonged to squid jigger vessels flagged to China and Chinese Taipei, some of which stopped transmitting in close proximity to the northern ATBA (figure 10). When we look at the extended tracks of these vessels, AIS gaps are reasonably regular as the vessels cross the Indian and south Atlantic Oceans, which does not suggest that these vessels are disproportionately disabling their AIS devices near Tristan (figure 11).

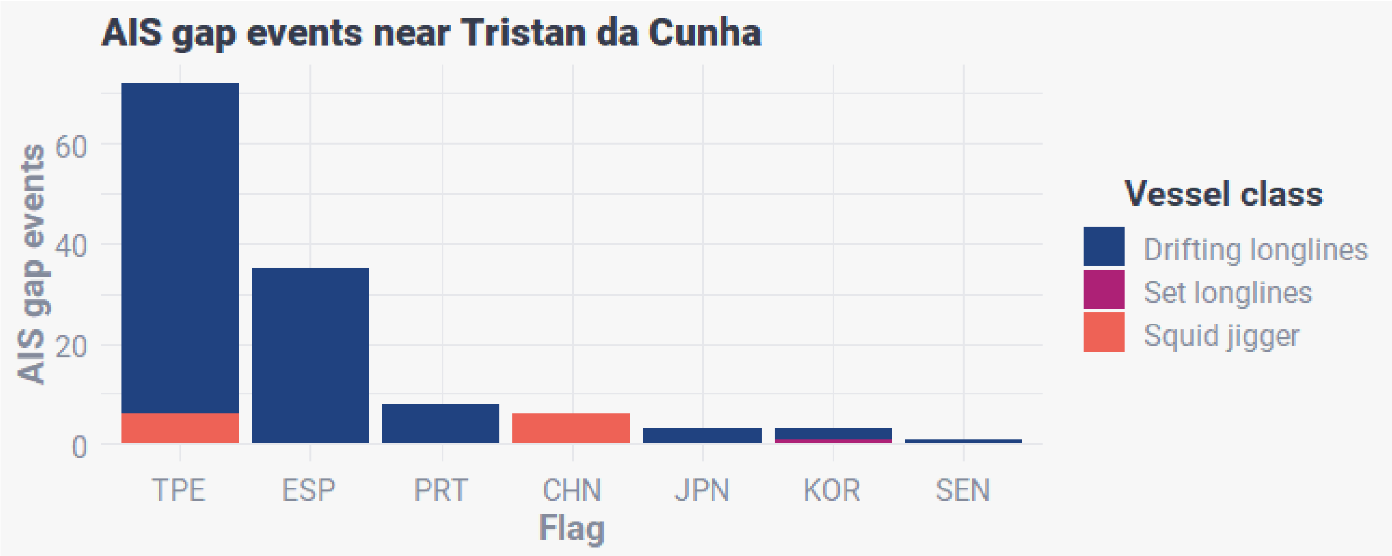

Figure 9: Number of AIS gap events of more than 12 hours linked to suspected disabling of AIS devices by fishing vessels belonging to each flag state near Tristan da Cunha between Jan. 1, 2019 and June 30, 2021.

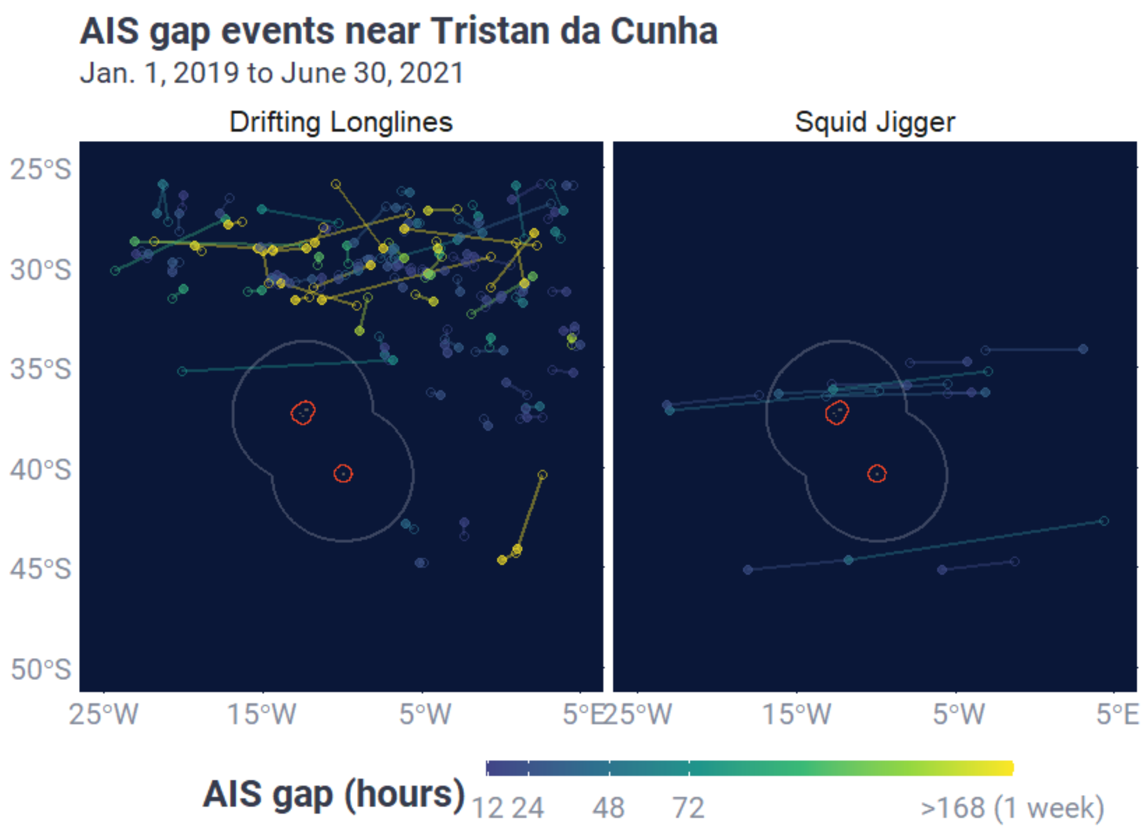

Figure 10: Gaps in automatic identification system (AIS) transmission, by drifting longliners and squid jigger vessels linked to suspected disabling of AIS devices near Tristan da Cunha between Jan. 1, 2019 and June 30, 2021. Solid circles indicate the location where a vessel stopped transmitting, and empty circles indicate

the locations where vessels resumed transmissions. The white line indicates the boundary of Tristan da Cunha's exclusive economic zone and the red line delineates the areas to be avoided.

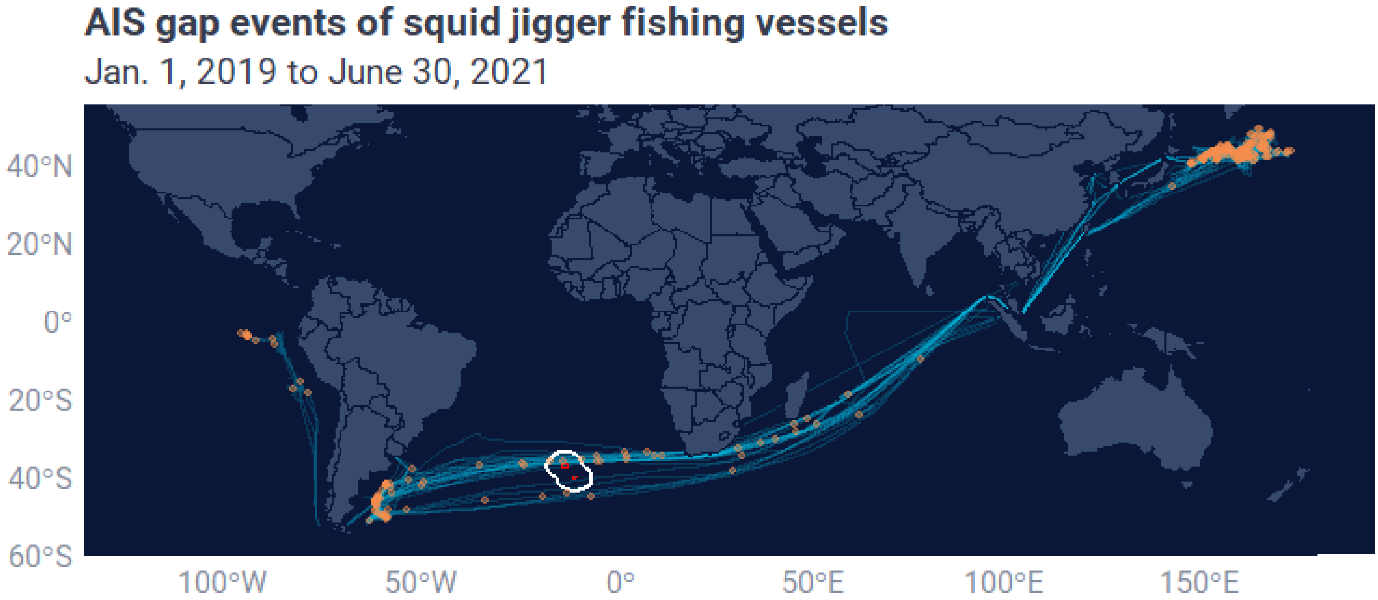

Figure 11: Gaps in automatic identification system (AIS) transmission by squid jigger fishing vessels potentially linked to suspected disabling of AIS devices between Jan. 1, 2019 and June 30, 2021 (orange dots). Each of the vessels had a gap event within approximately 500 nautical miles of Tristan da Cunha's exclusive economic zone (white line). The red line delineates Tristan da Cunha's areas to be avoided.

Conclusion

Between April 1, 2020, when the ATBA was first implemented, and June 30, 2021, a total of 123 vessels were detected making 125 transits through the ATBA. The majority of these vessels were identified as cargo vessels or squid jigger fishing vessels, and China, Liberia, and Panama were the three flags most frequently associated with transiting vessels. Vessels visited a total of 64 ports before and after transiting through the ATBA, with Singapore and Puerto Ingeniero White, Argentina being the most frequently visited ports. A total of 128 gaps in AIS transmission of 12 hours or more by 41 fishing vessels were detected near Tristan da Cunha between Jan. 1, 2019 and June 30, 2021. The majority of these gaps were associated with longline fishing vessels operating to the north of Tristan da Cunha, but 12 gaps were associated with Chinese squid jigger vessels transiting through the area, some of which occurred close to the ATBA. Continued data collection and analysis is required to determine the effectiveness of the ATBA in reducing vessel traffic through the area.

2. The use of night-setting as a mitigation measure for Tristan albatross bycatch

Background

The critically endangered Tristan albatross (*Diomedea dabbenena*) is endemic to Gough Island, and has a decreasing population of fewer than 5,000 individuals (BirdLife International 2018). The two major threats they face are predation by invasive mice (Jones et al., 2019; Wanless et al., 2009), and bycatch in longline fisheries.

This analysis aims to provide an assessment of bycatch risk for Tristan albatross from longliners operating near Tristan da Cunha. By applying machine learning algorithms to automatic identification system (AIS) data, Global Fishing Watch can identify the fishing activity of all AIS-using vessels in near real time. Furthermore, we have recently developed an improved algorithm for longline fishing vessels, which can differentiate between setting and hauling activity in longline fishing.

The risk of seabird bycatch is highest in longline fisheries while longlines are being set, as birds are attracted to sinking baited hooks. Longline fishing vessels operating south of -25° latitude within the International Commission for the Conservation of Atlantic Tuna (ICCAT) Convention Area, which includes Tristan da Cunha, are required to deploy at least two mitigation measures against seabird bycatch, and vessels registered with the Commission for the Conservation of southern bluefin tuna (CCSBT) are also required to adhere to these requirements while operating within the ICCAT area. These mitigation measures include bird-scaring lines, weighted branch lines, and setting lines at night. Night-setting has proven especially effective for albatross species which are inactive at night (Jiménez et al., 2020; Phalan et al., 2007). However, monitoring the use of night-setting as a mitigation measure has, to-date, been impossible without on-board observers or electronic monitoring. In this analysis, we apply a newly developed dataset of longline fishing activity to determine when and where longlines have been set near Tristan da Cunha and assess if and to what extent night-setting is being used to mitigate Tristan albatross bycatch.

Methods

Global Fishing Watch, in collaboration with Birdlife International, has developed a machine learning model to differentiate the stages of longline fishing activity into “setting”, “hauling”, and “other”. This model, which is currently being prepared for peer review, was applied to the global pelagic longline fleet. The model is estimated to predict 90% of start and end times of setting events to within 2 hours of actual start and end times. Therefore, for the purpose of this analysis, all longline setting events which overlapped with nautical dawn or dusk by 2 hours or less were considered to be set at night. A similar methodology was used to show that the level of night-setting in a subset of longline fishing vessels was significantly lower than what was reported (Winnard et al. 2018).

First, we considered all longlines set throughout the South Atlantic, defined here as the area between -69.7° and 25.0° longitude, and -23.0° and -62.3° latitude, from Jan. 1, 2019 to June 30, 2021, to gain an insight into where and when longlines were set, how many were set during the day or night, and which flags were making the most use of night-setting. Next, we focused this analysis on longline activity in the high seas closest to Gough Island, where 99% of Tristan albatross breed, to identify when bycatch risk was highest in this area and explore the prevalence of night-setting as a mitigation measure in vessels with a high likelihood of encountering Tristan albatross.

Albatross predominantly forage during the day, with flight activity peaking at dawn (Pajot et al., 2021; Phalan et al., 2007). This is the period when albatross bycatch risk is highest for longline fishing. To understand the potential for increased bycatch risk for Tristan albatross, we looked at the timing of setting within the area of interest in relation to the timing of nautical dawn.

Results

Night-setting in the South Atlantic

Within the South Atlantic, 274 longliners belonging to 17 flags deployed nearly 29,685 potential sets between Jan. 1, 2019 and June 30, 2021 (figure 12). Of these, 75% (22,318) were set mostly during the day, and 25% (7,367) were set mostly at night. The total number of sets per month typically peaked between April and June (figure 13) and the vessels flagged to Chinese Taipei, Spain, and Japan deployed the most sets across the South Atlantic (figure 14). Of the ten flags responsible for the majority (96%) of longlines set in the South Atlantic, only vessels flagged to South Africa and Brazil deployed at least half of their sets at night, suggesting that most of vessels are utilizing other mitigation measures or are potentially not complying with regulations, which would lead to a higher risk of albatross bycatch.

