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Vessel activity in Nazca-Desventuradas and Juan Fernández proposed MPA expansion areas

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Executive summary

The President of Chile, Gabriel Boric, announced the intention to expand the Nazca Desventuradas and Juan Fernández marine protected areas during his 2025 Public Account. The Minister of Environment also announced it during the United Nations Conference on the Oceans (UNOC 3) held in Nice last June. It's a proposal that has been publicly addressed by Chilean authorities, the local communities and other stakeholders. In Juan Fernández, through the Local Management Council, which is the inter-institutional body coordinating work on the MPAs of both archipelagos and which includes the Navy, Subpesca, and Sernapesca, among other institutions. The Pew Bertarelli Ocean Legacy (PBOL) initiative is supporting these efforts. In addition, PBOL reached out to Global Fishing Watch (GFW) to prepare an analysis of the areas of interest using our technology and public data to inform this process.

Accordingly, this report summarizes vessel activity from January 1, 2012, to July 1, 2025, within three adjoining areas: the Nazca-Desventuradas marine protected area (MPA) expansion area, the Juan Fernández MPA expansion area, and the high seas corridor between the two areas.

Distinct north-south shipping lanes crossed all three areas, with cargo vessels being the most commonly detected vessel type. Most cargo vessels were flagged to Panama, followed by the Marshall Islands and Liberia.

In the Nazca-Desventuradas expansion area, little to no apparent fishing activity was detected by vessels using AIS. The Global Fishing Watch fishing detection model identified some small segments of vessel activity as potential fishing; however, most appear to be false positives, likely corresponding to vessels transiting through the area. In short, no significant apparent fishing activity was detected by AIS in this area. Using VMS, eight vessels were detected with apparent fishing activity, though further investigation is recommended to validate whether actual fishing occurred.

In the Juan Fernández expansion area, 102 AIS-using vessels were detected with at least one hour of apparent fishing activity, primarily in the south-eastern portion of the area. However, overall levels of apparent fishing remained very low compared to adjacent waters. The majority of these vessels were flagged to China. Chilean VMS data identified 50 vessels apparently fishing in the eastern portion of the area.

The high seas corridor between the two MPAs showed significantly more apparent fishing activity than either expansion area, with total apparent fishing hours approximately 26 times greater than those detected in the Juan Fernández expansion area. Most of the 140 fishing vessels detected were Chinese-flagged and used squid jigs or unidentified fishing gear. Spanish and Japanese longline vessels were also present. Only two Chilean-flagged fishing vessels were detected in this area based on AIS data. VMS data showed apparent fishing activity by 28 vessels, although the total fishing hours detected via VMS were much lower than those recorded by AIS, suggesting that this area is likely more important to international than national fishing fleets.

Of 284 Chilean vessels known to target swordfish and jack mackerel (*jurel*), 13 were detected fishing for one hour or more inside the Juan Fernández expansion area, all apparently targeting jack mackerel. None were detected fishing within the Nazca-Desventuradas expansion area.

Introduction

Last June, at the plenary session of the United Nations Conference on the Oceans (UNOC 3), the Minister of Environment of Chile announced the start of work to increase the protected areas around the "Mar de Juan Fernández" and "Nazca-Desventuradas" marine parks, in addition to the Desventuradas Multiple Use Conservation Area (ACMU), all of which are of great ecological importance due to their high endemism.

The Nazca-Desventuradas Marine Park was established in August 2016. This park consists of a protected area of 300,035 km², where fishing and other extractive activities are prohibited. The main objective of this Marine Park is to preserve the pristine state of the unique and endemic biodiversity found in the area, protect the seamounts and their vulnerable ecosystems, and contribute to the development of scientific knowledge of deep-sea ecosystems. This Park surrounds what are known as the Desventuradas Islands, which are made up of the San Ambrosio and San Félix islands, and the González and Roca Catedral islets. This archipelago is located just over 850 km off the coast of continental Chile.

The Juan Fernández Marine Park, with 262,000 km², was created in December 2018. The objective of this decree has been to protect the biodiversity and species present in the ecosystem, such as the southern bluefin tuna, the shortfin mako shark, the blue shark, sea turtles, and whales, several of which have been classified as vulnerable and endangered. Along with the creation of the marine park, there are other MPAs in the area, such as the Juan Fernández Sea Multiple-Use Coastal Marine Protected Area (24,000 km²), the Crusoe and Selkirk Seamounts National Park, covering 1,078 km², and the network of small island coastal national parks: Lobería Selkirk, El Arenal, Tierra Blanca, and El Palillo.

PBOL is supporting the efforts to expand the Nazca–Desventuradas and Juan Fernández MPAs. In addition, there is interest in proposing that the area of high seas between both of those MPAs be designated as an MPA when the BBNJ agreement enters into force. For this reason, PBOL reached out to Global Fishing Watch (GFW) to prepare an analysis of the areas of interest using our technology and data.

Accordingly, this report provides an overview of historical vessel activity within the proposed expansion areas for the Nazca-Desventuradas and Juan Fernández Marine Protected Areas (MPAs), as well as the high seas corridor between the two areas (Figure 1), covering the period from January 1, 2012, to July 1, 2025.

For each area, the following activities were analyzed:

- **Vessel presence**, based on AIS data. When addressing Vessel presence in this report, we are referring to the aggregated amount of hours of activity of all vessels detected within each area of interest for the analysis period.
- **Apparent fishing activity**, derived from the application of the Global Fishing Watch fishing detection algorithm to **AIS data**. In this report, whenever there is a reference to fishing activity, it should be understood that we are referring to apparent fishing.
- **Apparent fishing activity** based on the application of the Global Fishing Watch fishing detection algorithm to **VMS data**.

Note: Chile has made its VMS data available through the Global Fishing Watch map since March 2019.