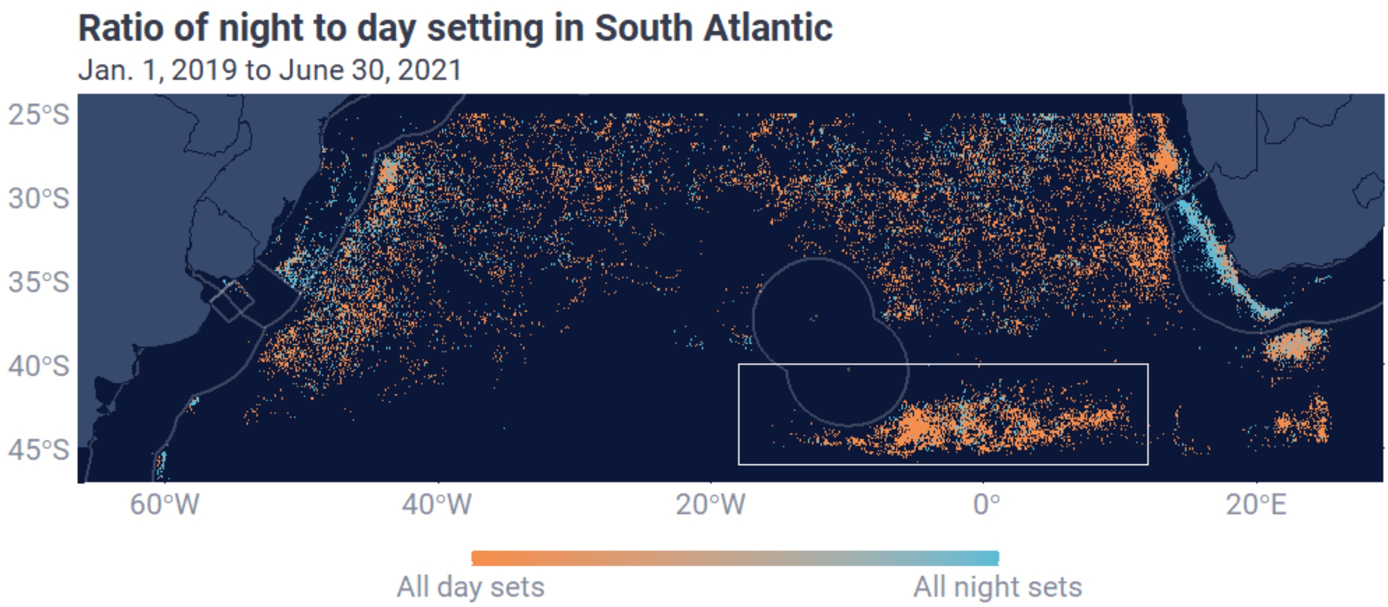

Figure 12: Locations of longline sets (at 1/10th of a degree resolution), coloured by the proportion of sets at that location that were deployed mostly during the day or mostly at night. The white box shows an area of high longline fishing activity southeast of Gough Island.

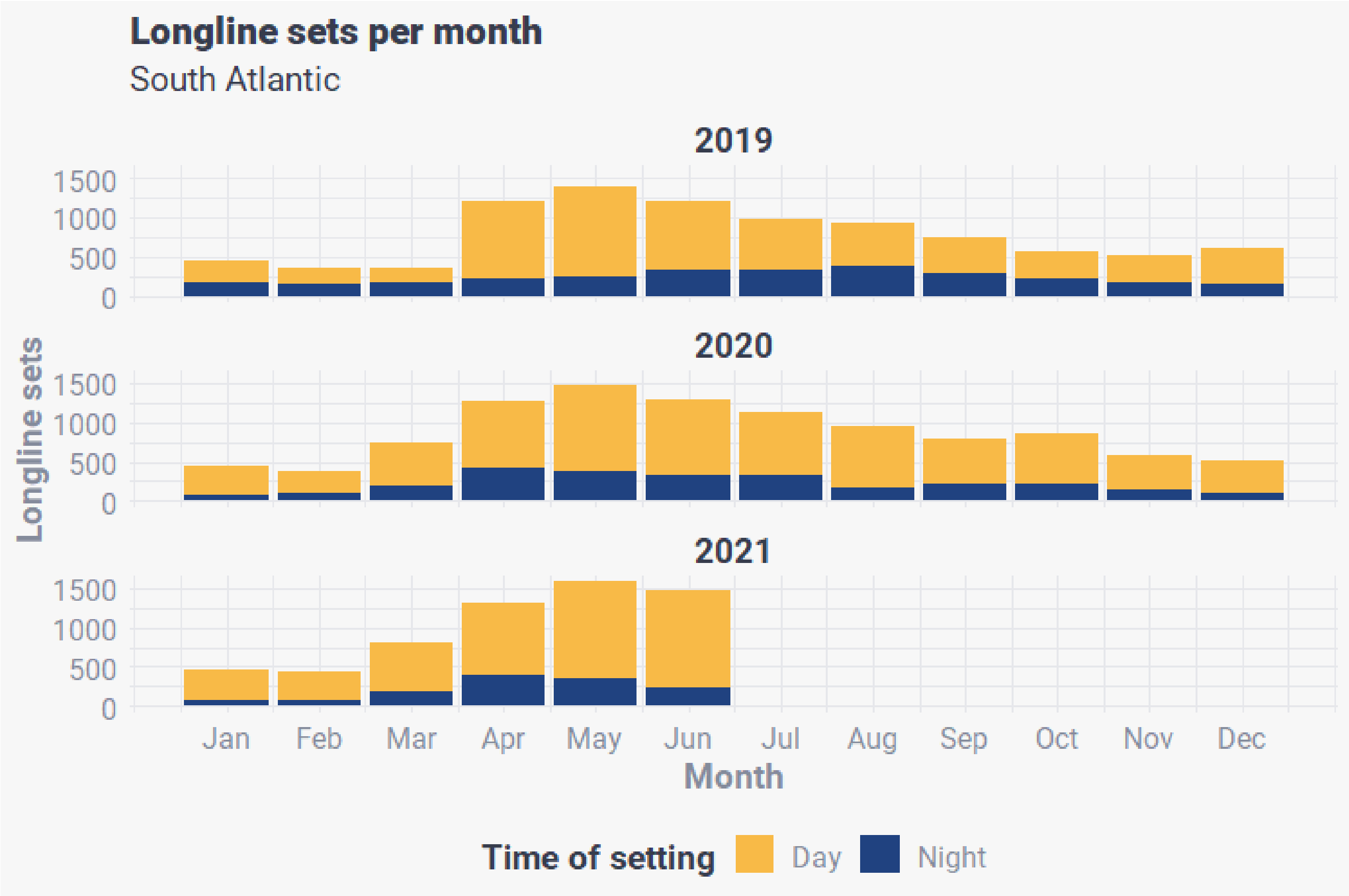

Figure 13: Total number of longlines set during the day, or at night, per month within the South Atlantic region between Jan. 1, 2019 and June 30, 2021.

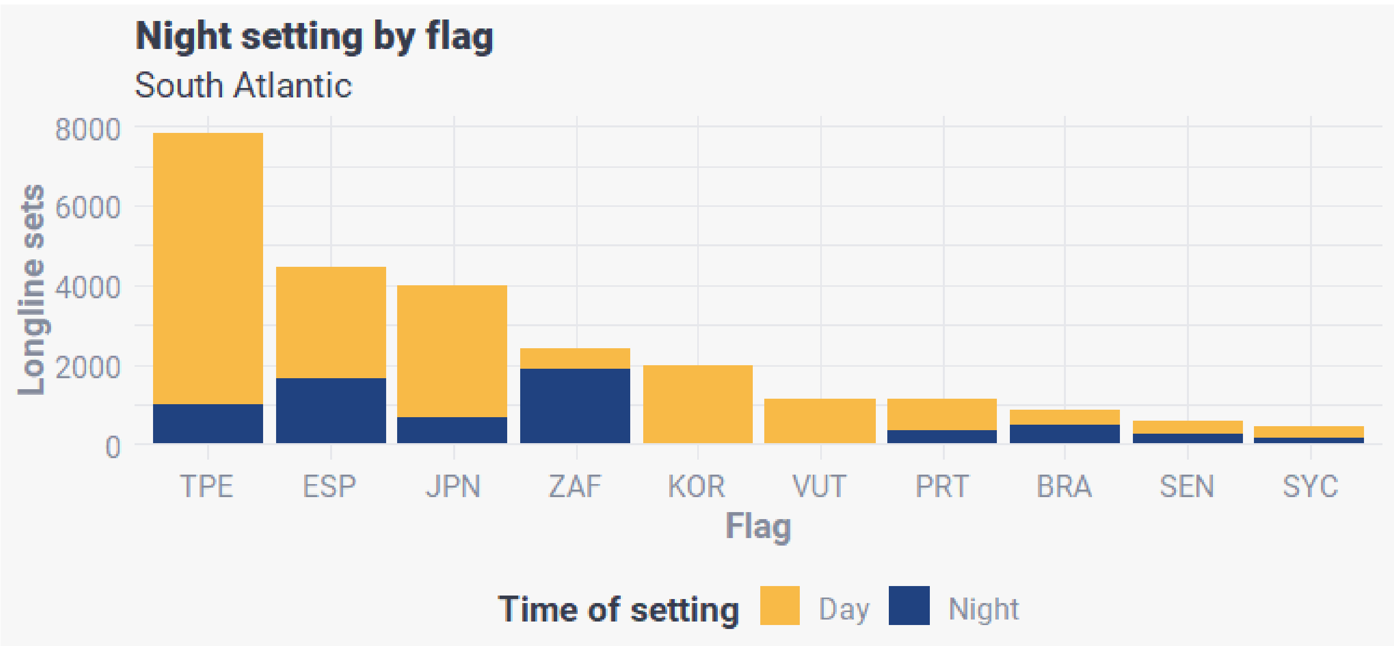

Figure 14: Total number of longlines deployed during the day, or at night, by vessels belonging to the 10 flags responsible for the most longlines deployed in the South Atlantic region between Jan. 1, 2019 and June 30, 2021.

Night-setting in the high seas near Gough Island

Figure 12 shows the distribution of longline sets within the South Atlantic, highlighting a high level of activity to the south east of Tristan da Cunha's EEZ. Given the proximity of this activity to Gough Island, where 99% of Tristan albatross breeding occurs, we focused on this area to identify vessel activity with a potentially high risk of bycatch for Tristan albatross.

Like many species of albatross, Tristan albatross breed every second year, if successful in fledging a chick. Breeding adults typically return to Gough Island in November and December, lay eggs in January, and chicks fledge in November (BirdLife International 2022). This means that throughout the year there will typically be a cohort of breeding albatross making return trips to and from Gough Island, to take turns incubating eggs and feeding the chicks. As we can see in figure 15, longline fishing activity to the southeast of Gough Island peaked between April and June each year, with little to no fishing occurring between September and February. As non-breeding albatross will typically range farther than breeders (Cuthbert et al., 2005; Reid et al., 2013), and chicks won't fledge until after the apparent fishing season, bycatch risk is potentially highest for breeding adult albatross in this area.

While longliner activity across the South Atlantic involved vessels belonging to 17 flags, longliners operating to the southeast of Gough Island were almost exclusively flagged to Japan and Korea (figure 16). Of the 43 longliners active in this area between Jan. 1, 2019 and June 30, 2020, 31 were flagged to Japan, 10 to Korea, one to China, and one to Spain. Figure 17 shows the distribution of longline sets by Japanese and Korean flagged vessels across the Southern Atlantic, and clearly demonstrates that this area to the southeast of Gough Island represents the main Atlantic fishing ground targeted by these fleets.

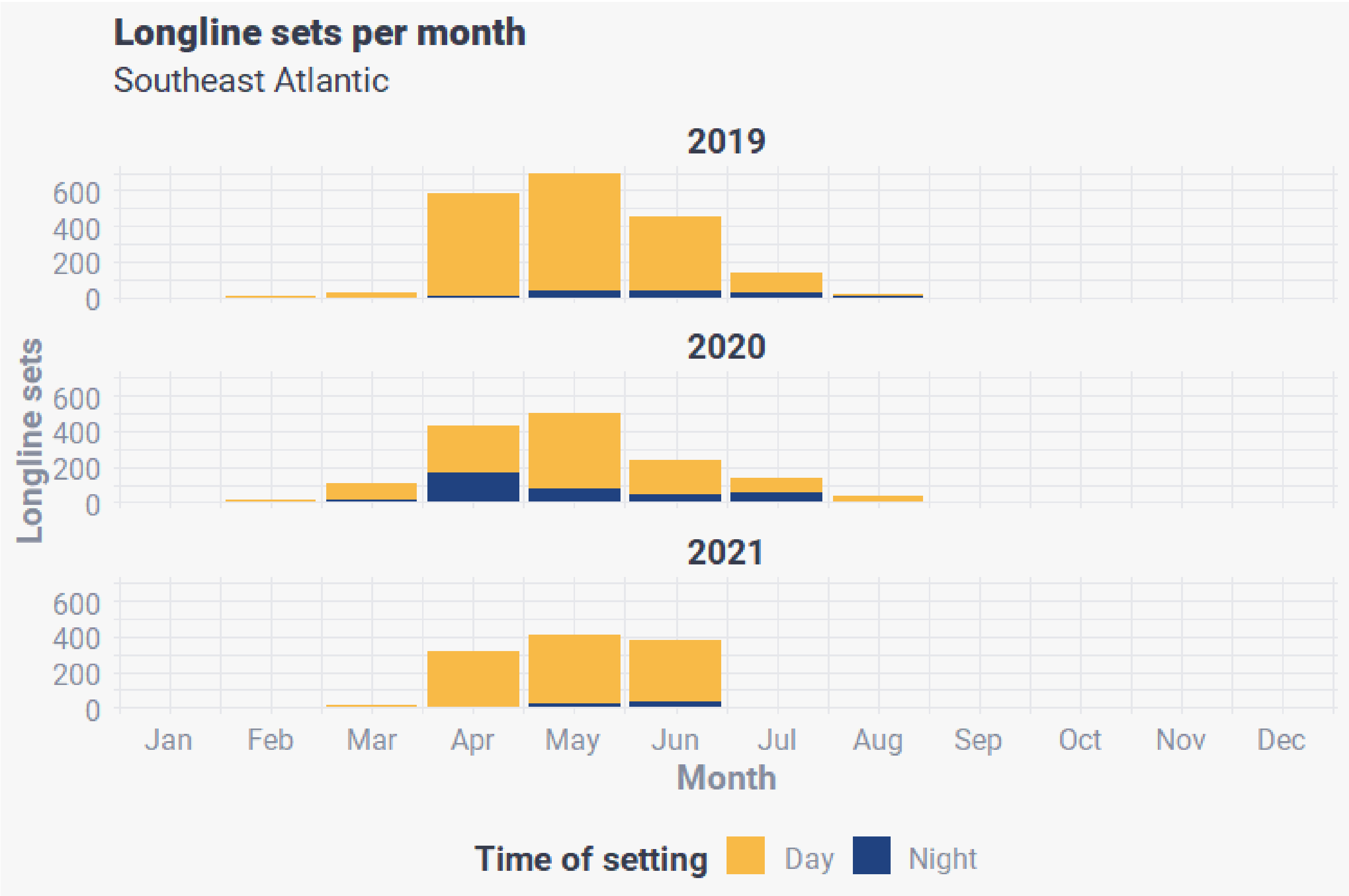

Figure 15: Longline sets deployed within the area of interest each month between Jan. 1, 2019 and June 30, 2021, colored by longlines set mostly during the day and mostly at night.

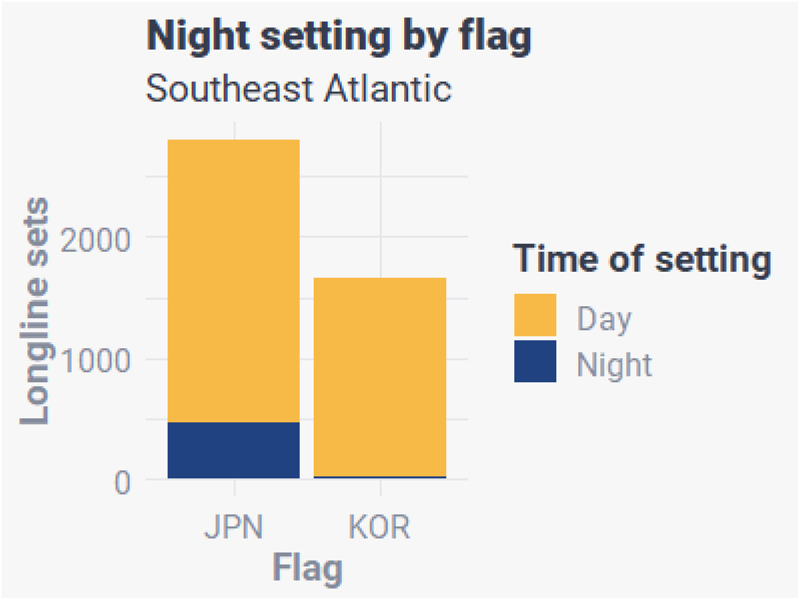

Figure 16: Longline sets deployed within the AOI by Japanese and Korean flagged vessels between Jan. 1, 2019 and June 30, 2021, colored by longlines set during the day and at night.

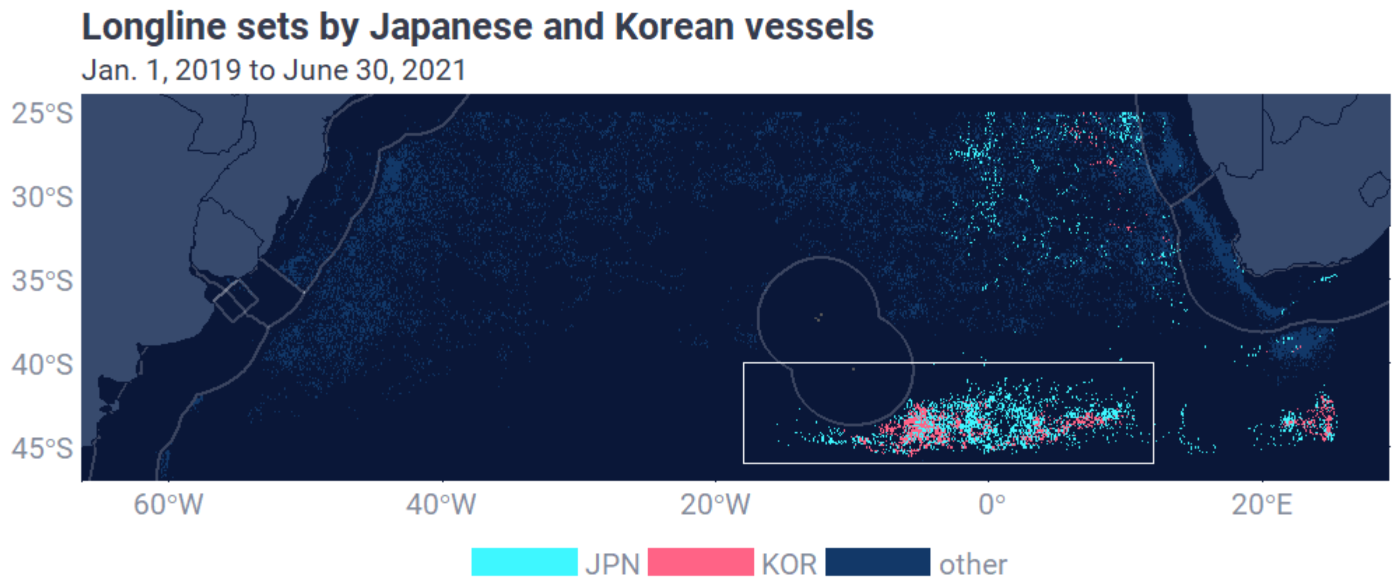

Figure 17: Locations of longline sets (at 1/10th of a degree resolution) by Japanese and Korean longliner vessels between Jan. 1, 2019 and June 30, 2021. The white box delineates our area of interest.

Setting over dawn

As figure 18 shows, the majority of longlines were set at or just before nautical dawn and continued well into daylight hours. This is precisely the period when bycatch risk is highest for Tristan albatross (Pajot et al., 2021; Phalan et al., 2007), highlighting the importance of additional bycatch mitigation measures.

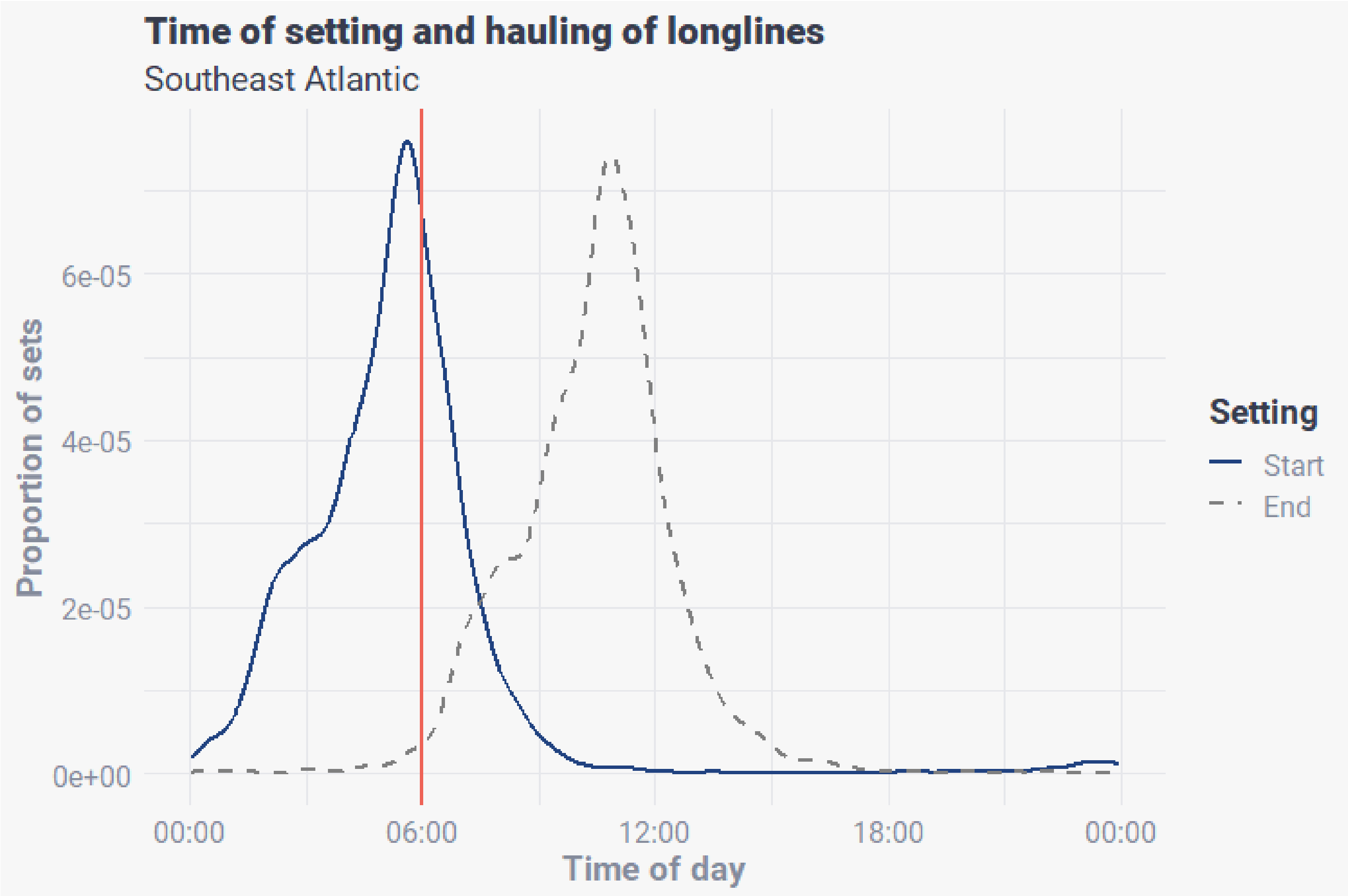

Figure 18: The time of day that the setting of longlines started (solid blue) and ended (broken grey) within the area of interest, southeast of Gough Island, between Jan. 1, 2019 and June 30, 2021. The orange vertical line indicates the mean time of nautical dawn when setting activity took place.

Conclusion

Bycatch in longline fisheries is one of the primary threats facing the critically endangered Tristan albatross. Setting longlines at night has the potential to significantly reduce bycatch risk for this species, yet throughout the South Atlantic—and particularly in the longline fisheries that operate closest to Gough Island—the majority of longlines have been set during the day. Furthermore, most setting occurs over the dawn period when albatross are most active and bycatch risk is highest. Therefore it is essential that these vessels are adhering to ICCAT and CCSBT regulations and are effectively deploying alternative bycatch mitigation measures, including weighted branch-lines, bird-scaring lines, and/or hook-shielding devices.

Japanese vessels reportedly use weighted branch-lines in combination with bird-scaring lines most often, with other vessels using bird-scaring lines in combination with night-setting until one hour before dawn, and bird-scaring lines with weighted branch lines thereafter. However, according to the most recent report from the CCSBT Compliance Committee, about 50% of observed effort by Japanese vessels in 2020 used only a single bycatch mitigation measure in areas where two or more were required. This was an improvement from 2019 when 71.5% of observed effort used only a single mitigation measure where two were required. There is also a lack of clarity regarding how effectively reported night-setting has been used, as the CCSBT Secretariat recently advised that it will contact members to confirm if reported night-setting means that the entire set was conducted at night. To reduce bycatch risk for Tristan albatross it is important to know what mitigation measures are being used while fishing in the ICCAT/CCSBT overlap area. If night-setting has been used as a lone mitigation measure and setting activity has continued into daylight hours, then this is unlikely to be effective in mitigating bycatch risk for Tristan albatross, and may even inflate bycatch risk during the dawn period.

Korea reports that their longline vessels use bird-scaring lines and weighted branch lines as seabird bycatch mitigation measures, and their use is monitored by on-board observers and electronic reporting. Due to the Covid-19 pandemic, Korean vessels carried no observers in 2020 or 2021. Considering that Korean vessels set almost all of their longlines during the day while operating near Gough Island, improving observer coverage on these vessels, along with greater transparency on mitigation measures being used is a priority to ensure that measures are being used effectively to mitigate bycatch risk for Tristan albatross.

Based on the results of this analysis, a potential next step would be to submit an information request to ICCAT and CCSBT, to seek clarity on:

1. What mitigation measures have been used by longline vessels in the ICCAT-CCSBT overlap area?
2. When night-setting has been reported, does this include only longlines set entirely at night?
3. Whether observer coverage on vessels operating near Gough Island can be increased as a priority?

3. Inter-annual trends in the distribution of tuna fisheries

Background

Longline fishing has the largest spatial footprint of any fishing gear (Kroodsma et al., 2018). The Global Fishing Watch map shows that longliner activity is ubiquitous across the South Atlantic, between the equator and approximately 45°S (figure 19). Many of these vessels target a range of tuna species, including bigeye tuna (*Thunnus obesus*), albacore (*T. alalunga*), yellowfin tuna (*T. albacares*), skipjack tuna (*Katsuwonus pelamis*) and southern bluefin tuna (*T. maccoyii*).

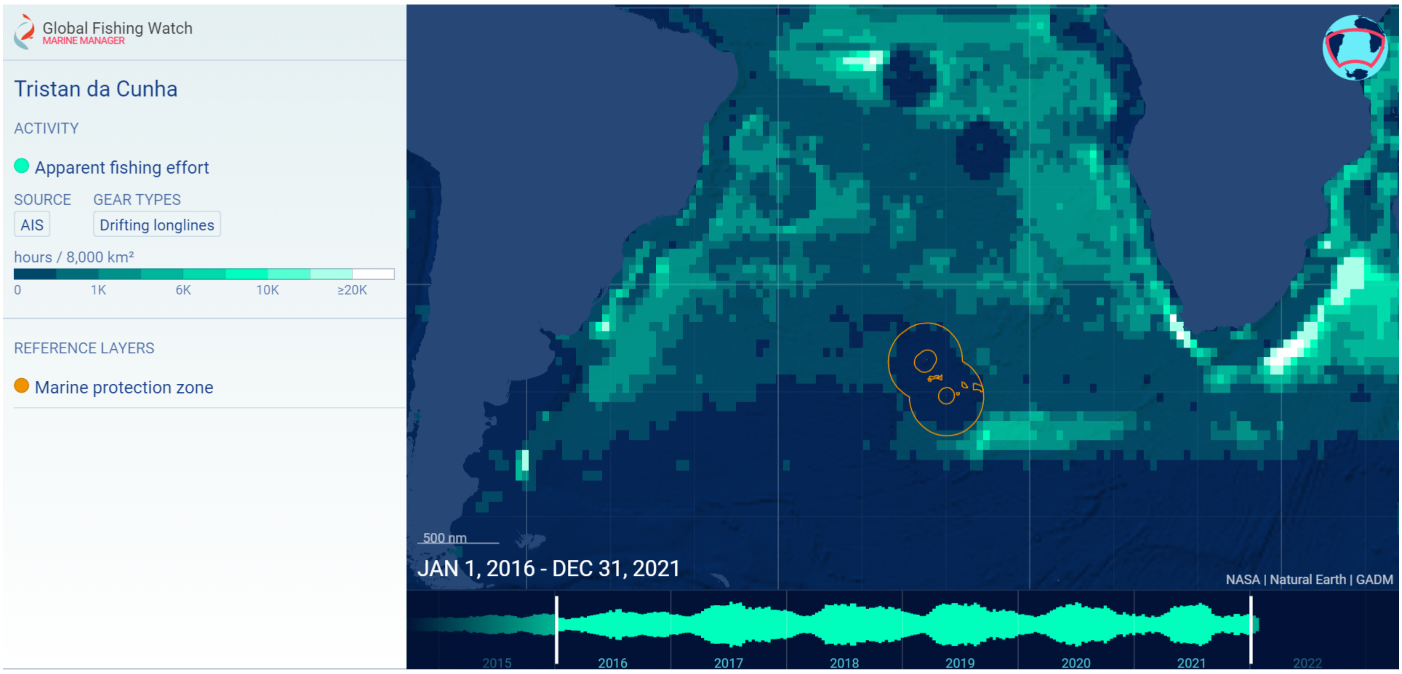

Figure 19: Fishing activity by longline vessels in the South Atlantic between Jan. 1, 2016 and Dec. 31, 2021. The marine protected zone of Tristan da Cunha is shown in orange. Link to marine manager workspace here.

The marine protected zone (MPZ) of Tristan da Cunha is the Atlantic's largest no-take area, providing an important conservation area for several marine species, including the critically endangered Tristan albatross (*Diomedea dabbenena*), the southern bluefin tuna, and the near threatened blue shark (*Prionace glauca*). While longline fishing is prohibited within the MPZ, longline fishing vessels are extremely active in adjacent waters and often fish right up to the boundary of Tristan da Cunha's waters.

The activity of these fisheries has important implications for management of many of the species that Tristan da Cunha aims to conserve. Incidental bycatch in longline fisheries is one the major threats facing the Tristan albatross, and blue sharks are often caught as bycatch or target catch. The waters of Tristan da Cunha are considered to be extremely suitable for southern bluefin tuna, and to the southeast of the MPZ, longline fishing vessels target southern bluefin tuna at the western extent of their annual migration (Hobday et al., 2015; Patterson et al., 2018).

Understanding the scale and distribution of longline fishing effort is vital to understanding the pressures that this activity might be placing on key species of interest, but equally important is identifying how this activity is likely to change over time so as to identify future risks and prioritize future management. Globally, fisheries catches are predicted to shift polewards this century as a result of climate change (Cheung et al., 2010), and high seas fishing activity is likely to follow. The waters around Tristan da Cunha are predicted to remain most suitable for southern bluefin tuna, while habitat suitability for other tuna species is predicted to increase only slightly (Townhill et al., 2021).