In addition, this report includes an analysis of large vessels (cargo) transiting at 15 knots or more in the areas of interest, given the high risks that scientists have associated with the potential collision of large vessels traveling at over 15 knots with vulnerable species such as whales, other mammals, and sea turtles. Finally, this report also includes an analysis of the activity of vessels known to target swordfish and jack mackerel within each of these areas.

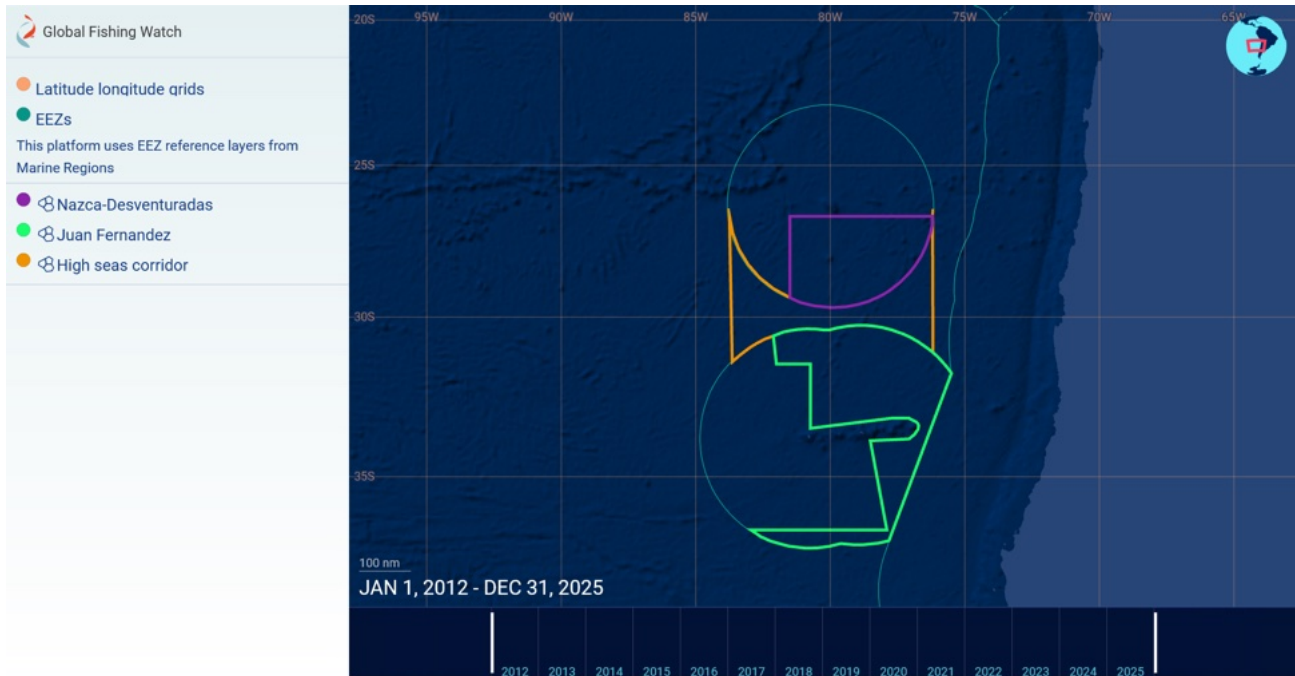


Figure 1. Map of the areas of interest included in this analysis: the Nazca-Desventuradas expansion area (purple), the Juan Fernández expansion area (green), and the high seas corridor (orange) between them. See the Global Fishing Watch map [workspace](#) for more information

Data description

Below is a description of the various datasets used in this report, along with key considerations and caveats associated with each.

Automatic Identification System (AIS):

As mandated by the International Maritime Organization (IMO), vessels over 300 gross tons are required to broadcast their locations using AIS. The use of AIS has steadily increased in recent years, as a growing number of flag and coastal states have mandated its use in national or regional regulations. AIS devices broadcast a vessel's location, identity information, course, and speed. As such, AIS data can offer valuable insight into vessel activity and serve as a useful complement to existing monitoring, control, and surveillance programs.

The completeness and accuracy of vessel activity patterns derived from AIS depend primarily on two factors: AIS and signal reception. For a vessel to be detected, it must have AIS installed and actively broadcasting. Reception refers to the likelihood that a vessel's AIS transmission is successfully received by the existing network of satellites and terrestrial antennas along global coastlines. In regions with dense maritime traffic, overlapping AIS signals can interfere with one another, reducing the reliability of satellite-based reception.

Apparent fishing activity:

Global Fishing Watch has developed machine learning algorithms that are applied to AIS transmissions to infer vessel identity and activity at sea. All references to “fishing” in this report should be understood in the context of Global Fishing Watch’s fishing detection algorithm, which estimates “apparent fishing effort” based on AIS data collected via satellites and terrestrial receivers.

Because AIS data varies in completeness, accuracy, and quality, some fishing effort goes undetected, and some activity identified as fishing may not be fishing. Therefore, all references to vessel fishing activity in this report, whether using terms such as *fishing*, *fishing effort*, or *fishing activity*, should be understood as *apparent*, rather than certain. For readability, we use the shorter terminology that omits “apparent,” while maintaining this distinction throughout.

Vessel monitoring system (VMS):

This system tracks vessels in a similar way to AIS, but has historically been restricted to fisheries authorities and other government regulators. However, several countries have made their VMS data publicly available through the Global Fishing Watch platform. Global Fishing Watch applies the same algorithms developed for AIS to analyze VMS data, enabling the identification of apparent fishing activity and vessel behaviors. The algorithm classifies each vessel position as either apparent fishing or non-fishing, with apparent fishing activity visualized on Global Fishing Watch’s fishing activity heat map.

VMS transmits data at a different rate than AIS and may differ in terms of completeness, accuracy, and quality. Notably, Chile’s VMS data has been available transparently through the Global Fishing Watch map from March 2019 to date.