In this analysis, we provided a detailed overview of fishing activity by longline vessels in the waters adjacent to Tristan da Cunha, to provide a management perspective on the scale of activity and fleet compositions. Next, we looked at recent multi-year trends in longliner activity to identify where fishing pressure may be increasing or decreasing, and included environmental data to provide context on the relationship between sea surface temperature and longline activity. Finally we combined this information with publicly available data sourced from regional fisheries management organizations (RFMOs) to validate our approach and add valuable context for important species of conservation concern for Tristan da Cunha.

Methods

Firstly, we used the marine manager portal to visualize the last six years (Jan. 1, 2016 - Dec. 31, 2021) of apparent fishing activity by longline vessels near Tristan da Cunha (figure 20). Tristan da Cunha sits along a warm-cold water front, with waters to the north several degrees warmer than those to the south. Similarly, there is a clear spatial distinction between longline fisheries to the north and south as can be seen in figure 20. To the southeast we can see a high density of longline fishing activity by vessels targeting southern bluefin tuna, while to the north and east fishing activity is more widely dispersed. For the purposes of quantifying fishing effort and identifying trends over time we defined two “fishing areas”, delineated in figure 21 by orange rectangles. Our defined southern fishing area extended from -20° to 15° longitude, and -50° to -40° latitude, encompassing the majority of this effort. The northern fishing area extended from -20° to 10° longitude, and -40° to -30° latitude to cover an area that was roughly comparable in size to the southern fishing area, while excluding the high density of activity along the of the South African exclusive economic zone, which we felt was less relevant to Tristan da Cunha (figure 20).

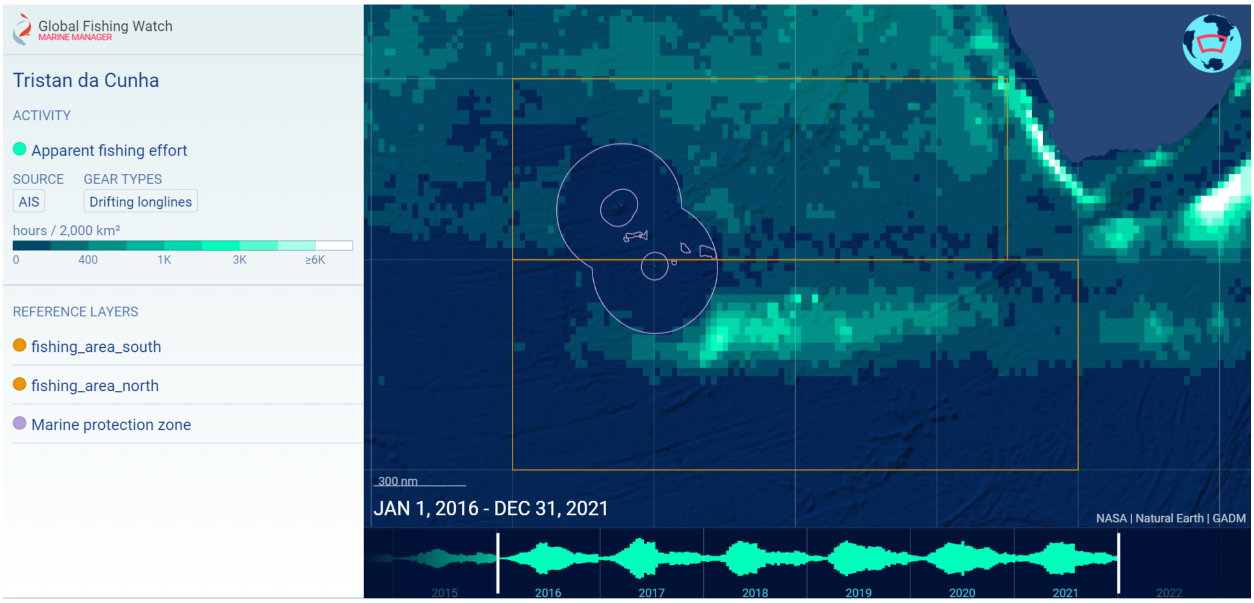

Figure 20: Fishing activity by longline vessels operating near Tristan da Cunha between Jan. 1, 2016 and Dec. 31, 2021. The defined “fishing areas” for the northern and southern tuna fisheries are delineated by orange rectangles. Link to marine manager workspace here.

The scale and extent of longline fishing activity in adjacent waters has many important management implications for Tristan da Cunha. The scale of fishing activity by the southern fleet has implications for the sustainable management of the endangered southern bluefin tuna. Bycatch in longline fisheries is a major threat to the critically endangered Tristan albatross, which breed on Gough Island in relatively close proximity to the southern fleet. The Marine Protected Zone of Tristan da Cunha is the largest no-take zone in the Atlantic, and therefore transparency and monitoring of adjacent fisheries is key to management. To understand how these pressures and risks have changed in recent years, and to identify priorities for future monitoring and management, we explored how the scale and extent of longline activity has changed over the past six years. To provide additional context to predicted changes in habitat suitability of tuna species predicted by Townhill et al. (2020), we compared the seasonality of longline activity with concurrent sea surface temperature data sourced from the publicly accessible Nasa Earth Observations Aqua/Modis dataset.

Finally, to validate and provide additional context for our findings, we compare the trends presented here, derived from automatic identification system (AIS) data, with catch and effort data reported to ICCAT and CCSBT.

Results

Overview of longline fishing activity

Between Jan. 1, 2016 and Dec. 31, 2021, the fleet of longline vessels fishing in the northern fishing area included nearly three times as many vessels (173) than the smaller fleet in the south (60). However, total fishing effort, in terms of hours fished, by the southerly fleet (approximately 220,000 hours) was more than 2.5 times greater than total fishing effort in the northern area of interest (approximately 83,000 hours). Longline vessels operating in the northern area of interest were associated with a total of 13 different flags, with Chinese Taipei, Japan, and Spain being the most common, while the fleet operating to the south comprised almost entirely Japanese and Korean-flagged vessels (figure 21).

When we map the distribution of fishing effort by the four most commonly flagged vessels in these areas we can see that vessels flagged to Chinese Taipei and Spain fished exclusively to the north of Tristan da Cunha, while Japanese and Korean-flagged vessels preferentially targeted the waters to the southeast (figures 22-25).

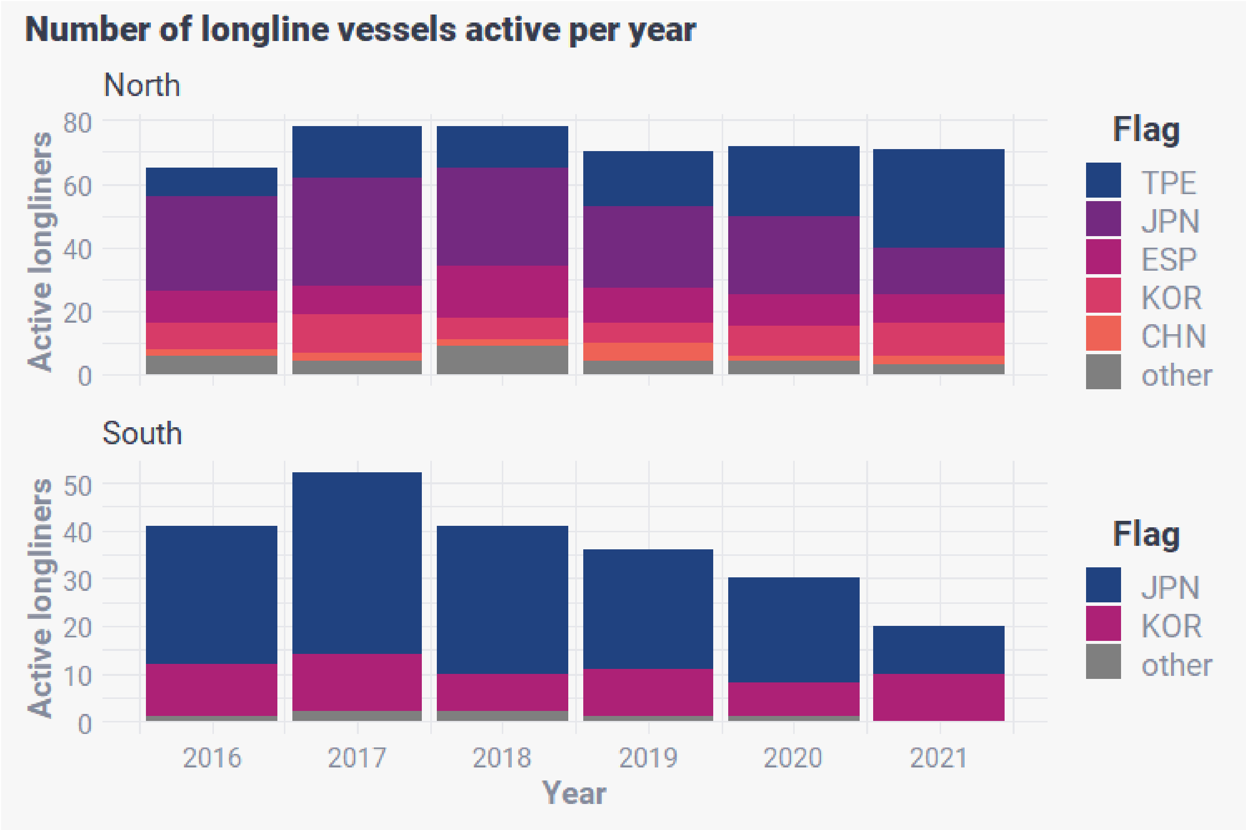

Figure 21: Total number of longliners active within the northern and southern fishing areas per year, colored by the most active flags in each area.

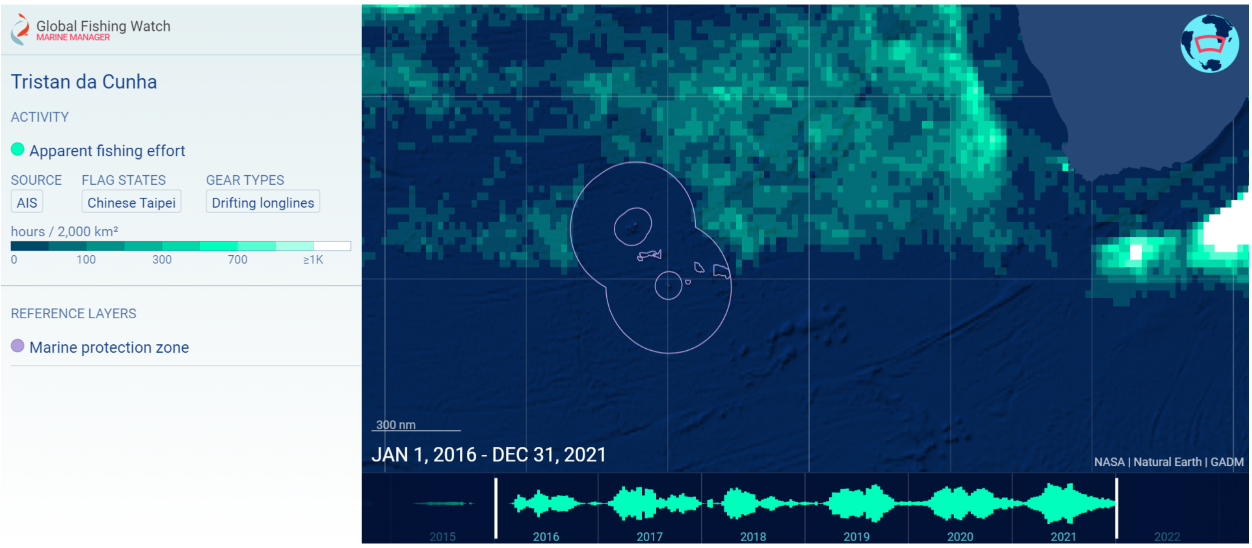

Figure 22: Fishing activity by longline vessels flagged to Chinese Taipei between Jan. 1, 2016 and Dec. 31, 2021. Link to marine manager workspace here.

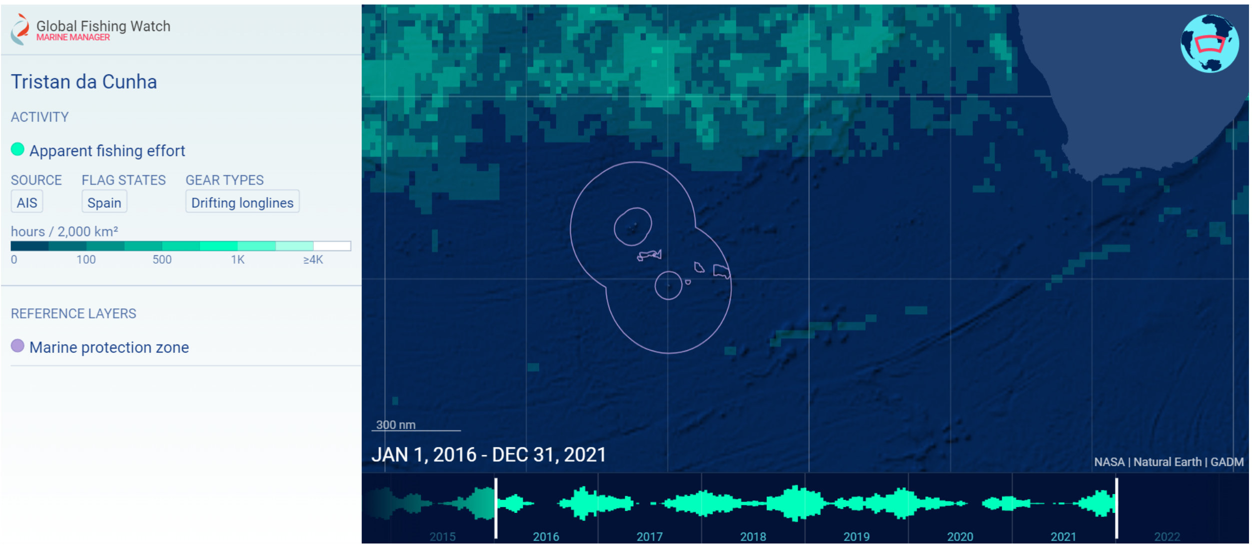

Figure 23: Fishing activity by longline vessels flagged to Spain between Jan. 1, 2016 and Dec. 31, 2021. Link to marine manager workspace here.

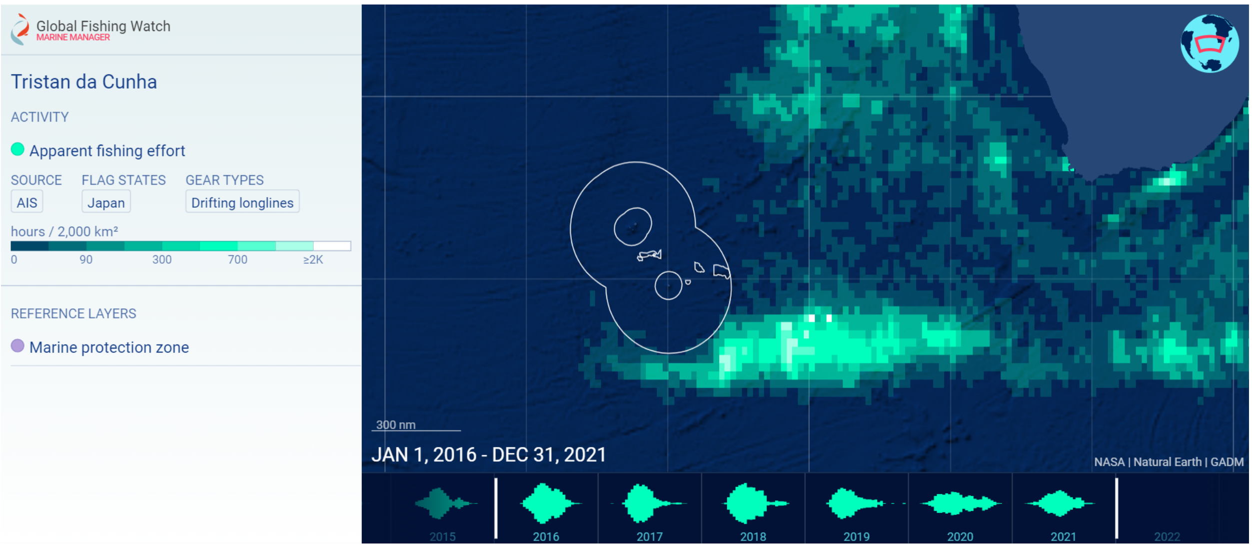

Figure 24: Fishing activity by longline vessels flagged to Japan between Jan. 1, 2016 and Dec. 31, 2021. Link to marine manager workspace here.