We refer readers to this [AIS Explainer brief](#) to better understand the differences, strengths, and limitations of AIS and VMS, the primary data sources used in this report.

Results

Nazca-Desventuradas

Vessel presence

Between January 1, 2012, and July 1, 2025, a total of 5,482 vessels associated with 80 flags were detected within the Nazca-Desventuradas expansion area, with vessel presence increasing most years from 2016 onwards (Figure 2). As Figure 3 shows, many of these vessels appeared to be transiting through the area, traveling north to south or south to north. Consequently, the most commonly detected ship type was cargo vessels (Figure 4), 580 of which were detected moving at more than 15 knots in the expansion area (Figure 5). Cargo vessels were most frequently flagged to Panama, followed by the Marshall Islands and Liberia (figure 6).

Fishing vessels detected in the area were most commonly flagged to China, which accounted for 634 of 732 fishing vessels detected in the area, representing 87% of the total.

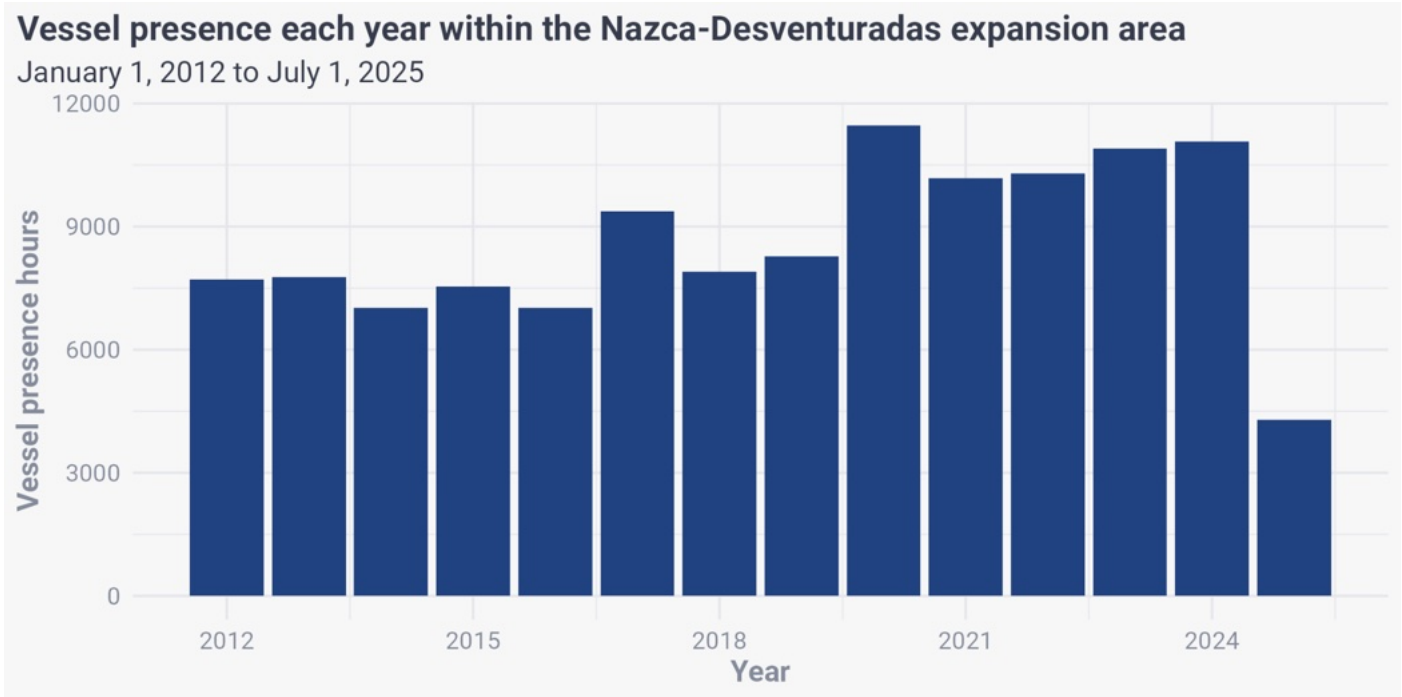


Figure 2. Overall vessel presence, derived from AIS data, each year within the Nazca-Desventuradas expansion area from January 1, 2012, to July 1, 2025