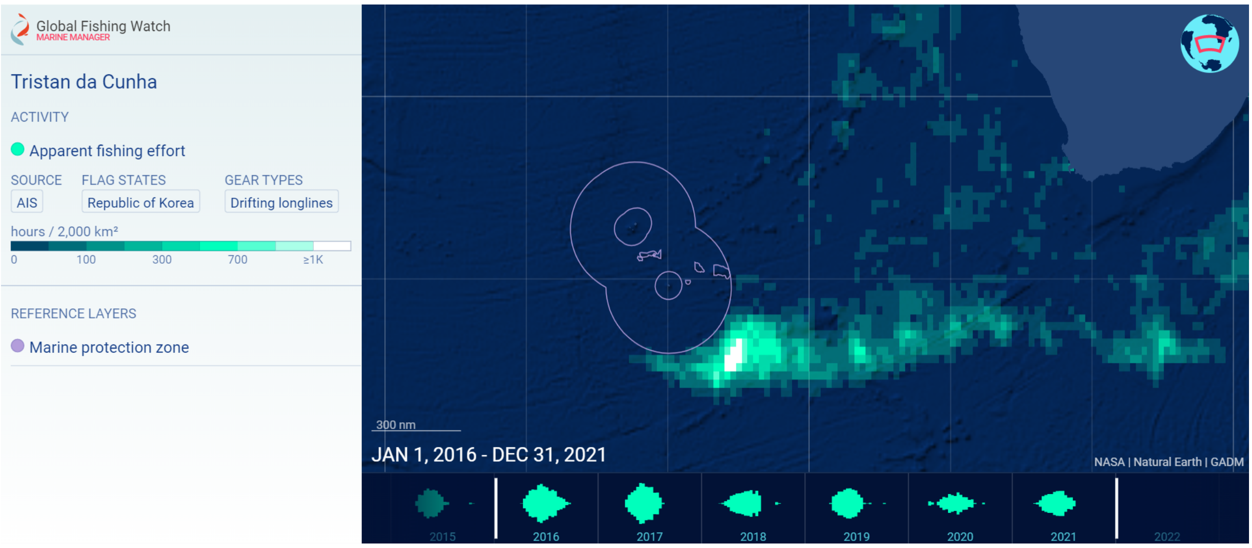

Figure 25: Fishing activity by longline vessels flagged to Korea between Jan. 1, 2016 and Dec. 31, 2021. Link to marine manager workspace here.

Trends in longliner activity over time

In 2016, the hours of total fishing activity were more than five times higher in the southern fishing area (~49,000) than the north (~9,400). However, between 2016 and 2021, fishing activity increased in the north and decreased in the south, and by 2021 the total fishing effort in the north (~22,700 hours) was equivalent to total fishing effort in the south (~22,200 hours; figure 26). Interestingly, the number of longline vessels active in the northern fishing area remained relatively constant over this period, while the fleet size to the south declined at a similar rate to fishing effort (figure 26).

In both the northern and southern areas, longline fishing was extremely seasonal, with activity peaking in the second quarter of each year. This was especially true in the south, where 69% of total fishing hours occurred in the months of April, May, and June (figure 26). In both areas, these seasonal peaks in fishing activity coincided with declining sea surface temperatures between the yearly maxima and minima (figure 26). Sea surface temperature was on average 9°C warmer in the northern area of interest compared to the south, and followed a similar seasonal pattern, with temperatures fluctuating each year by an average of 5.8°C in the north and 3.4°C in the south.

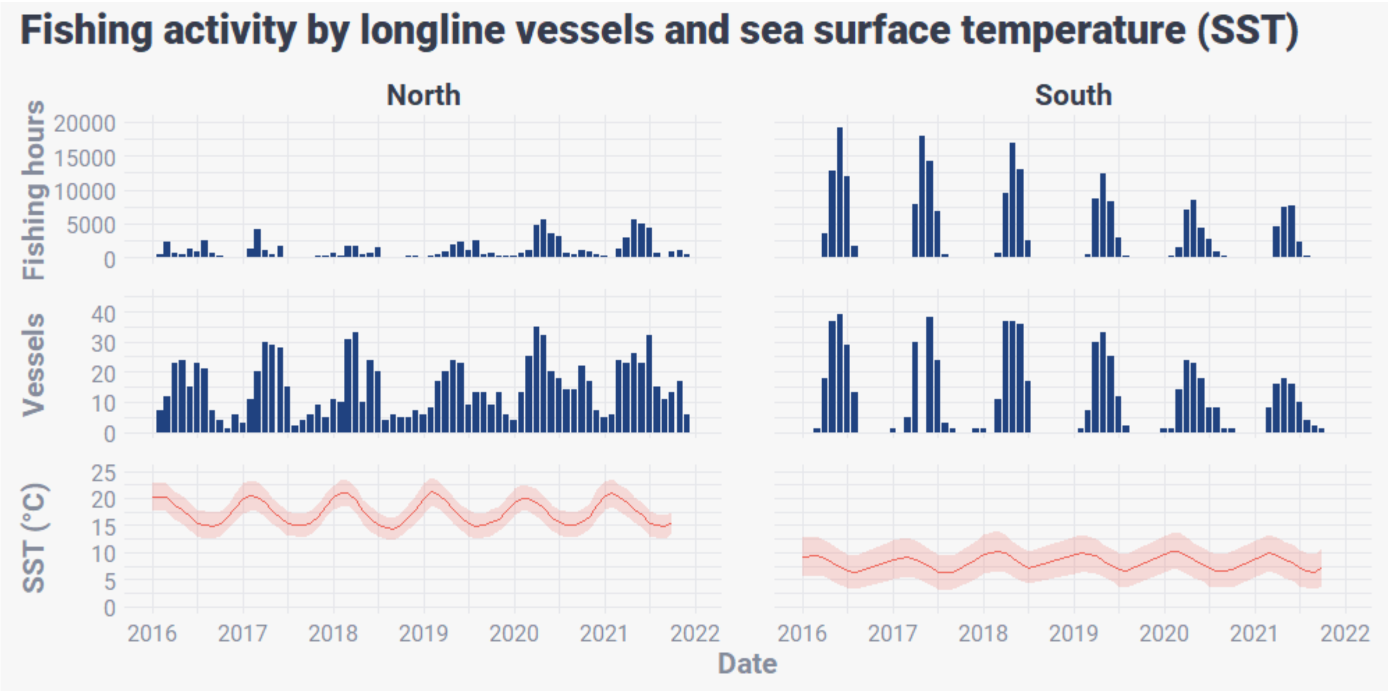

Figure 26: Total hours of fishing activity by longline vessels, number of active longline vessels, and monthly sea surface temperature within the northern and southern fishing area between Jan. 1, 2016 and Dec. 31, 2021.

Comparisons with RFMO datasets

At the time of writing this report, the CCSBT have published annual reported catch data of southern bluefin tuna from 1965 to 2020 inclusive. This detailed data includes information on total southern bluefin tuna catch (tons), when (month and year) and where (5° x 5° grid) it was caught, and what geartype was used. By filtering these data to include all reported southern bluefin tuna catch by longline vessels between -20° and 15° degrees longitude, -50° and -40° latitude, we were able to compare the fishing activity (derived from AIS) and reported catch within the southern area of interest between 2016 and 2020. The results show that the decline in fishing effort reported here is mirrored by a similar decline in reported catch of southern bluefin tuna (figure 27).

Importantly, this suggests that the AIS-derived fishing activity available through the marine manager portal provides a reliable indication of longline fishing activity in the area. While the catch and effort data reported to RFMOs is typically provided on an annual basis, Global Fishing Watch data is available in near real time, with only a three-day delay, demonstrating that the marine manager portal can provide an important and immediate complementary source of information on fishing activity relevant to Tristan da Cunha.

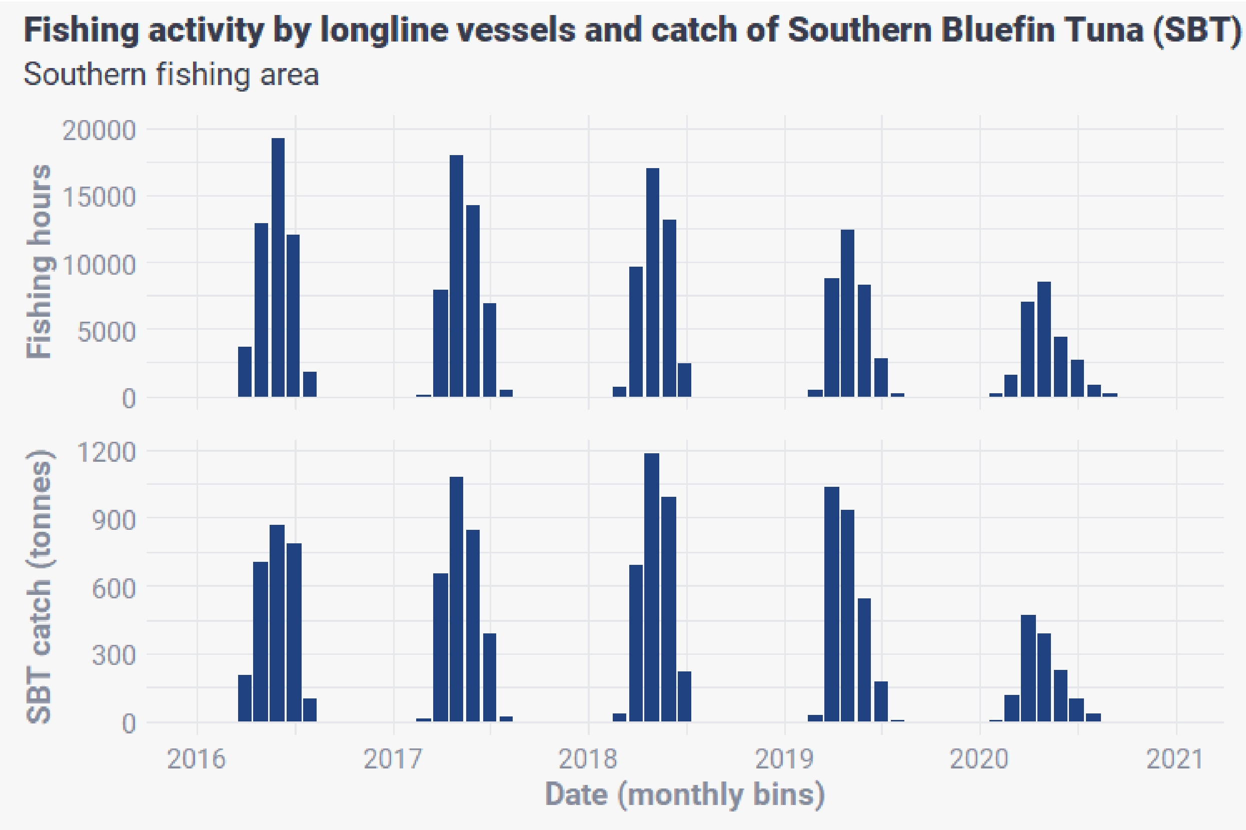

Figure 27: Total hours of fishing activity by longline vessels and total reported catch of southern bluefin tuna within the southern fishing area between Jan. 1, 2016 and Oct. 31, 2021.

The catch data provided by ICCAT is less easily compared to the AIS-derived data presented here as ICCAT data are aggregated at regional (South Atlantic) and yearly scales. However, a brief analysis of these data adds some interesting context to the trends reported here. Tristan da Cunha has been recognised as an important conservation area for blue sharks (*Prionace glauca*), a near threatened species which is often caught as incidental bycatch but may also be a target species of certain fisheries. Looking at the catch data reported to ICCAT, we can see that Spanish-flagged longline vessels have caught more blue sharks throughout the South Atlantic than any other flag (figure 28). Considering that Spanish-flagged vessels were the third most numerous within the northern fishing area (figure 21), here we provided a closer look at the recent trends in activity by these vessels to identify whether fishing activity has increased in the area or whether these vessels are moving closer to Tristan da Cunha.

Since 2016, while the reported catch of blue sharks by Spanish-flagged vessels throughout the South Atlantic has increased (Appendix C), fishing activity within the northern fishing area has generally declined over the same period (figure 29). Additionally, using the period comparison tool within the marine manager portal, we can see that between 2016 and 2021 there has been no noticeable southerly shift by Spanish-flagged vessels in this area, and vessels are not noticeably fishing closer to Tristan da Cunha's waters (figure 30). Again, this demonstrates how the marine manager portal can provide an important complementary source of information in addition to RFMO reporting. While catch data from ICCAT highlights increasing catch of an important conservation species across the South Atlantic, the marine manager portal can provide a more focused overview of vessel activity near Tristan da Cunha.

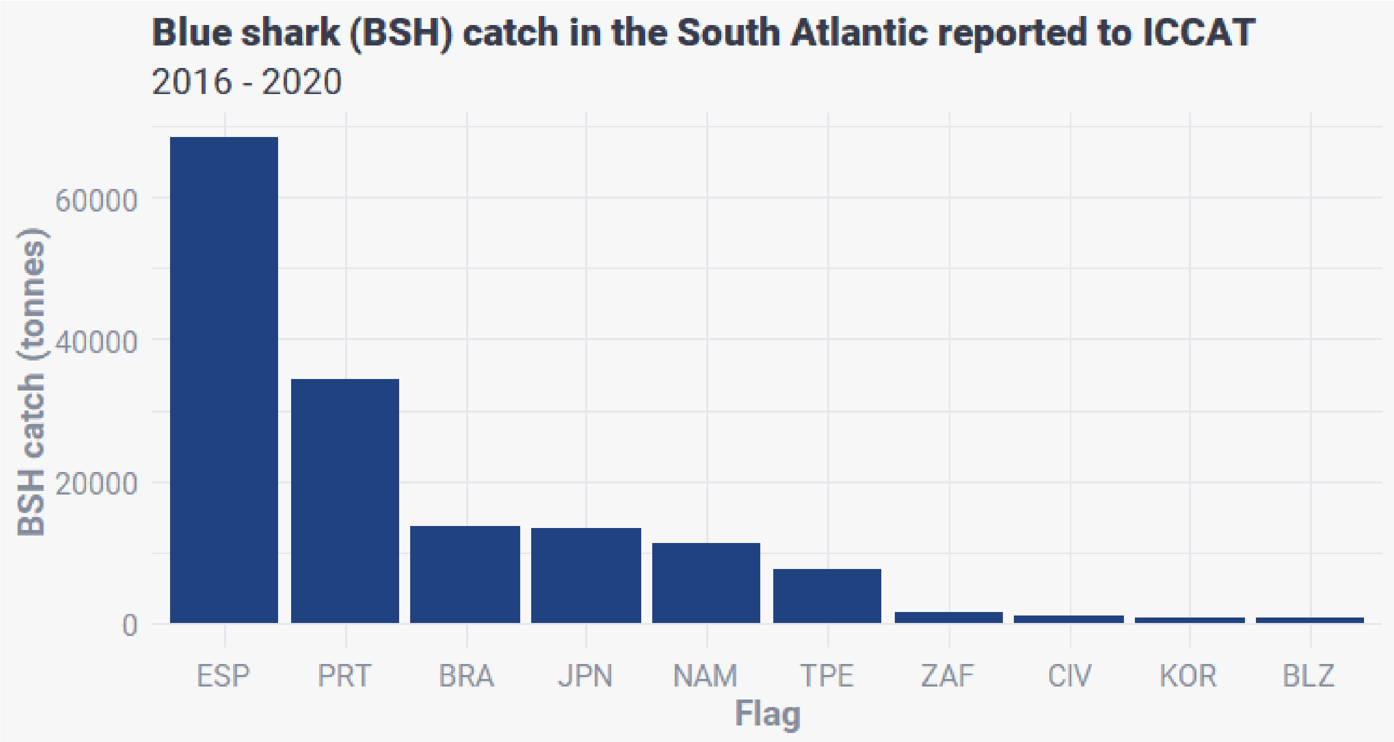

Figure 28: Total blue shark catch by longline vessels in the South Atlantic per flag, according to landings data sourced from ICCAT.

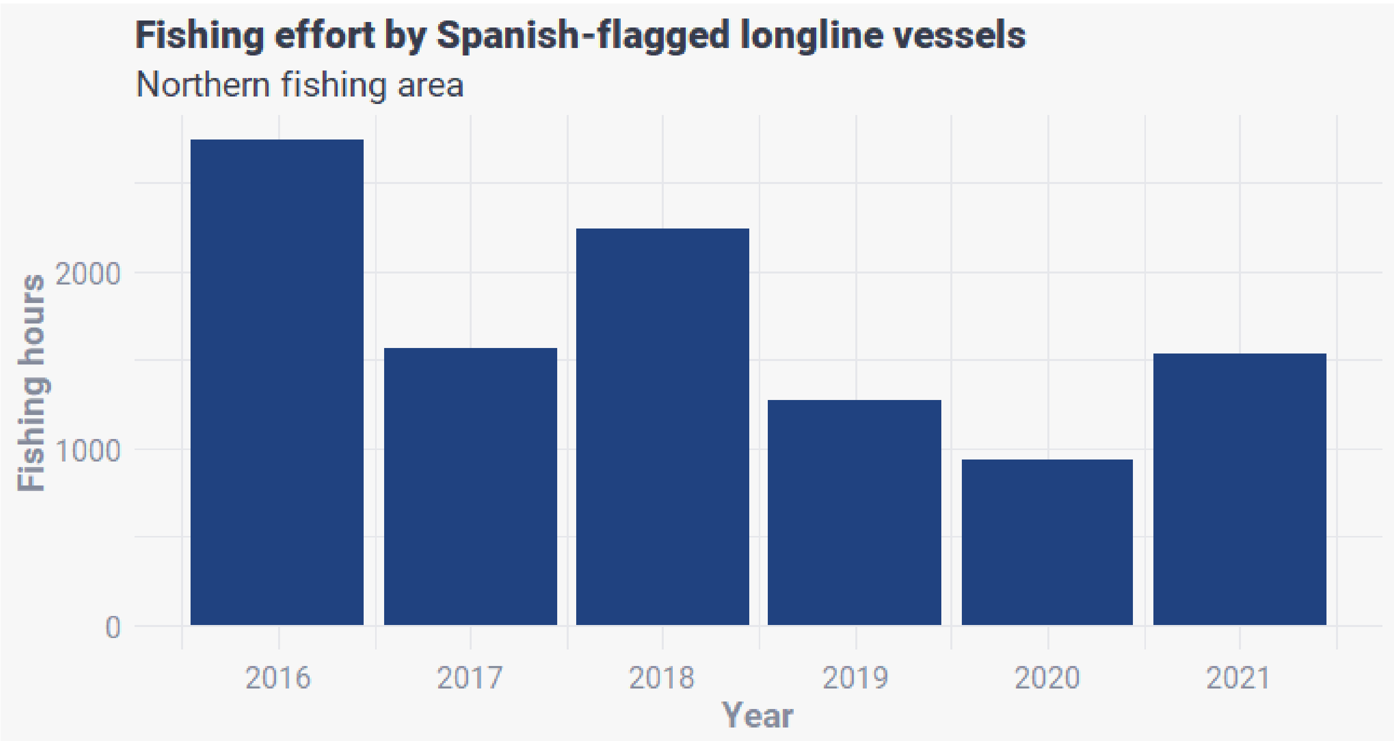

Figure 29: Total hours of fishing activity by Spanish-flagged longline vessels within the northern fishing area each year from Jan 1, 2016. to Oct. 31, 2021.

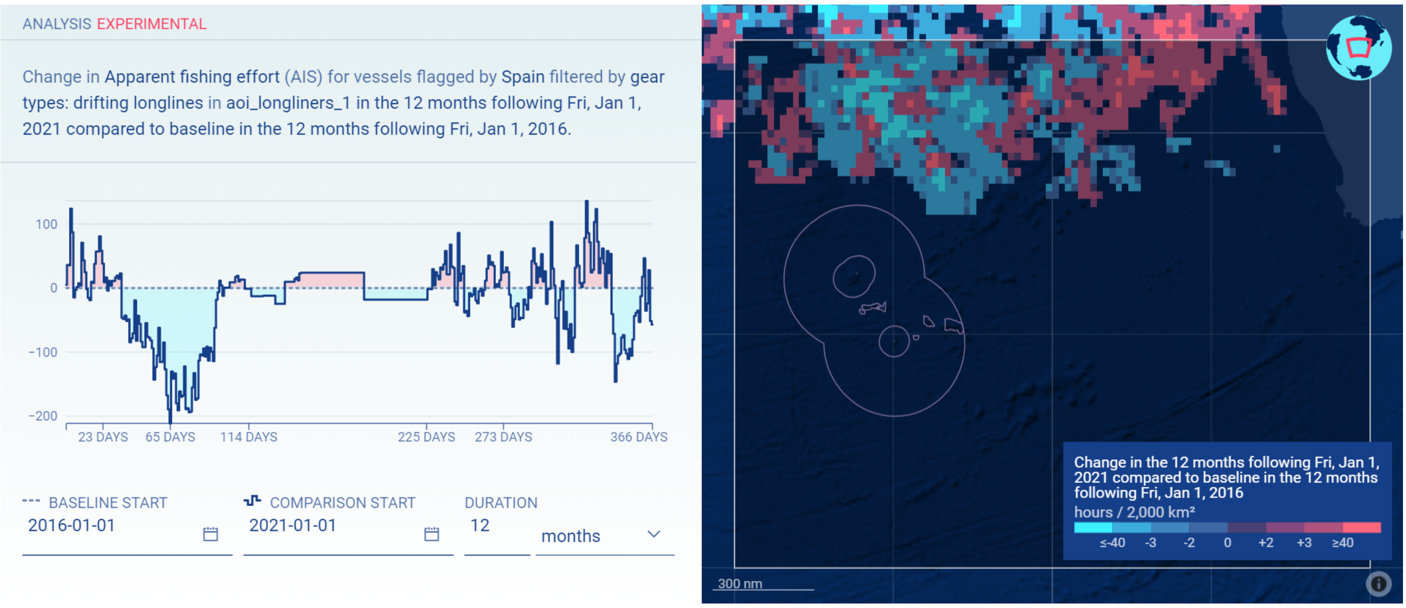

Figure 30: Change in apparent fishing effort by longliners near Tristan da Cunha in 2016 compared to 2021. Red indicates areas with higher levels of fishing in 2021 and blue indicates areas with lower fishing in 2021. Link to analysis workspace here.

Conclusion

In conclusion, this analysis demonstrates that the Global Fishing Watch Marine Manager can provide near real time insights, and multi-year analyses of key fisheries near Tristan da Cunha, adding value to existing sources of information such as RFMO reporting and providing important context specific to Tristan da Cunha.

To summarize:

- We mapped longline fishing activity and showed a high density of activity over a small area to the south and a lower density of activity spread over a much wider area to the north.
- Fishing activity to the north included a large number of vessels and flags, while the fishing activity to the south was carried out by a smaller number of mostly Japanese and Korean-flagged fishing vessels.
- There is a clearly defined fishing season in both fishing areas, with fishing activity peaking between April and July each year. This coincides with seasonal declines in sea surface temperatures, and is most pronounced in the south, where more than 69% of annual fishing effort occurs over 3 months.
- Between 2016 and 2021, total fishing hours have been higher to the south than north. However, fishing effort has decreased in the north and increased in the south to the point where total fishing effort is roughly equal in both areas.
- Declining effort in the southern fishing area is closely mirrored by a reported decline in southern bluefin tuna catch, according to CCSBT-reported data. It is encouraging that the marine manager data may provide a reliable and more readily available source of information on longline fishing activity near Tristan da Cunha.
- Tristan da Cunha represents an important conservation area for the near threatened blue shark. Data reported to ICCAT suggests that, since 2016, the total catch of blue sharks by Spanish-flagged vessels has increased throughout the South Atlantic, but this report demonstrates that in waters adjacent to Tristan da Cunha, effort by Spanish-flagged longliners has generally decreased over the same period, and there is no evidence of these vessels fishing any closer to Tristan da Cunha.

4. Marine manager as a tool for fisheries monitoring, control, and surveillance

Not only does the Global Fishing Watch Marine Manager provide decision-makers with the tools to monitor long-term trends in human activity and environmental data in and around protected areas, but the near-real time positional data visualized by the portal can also highlight potential cases of illegal, unreported, and unregulated fishing. This can be especially effective when the data is made immediately available to stakeholders with a tacit knowledge of the area to be managed.

An excellent example of this utility came during a demonstration of the marine manager portal in November 2021 to members of the Tristan da Cunha government and Royal Society for the Protection of Birds. During this demonstration, a small cluster of apparent fishing activity in the northern extent of Tristan da Cunha's exclusive economic zone (EEZ) was noticed by participants in the meeting (figure 31).

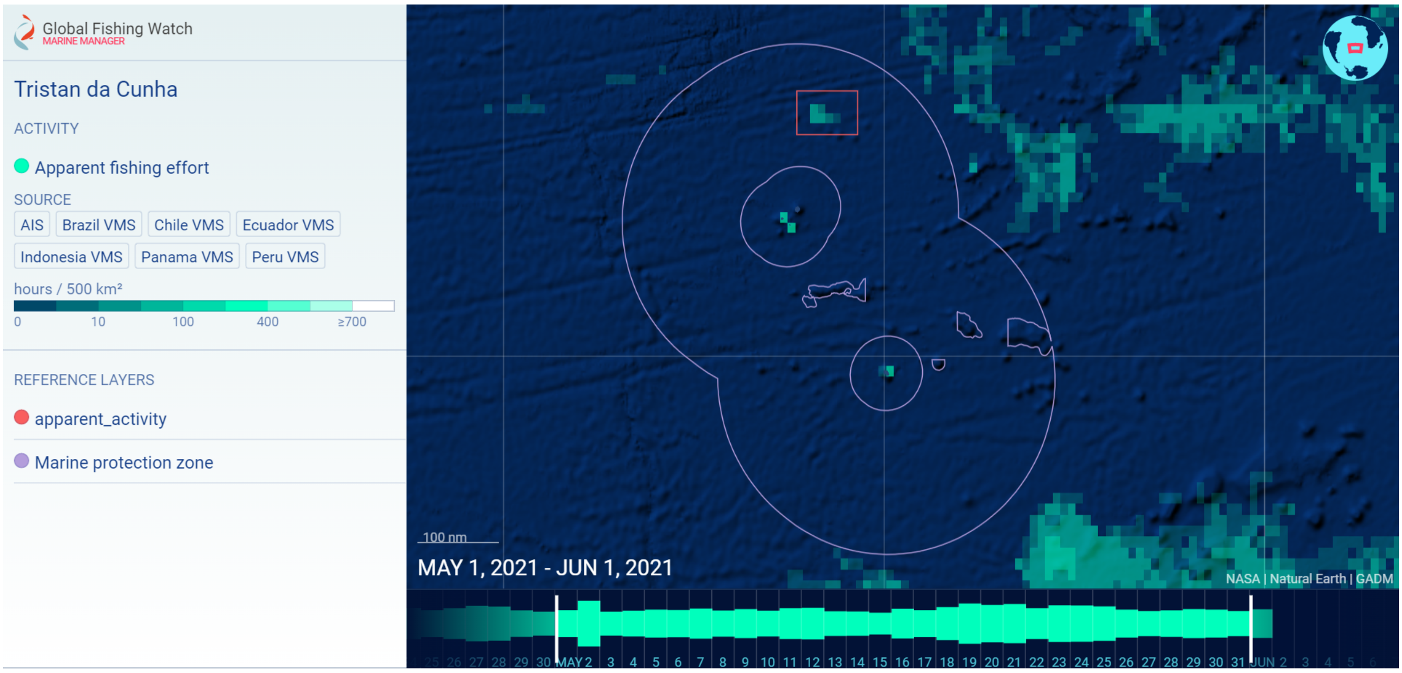

Figure 31: Apparent fishing activity (red rectangle) inside Tristan da Cunha's marine protection zone between May 1, 2021 and June 1, 2021. Click here for a link to the marine manager portal workspace.

First, it is important to consider that Global Fishing Watch identifies apparent fishing effort by applying machine learning algorithms to automatic identification system (AIS) data. While these algorithms can detect fishing activity with a high degree of accuracy, it is nonetheless likely that some fishing activity can go undetected, and conversely some non-fishing activity can occasionally be incorrectly labelled as fishing.

Nonetheless, upon closer inspection and follow up analysis by Global Fishing Watch analysts, this apparent fishing activity was found to involve seven Chinese-flagged squid jigger fishing vessels moving slowly and in unison, likely drifting, between 5 p.m. on May 21 and 4 a.m. on May 22, 2021 (figure 32). We can see a similar pattern of movement outside of the EEZ the following night, between 12 a.m. and 8 a.m. on May 23.