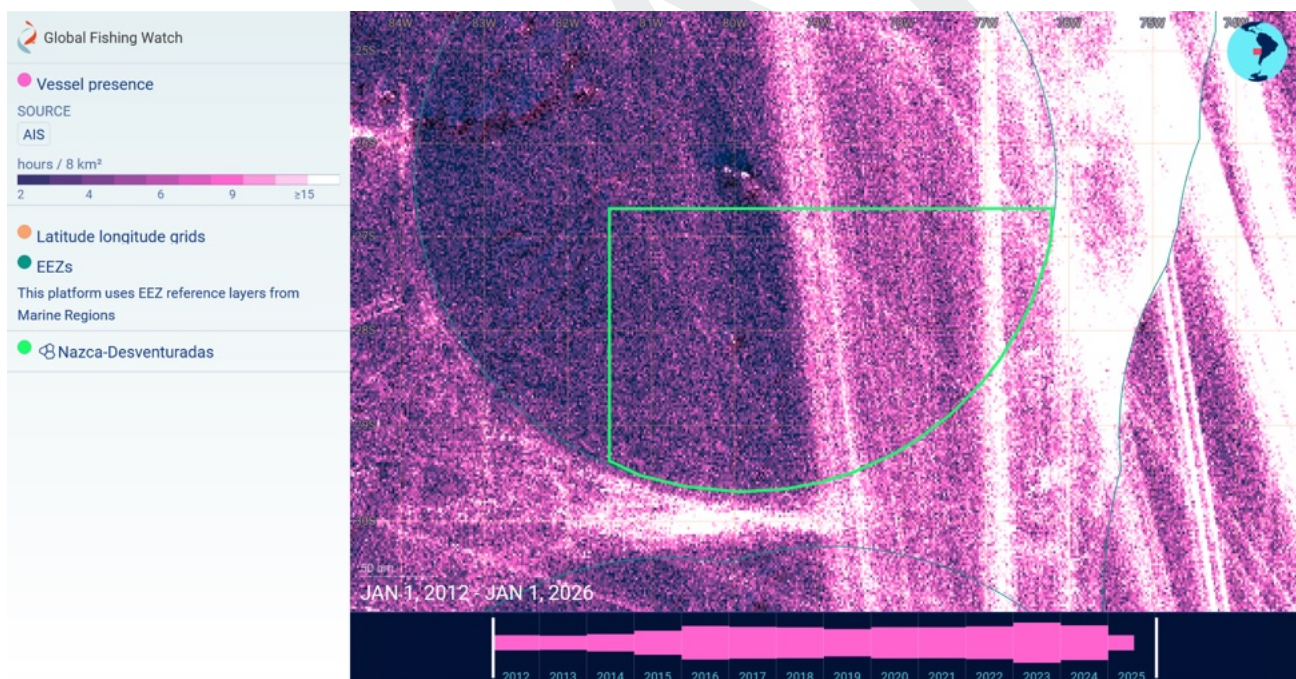


Figure 3. Vessel presence, derived from AIS data, within the Nazca-Desventuradas expansion area (green) between January 1, 2012, and July 1, 2025. See the Global Fishing Watch map [workspace](#) for more information

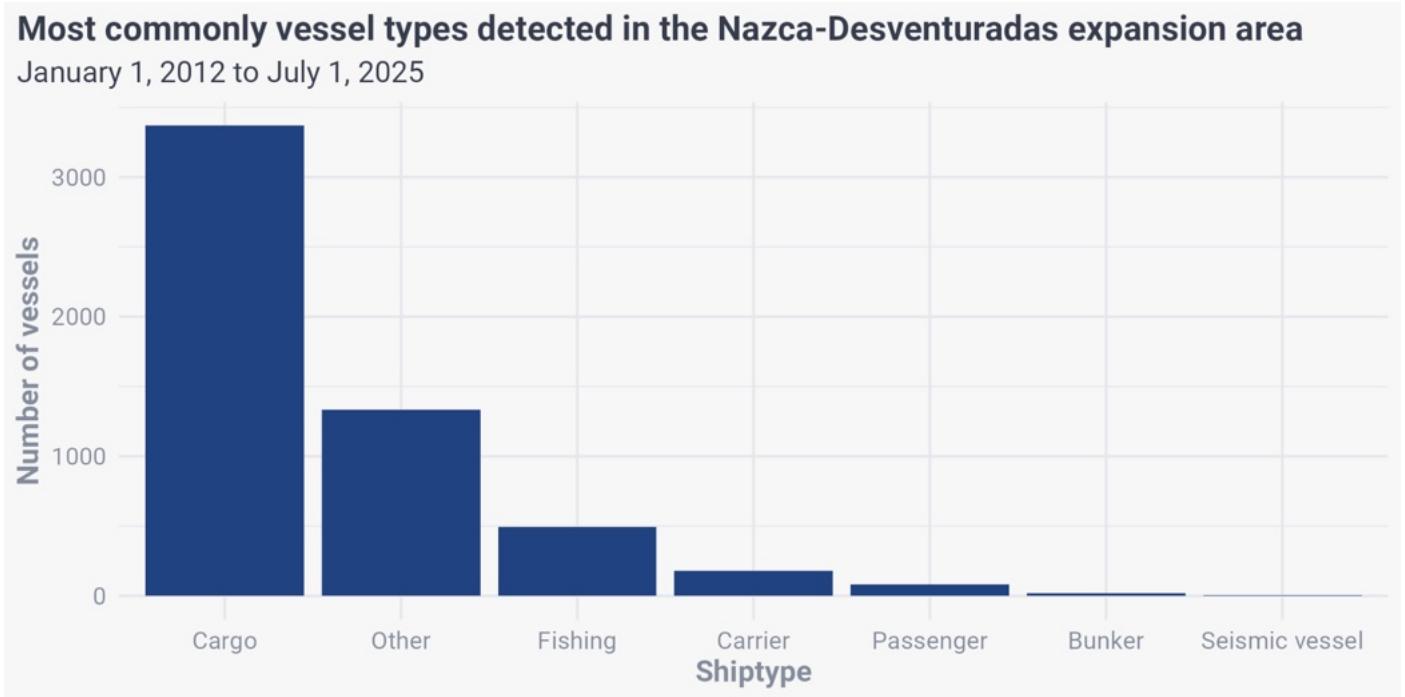


Figure 4. Number of distinct vessels, derived from AIS data, by ship type detected within the Nazca-Desventuradas expansion area, between January 1, 2012, and July 1, 2025