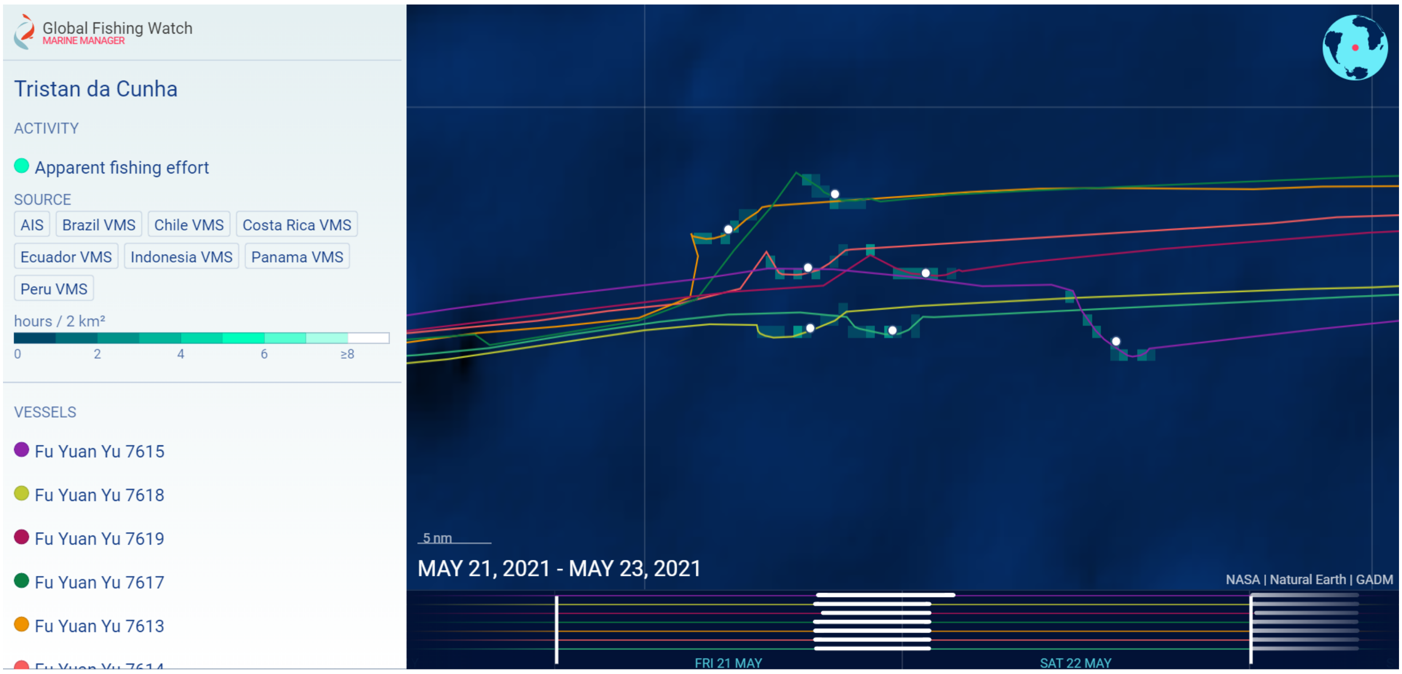

Figure 32: Tracks of seven squid jigger fishing vessels with apparent fishing activity inside Tristan da Cunha's marine protection zone between May 21 and May 22, 2021. Click here for a link to the marine manager portal workspace.

Squid jigger vessels typically use powerful artificial lights while fishing at night to attract target squid species. The Visible Infrared Imaging Radiometer Suite, or VIIRS, is a polar orbiting satellite that uses highly sensitive optical sensors to detect lights at night. For vessels that use bright lights at night, such as squid jiggers, VIIRS provides a complementary data source to AIS that can be used to detect vessels that are not transmitting or detectable by AIS and identify likely fishing activity. The VIIRS satellite sensors generally do not pick up weaker light sources associated with non-fishing activity such as moving and drifting, but detect only the bright lights used in fishing (Hsu et al., 2019; Li et al., 2021). For example, in the South China Sea, Li et al. (2021) compared VIIRS detections of large squid-jigging vessels to vessel monitoring system (VMS) records of fishing activity and found that 100% of VIIRS detections matched to VMS data occurred when the vessels were fishing. This may be because operating the hundreds of bright lamps that larger squid jigging vessels typically use comes at a high cost to the vessel operators, and therefore it is most efficient to restrict their use to fishing activity. When we compare the AIS-derived tracks of these seven squid jiggers to VIIRS night light detections, we can see that each of these vessels used bright lights at night while inside Tristan da Cunha's EEZ (figures 33, 34).

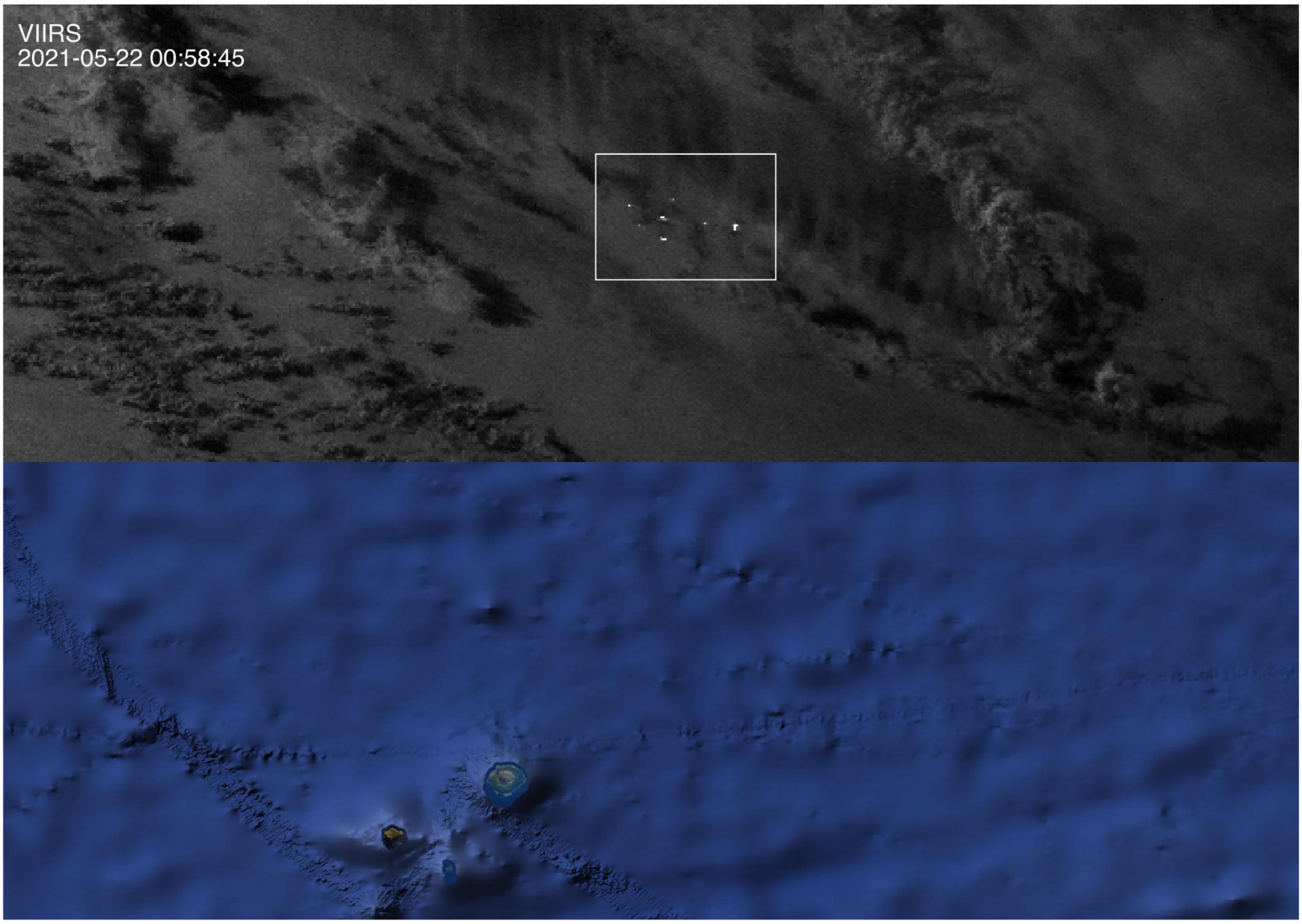

Figure 33: Visible infrared imaging radiometer showing vessels using bright lights at night to the north of Tristan da Cunha at 12:58 a.m. on May 22, 2021.

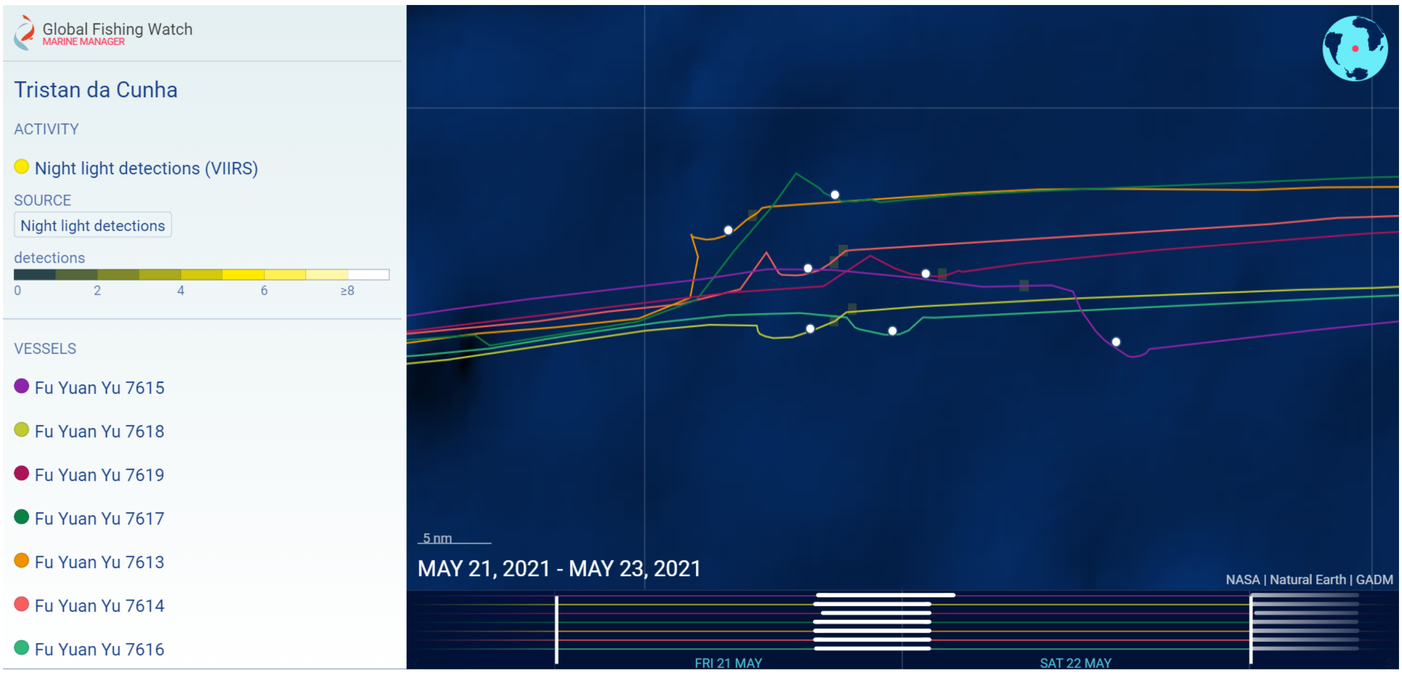

Figure 34: Night light detections, using VIIRS, overlapping with vessel tracks, derived from AIS, of squid jigger vessels within the Tristan da Cunha exclusive economic zone between May 21 and May 22, 2021. Click here for a link to the marine manager portal workspace.

Looking at the extended tracks of these vessels between Jan. 1 and June 1, 2021, we can see that these movement patterns are not typical of the vessels nightly activity while transiting across the South Atlantic (figure 35).

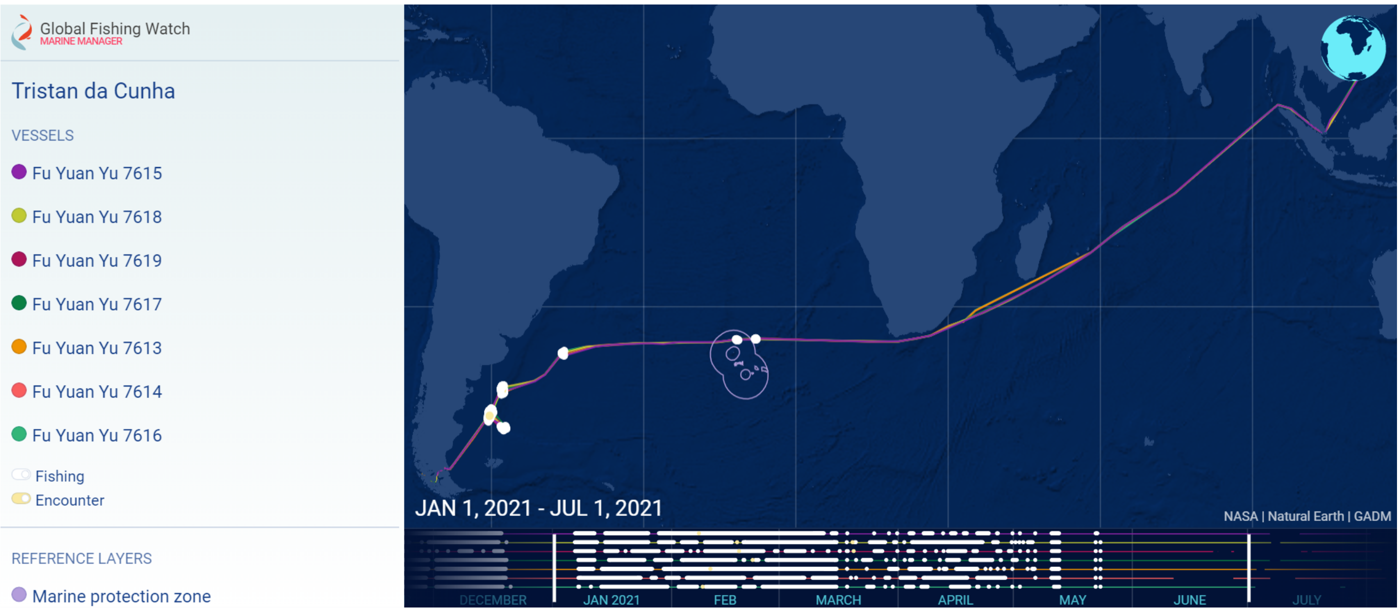

Figure 35: Tracks of seven squid jigger fishing vessels between Jan. 1, 2021 and July 1, 2021, with apparent fishing activity inside Tristan da Cunha's Marine Protection Zone between May 21 and May 22, 2021. Click here for a link to the marine manager portal workspace.

While it is possible that these vessels were engaging in opportunistic fishing activity while transiting through the EEZ of Tristan da Cunha, it is not the only possible explanation for this activity. For example, these vessels were likely travelling in convoy, and as such, if one or more vessels experienced technical difficulties, the other vessels would potentially drift close by until repairs were completed. A potential next step would be to reach out to the vessel operators and request clarification on the nature of their activity during this period. This information has already been passed on to the UK Marine Management Organisation, which is continuing the investigation.

The mission statement of Global Fishing Watch begins with "Global Fishing Watch advances ocean governance through increased transparency of human activity at sea." This is an example of the power of transparency. By making these data visible and accessible to managers with the expertise to interpret them, it is our hope that the marine manager portal can be an asset to the successful management of Tristan da Cunha's waters and marine protected zone.