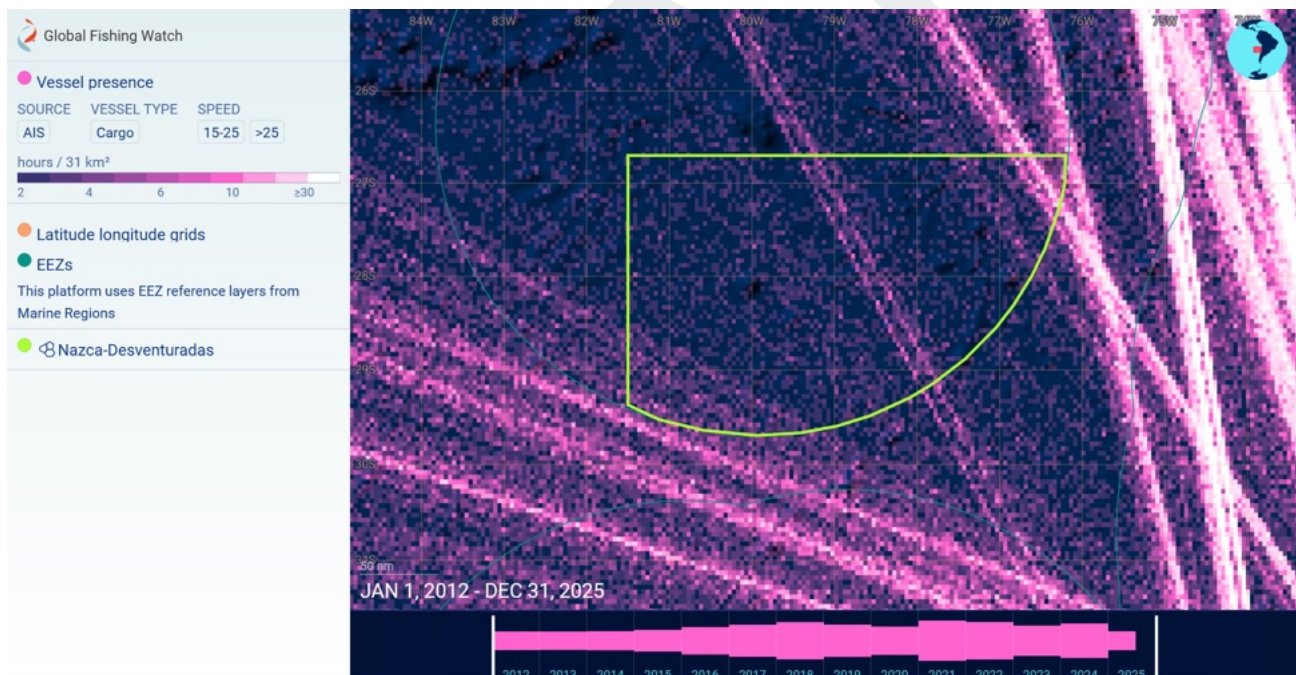


Figure 5. Aggregated detections of **cargo** vessels moving at speeds of 15 knots or higher in the Nazca-Desventuradas expansion area between January 1, 2012, and July 1, 2025. Access the Global Fishing Watch map workspace [here](#)

Ten most frequent flags associated with cargo vessels detected in the Nazca-Desventuradas expansion area

January 1, 2012 to July 1, 2025

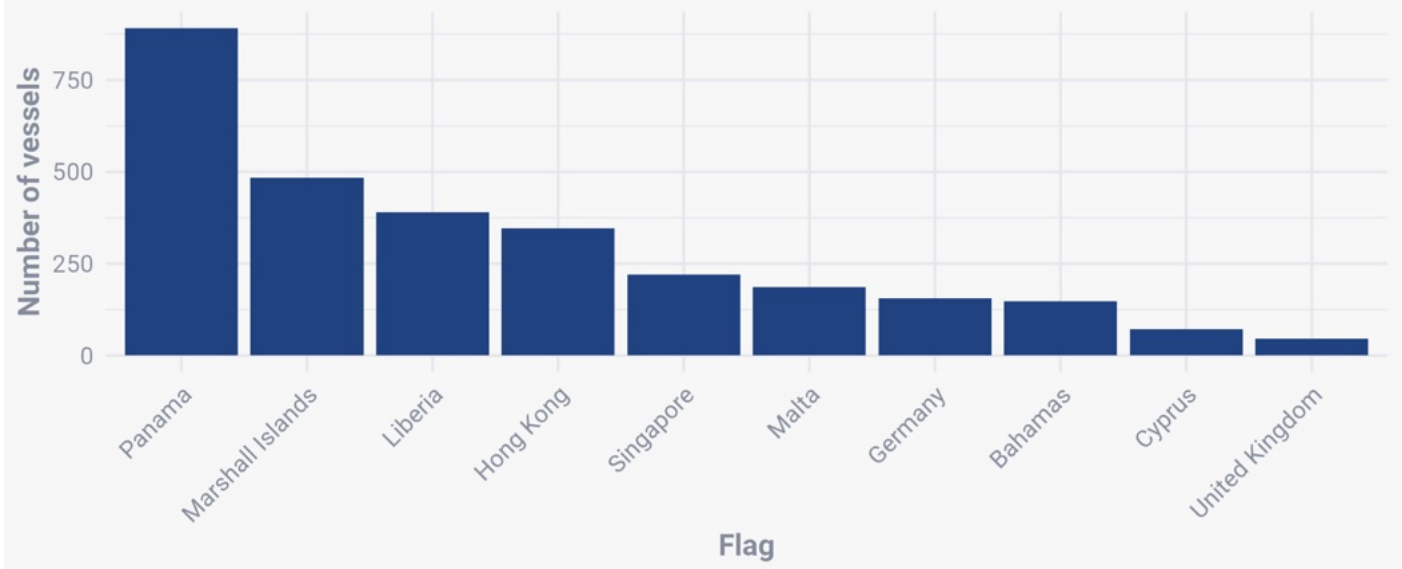


Figure 6. Number of **cargo** vessels, derived from AIS data, associated with the ten most commonly detected flags within the Nazca-Desventuradas expansion area, between January 1, 2012, and July 1, 2025

Apparent fishing activity

As Figure 7 shows, derived from AIS data, little to no fishing activity was detected in this area between January 1, 2012, and July 1, 2025. The few apparent fishing detections within the area included what appeared to be fishing vessels moving in a straight line, which is more consistent with transiting behavior than with actual fishing.

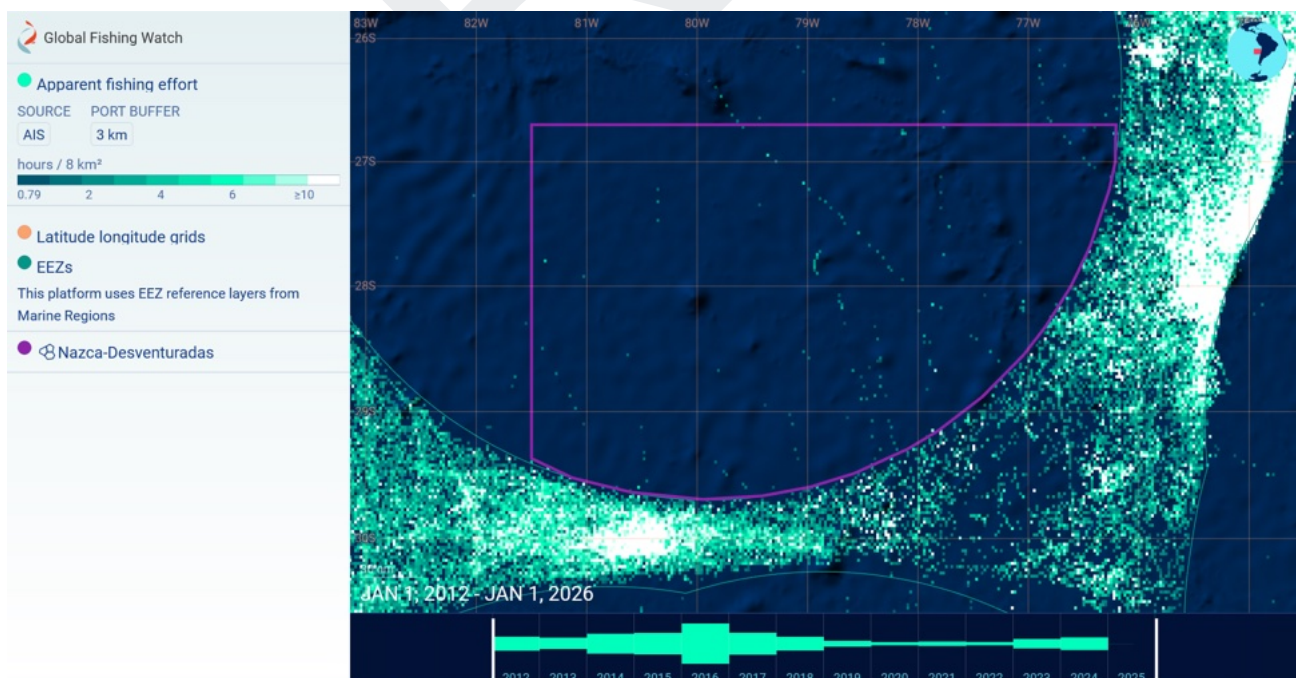


Figure 7. Apparent fishing effort, derived from AIS data, within the Nazca-Desventuradas expansion area (purple), between January 1, 2012, and July 1, 2025. See the Global Fishing Watch map [workspace](#) for more information

To reduce misclassification, we only counted vessels that were detected with at least one hour of apparent fishing activity within the area. Based on this criterion, 39 vessels associated with 6 flags were identified, with a total of 285 hours of apparent fishing activity over the 13 years of this analysis, which is relatively low. The majority of these vessels were Chinese-flagged, using either squid jigger gear or unidentified fishing gear (Figure 8).