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Cover photo by Charles Kilgour

Appendices

Appendix A: Table of vessels that transited through the Areas to be Avoided between 1 April 2020 and 30 June 2021

MMSI	Vessel name	Flag	No. transits	Distance to shore (km)
412420688	HUA LI 19	CHN	1	3.29
538002999	JOHNNY CASH	MHL	1	6.14
477410100	XIN RONG	HKG	1	6.94
538004367	MOON GLOBE	MHL	1	7.05
229623000	ANDREAS PETRAKIS	MLT	1	7.33
356362000	MAJESTIC ISLAND	PAN	1	9.15
636015499	TYCOON	LBR	1	10.06
373158000	ASAHI BULKER	PAN	1	10.46
636019187	HONG RUN 6	LBR	1	11.41
636015288	GOOD WISH	CHN	1	12.46
374724000	CALYPSO ISLAND	PAN	1	13.41
351170000	SAKIZAYA BRAVE	PAN	1	13.81
538007456	MONDIAL SUCCESS	MHL	1	14.18
209447000	ADRIATICA GRAECA	CYP	1	14.35
636017169	OMICRON SKY	LBR	1	15.79
371674000	PEACE PEARL	PAN	1	16.12
636017992	EPIC TRADER	LBR	1	16.39
565259000	BULK SWEDEN	SGP	1	16.96
636017368	KANG MAY	LBR	1	17.11
210043000	EFRAIM A	CYP	1	17.18
374155000	MEDI OITA	CHN	1	17.34
477434600	SHANDONG CHONG WEN	HKG	1	17.48
354853000	HARBOUR WELL	CHN	1	18.52
477230500	CSSC YUAN JING	HKG	1	18.86
371397000	ZHENG RONG	PAN	1	19.01
636020274	IVESTOS 8	LBR	1	19.17
538004459	ANTWERPIA	MHL	1	20.03
209854000	PEDHOULAS COMMANDER	CYP	1	20.07
538007343	JOHNNY P	MHL	2	20.26
636015637	JUNIOR	LBR	1	20.36
548989000	LEMAN TRADER	CHN	1	21.06
538004903	ATHINOULA	MHL	1	21.39

412329657	LU HUANG YUAN YU 107	CHN	1	21.57
636019555	BULK MUSTIQUE	CHN	1	22.39
311000380	STAR TRADER	BHS	1	22.87
412329658	LU HUANG YUAN YU 108	CHN	1	22.9
371584000	BLUE CHIP	PAN	1	23.65
636015794	ALTHEA	LBR	1	23.76
563666000	PRABHU YUVIKA	SGP	1	23.83
412420457	HONG DA 2	CHN	1	24.01
371332000	RISING WIND	PAN	1	24.19
412330931	LUPENGYUANYU097	CHN	1	24.34
311001037	STAR DIAMOND	BHS	1	24.4
636017854	LAGUNA SECA	CHN	1	24.69
477686600	KALIMANTAN EXPRESS	HKG	1	25.06
563109100	NORD SATURN	SGP	1	25.11
412329654	LUPENGYUANYU027	CHN	1	25.54
538007419	KMARIN GOTEBORG	PAN	1	25.61
241404000	MARAN GAS ULYSSES	GRC	1	25.89
636015124	ATHINA L	LBR	1	26.26
416238500	LUNG SOON FA NO.1	TWN	1	26.32
636015954	ASPASIA LUCK	LBR	1	26.85
636013148	EVEREST BAY	LBR	1	26.97
209682000	AESCHYLUS GRAECIA	CHN	1	27.04
636018216	INTERCEPTOR	CHN	1	27.36
636013612	BEIJING 2008	LBR	1	27.41
210655000	ATTIKI SB	CYP	1	27.49
354281000	SHUN YING	PAN	1	27.72
576990000	OCEAN VENTURE 6	VUT	1	27.76
440038000	SKYMAX 101	KOR	1	28.7
636020065	KEY ACTION	CHN	1	28.89
477743200	ROSCO POPLAR	HKG	1	28.97
538005205	HALOPHYLA	MHL	1	28.97
636016708	YANGZE 7	LBR	1	29.76
372161000	MARIO	PAN	1	29.86
212460000	KYPROS SPIRIT	CYP	1	30.08
636011902	CHAILEASE GLORY	LBR	1	30.15
403518000	BAHRI WAFI	SAU	1	30.16
355187000	BULK CASTOR	PAN	1	30.19
538008657	PRAIRIE	CHN	1	30.32
636015390	CHARIKLIA JUNIOR	LBR	1	30.32

477686800	JOSCO DEZHOU	HKG	1	30.33
374922000	BERGE HALLASAN	PAN	1	30.37
477162900	OCEAN TIANCHEN	HKG	1	30.39
538005446	SEA GEMINI	CHN	1	30.41
416037900	NA	TWN	1	30.62
311054500	LYRIC STAR	BHS	1	30.65
477218100	FORTUNE IRIS	PAN	1	30.91
412331059	LU PENG YUAN YU 078	CHN	2	31.13
356258000	SHUN ZE LENG 7	PAN	1	31.29
636018003	ANAIS	LBR	1	32.33
636019922	TALBOT	CHN	1	32.47
477468600	JOSCO YONGZHOU	HKG	1	32.73
477392300	DHT PEONY	HKG	1	32.99
373352000	CECILIA B	PAN	1	33.4
538006146	SBI RUMBA	MHL	1	33.41
636019280	DOCHUDSON	CHN	1	33.51
538006963	FLAG LAMA	MHL	1	33.61
355179000	MSXT OCEANUS	PAN	1	34.15
371888000	GLOBAL BONANZA	PAN	1	34.24
441413000	AGNES101	KOR	1	34.42
538003656	HOUSTON	MHL	1	34.49
412420822	HUALI17	CHN	1	34.76
412420651	RUNDA617	CHN	1	34.82
538006527	LADY I	MHL	1	35.18
538004507	YASA EAGLE	MHL	1	35.47
477203600	BBG ENDEAVOR	HKG	1	35.56
538004530	LBC NATURE	MHL	1	35.84
477213300	KING PEACE	HKG	1	36.33
354929000	KANO REEFER	PAN	1	36.83
352351000	AVUNDA REEFER	PAN	1	36.84
235068573	IMMANUEL SCHULTE	IMN	1	36.96
311000651	ALORA	CHN	1	37.3
111111234	KF8007	NA	1	37.59
538008627	SDTR DORA	CHN	1	37.8
412329638	LU RONG YUAN YU 998	CHN	1	37.81
200006639	NA	CHN	1	37.99
416146700	KAO FONG NO817	TWN	1	38.68
351522000	NAVIOS VENUS	PAN	1	38.71
412435461	OUYA17	CHN	1	39.51

412435469	OUYA18	CHN	1	39.52
412420377	ZHAN HAI 007	CHN	1	39.56
232008128	BERGE PHAN XI PANG	IMN	1	39.75
416240500	AN FONG NO 111	TWN	1	39.89
477153800	KOTA LAGU	HKG	1	40.42
477631800	XIN HAN	HKG	1	41.44
431650000	SHINSEI MARU NO.8	JPN	1	41.68
356728000	DON REEFER	PAN	1	42.51
412328741	LU RONG YUAN YU 777	CHN	1	42.67
601524000	SA AMANDLA	ZAF	1	43
477198000	SAGA SKY	HKG	1	43.28
370090000	NAVIOS VICTORY	PAN	1	44.15
229609000	THALASSINI	MLT	1	44.49

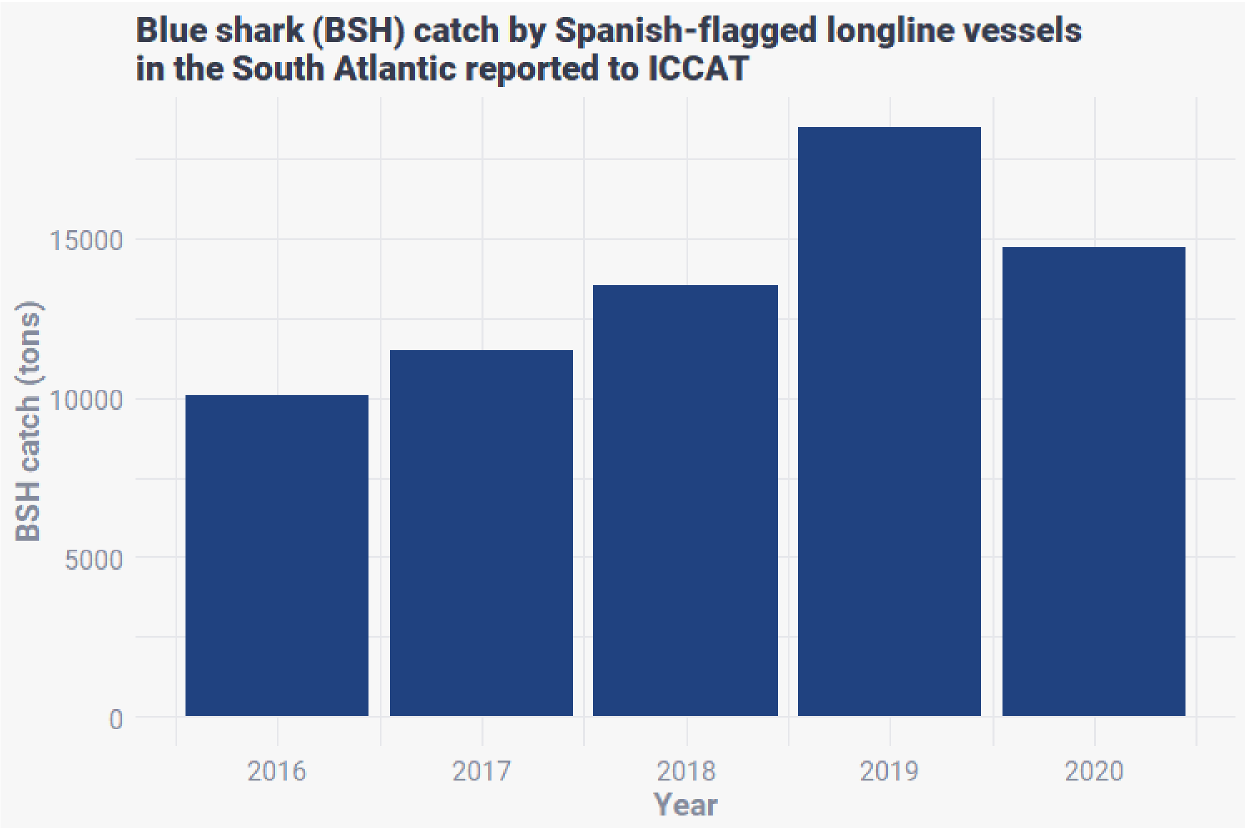
Appendix B: Table of ports visited by vessels before and after transiting through the areas to be avoided between April 1, 2020 and June 30, 2021

Port label	Lon	Lat	Number of transits	
			Origin	Destination
FUJAIRAH, ARE	56.58055	25.16518	2	2
BAHIA BLANCA, ARG	-61.8081	-39.0722	4	0
FRAY LUIS A. BELTRAN, ARG	-60.6999	-32.8018	1	0
PUERTO INGENIERO WHITE, ARG	-62.2574	-38.7979	24	0
QUEQUEN, ARG	-58.7063	-38.5756	12	0
ROSARIO, ARG	-58.5042	-34.3054	1	0
ZONA COMUN, ARG	-57.7781	-34.7427	8	0
BAHIA BLANCA, ARG	-61.5288	-39.3073	0	1
SAN LORENZO, ARG	-59.5789	-33.6771	0	1
CHITTAGONG, BGD	91.78131	21.7309	0	1
GUAIBA, BRA	-44.0937	-23.0262	1	0
IMBITUBA, BRA	-48.6111	-28.2014	2	0
ITAJAI, BRA	-48.6621	-26.8985	1	0
PARANAGUA, BRA	-48.3562	-25.5437	6	0
RIO GRANDE, BRA	-52.0866	-32.1618	5	0
SANTOS, BRA	-46.307	-24.1732	10	0
SAO FRANCISCO DO SUL, BRA	-48.5669	-26.1721	1	0
PARANAGUA, BRA	-48.152	-25.6493	0	1
RIO GRANDE, BRA	-51.9024	-32.2475	0	2
SAO FRANCISCO DO SUL, BRA	-48.3864	-26.1952	0	1
PUNTA ARENAS, CHL	-70.8562	-53.1663	1	0
CABO NEGRO, CHL	-70.7966	-52.9293	0	1
PUNTA ARENAS, CHL	-70.9068	-53.201	0	6
VALPARAISO, CHL	-71.5826	-32.9772	0	1
FUZHOU, CHN	119.8434	25.43386	1	0
NINGBO, CHN	122.4432	29.6353	1	0
TAIZHOU, CHN	121.904	28.39494	1	0
ZHOUSHAN, CHN	122.3524	30.07578	3	0
CANGZHOU, CHN	117.9926	38.41017	0	1

FANGCHENGGANG, CHN	108.3594	21.35101	0	1
SHANGHAI, CHN	122.4429	31.15026	0	2
WEIHAI, CHN	122.4752	36.77404	0	2
YANCHENG, CHN	120.8529	33.34657	0	1
YANTAI, CHN	120.5043	37.76818	0	4
ZHOUSHAN, CHN	122.5799	29.69074	0	1
ZHUHAI, CHN	113.891	21.95844	0	1
MORONI, COM	43.24666	-11.6987	0	1
PORTO GRANDE, CPV	-25.0139	16.89649	0	1
BERKELEY SOUND, FLK	-57.8727	-51.568	2	0
STANLEY, FLK	-57.7503	-51.6548	3	4
PUNTA EUROPA TERMINAL, GNQ	8.697862	3.782797	1	0
CILACAP, IDN	109.0714	-7.76291	0	1
CIWANDAN, IDN	105.9063	-6.01334	0	3
TARAHAN, IDN	105.3134	-5.53781	0	2
DHAMRA, IND	86.96992	20.81961	1	0
GANGAVARAM INDIA, IND	83.31158	17.57624	1	0
KARAIKAL PORT, IND	79.84821	10.83813	1	0
BUSAN, KOR	129.0703	35.016	3	0
BUSAN, KOR	129.0519	35.00185	0	1
KUNSAN, KOR	126.4341	35.95429	0	1
ULSAN, KOR	129.4674	35.40544	0	1
TRINCOMALEE, LKA	81.24902	8.601268	1	0
YANGON, MMR	96.26056	16.64449	0	1
MAPUTO, MOZ	32.85625	-25.9414	0	1
PORT LOUIS, MUS	57.43215	-20.1553	1	0
PORT LOUIS, MUS	57.45671	-20.1329	0	4
KLANG, MYS	101.2617	2.754922	0	6
LUDERITZ BAY, NAM	15.14021	-26.6045	1	0
MINA QABUS, OMN	58.57469	23.63741	0	1
CHIMBOTE, PER	-78.6027	-9.10663	1	0
RAS TANURA, SAU	50.1814	26.67352	0	3
SINGAPORE, SGP	103.4702	1.246558	12	0
SINGAPORE, SGP	103.8964	1.230851	0	44
SOUTH GEORGIA, SGS	-36.4444	-54.3058	1	0

TH LCH, THA	100.8265	13.04606	0	2
KAOHSIUNG, TWN	120.2258	22.55449	1	0
KAOHSIUNG, TWN	120.2434	22.52293	0	1
TAICHUNG, TWN	120.3981	24.23911	0	1
MONTEVIDEO, URY	-56.0803	-35.0288	3	0
MONTEVIDEO, URY	-55.6383	-35.1122	0	1
RECALADA, URY	-55.4774	-35.1744	0	4
LOS ANGELES, USA	-118.204	33.70254	1	0
HO CHI MINH, VNM	107.0631	10.25112	0	1
CAPE TOWN, ZAF	18.36542	-33.8901	3	0
PORT ELIZABETH, ZAF	25.68039	-33.9069	2	0
CAPE TOWN, ZAF	18.37142	-33.8859	0	6
PORT ELIZABETH, ZAF	25.68884	-33.9022	0	1

Appendix C: Blue shark catch by Spanish longline vessels in the South Atlantic, 2016 to 2020



Total blue shark catch by Spanish longline vessels in the South Atlantic between 2016 and 2020, according to landings data sourced from ICCAT.