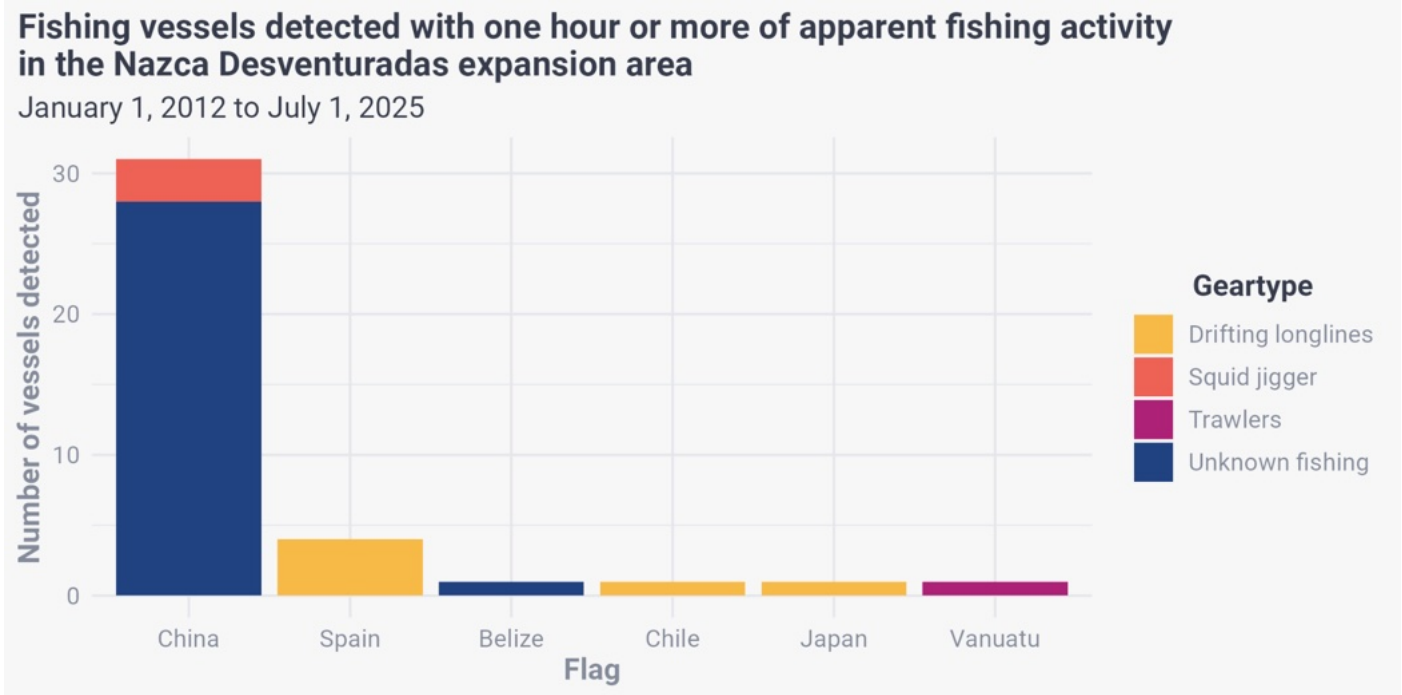


Figure 8. Number of fishing vessels, derived from AIS data, by flag and gear type detected with at least one hour of apparent fishing activity within the Nazca-Desventuradas expansion area, between January 1, 2012, and July 1, 2025

By applying the fishing detection model to available VMS data, eight vessels were detected using Chilean VMS with apparent fishing activity totaling 709 hours inside the area. While the apparent straight lines through the area similarly may represent false positive detections of fishing as vessels transit through the area, there is a noticeable cluster of apparent activity by Chilean vessels in the eastern extent of the area that took place during August 2020 only, that doesn't resemble transiting activity and may include actual fishing activity, pending further investigation (Figure 9).

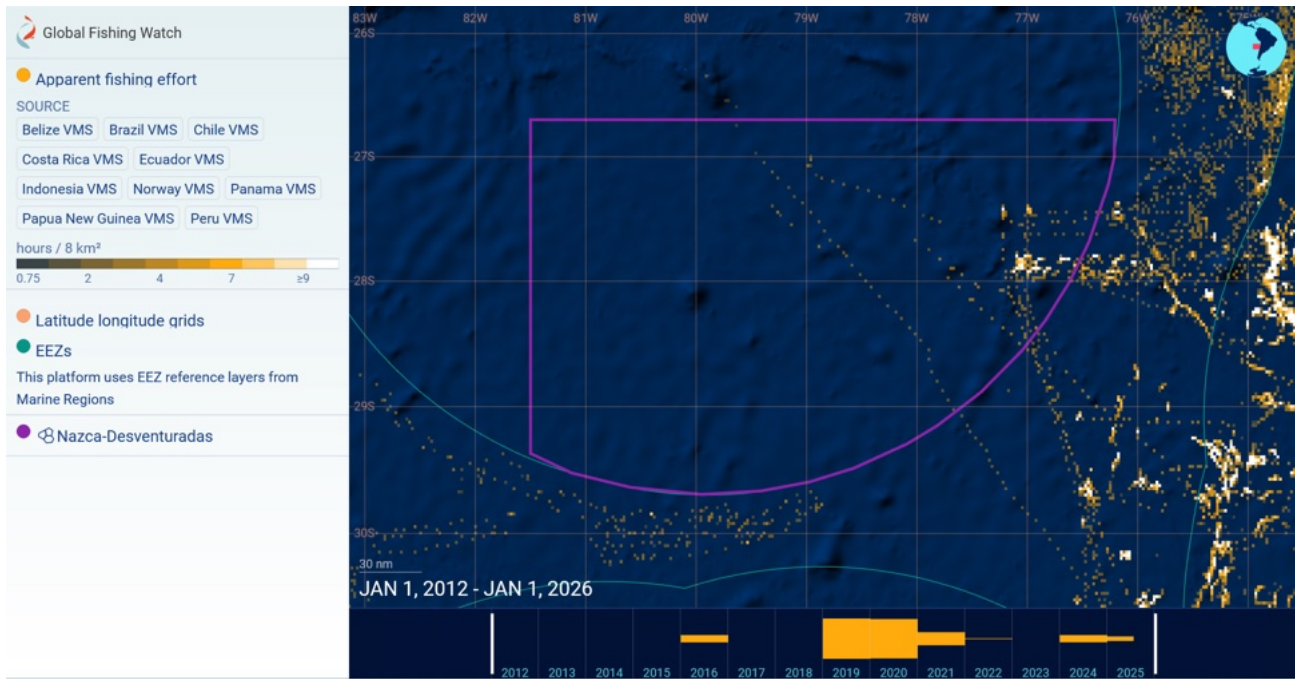


Figure 9. Apparent fishing effort, derived from VMS data, within the Nazca-Desventuradas expansion area (purple), between January 1, 2012, and July 1, 2025. See the Global Fishing Watch map [workspace](#) for more information

Juan Fernández

Vessel presence

Between January 1, 2012, and July 1, 2025, a total of 6,078 vessels associated with 85 flags were detected within the Juan Fernández expansion area, with overall vessel presence remaining relatively consistent in recent years (Figure 10). Similar to the Nazca-Desventuradas area, many vessels transited through the eastern extent, primarily traveling north to south or south to north. However, an additional clear corridor was observed, with vessels traveling west to east and east to west between the islands and the mainland (Figure 11).

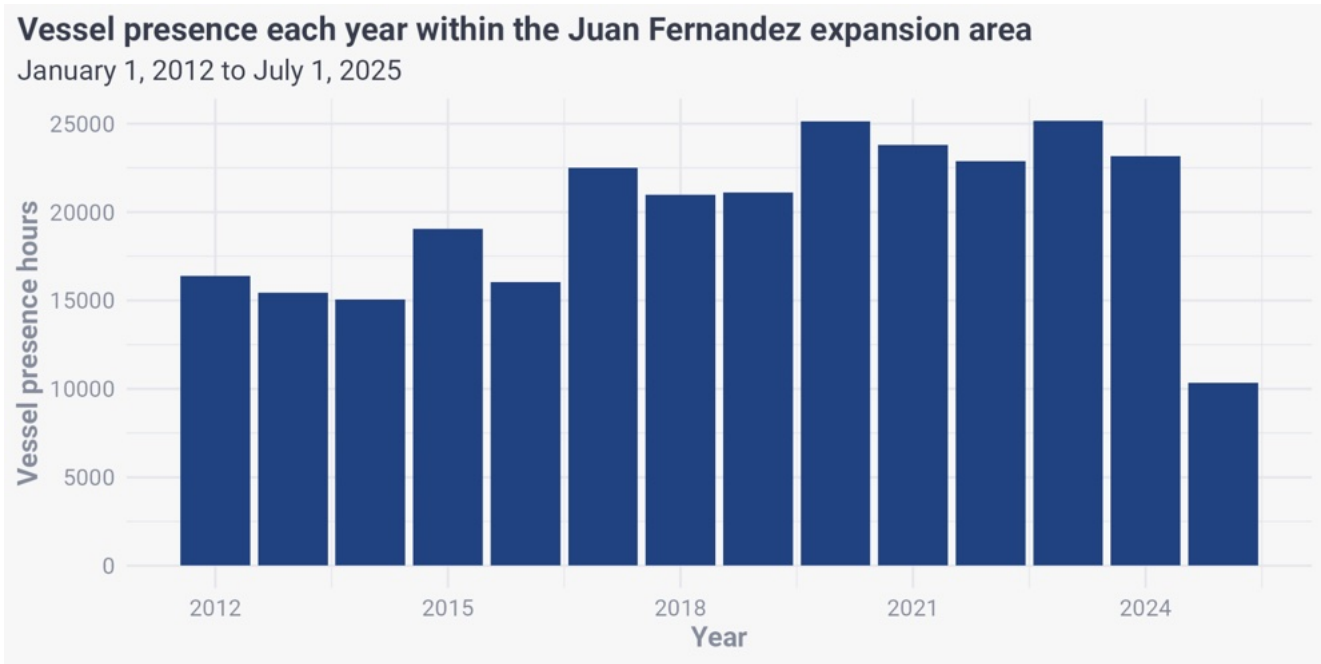


Figure 10. Overall vessel presence each year, derived from AIS data, within the Juan Fernández expansion area from January 1, 2012, to July 1, 2025

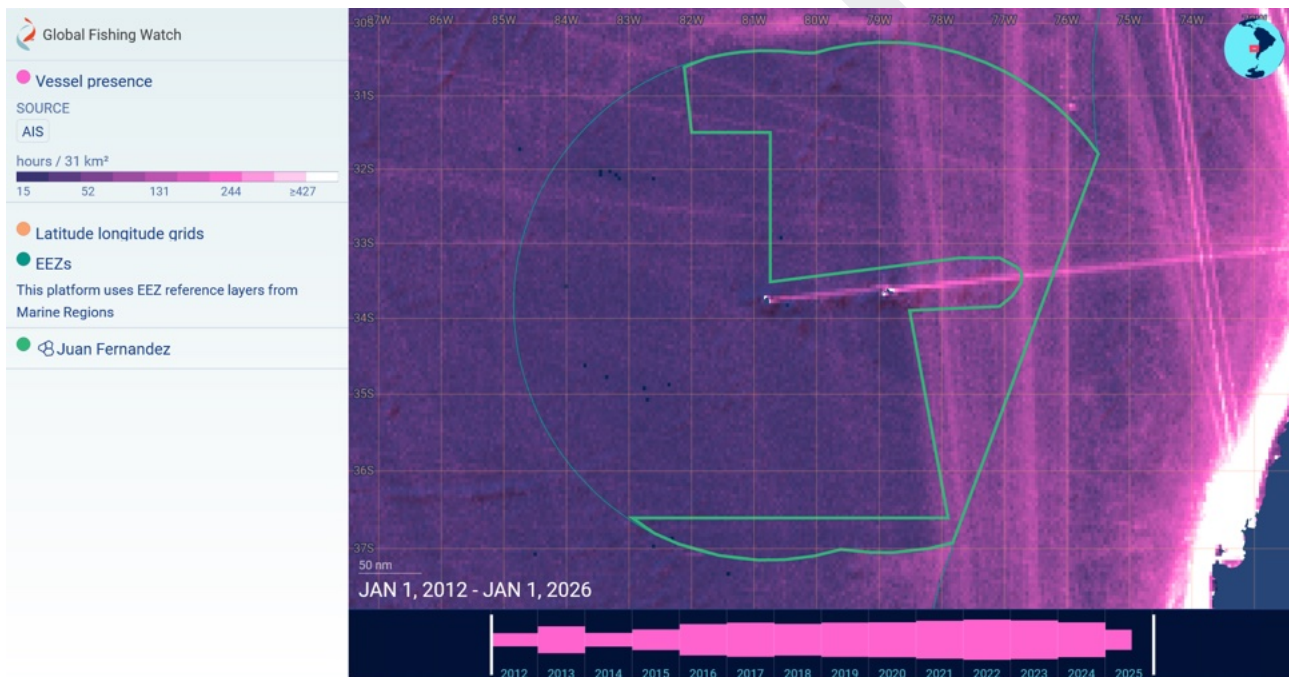


Figure 11. Vessel presence, derived from AIS data, within the Juan Fernández expansion area (green), between January 1, 2012, and July 1, 2025. See the Global Fishing Watch map [workspace](#) for more information

As was the case with Nazca-Desventuradas, cargo vessels were the most commonly detected ship type in the area, and these were most frequently flagged to Panama, the Marshall Islands, and Liberia (Figures 12 and 13). Nine hundred and ninety-three cargo vessels were detected moving at speeds of 15 knots or higher in the expansion area (Figure 14). Chinese-flagged vessels accounted for 739 out of the 892 fishing vessels (83%) detected in the area, followed by Chilean-flagged vessels, with 35 vessels (4%).

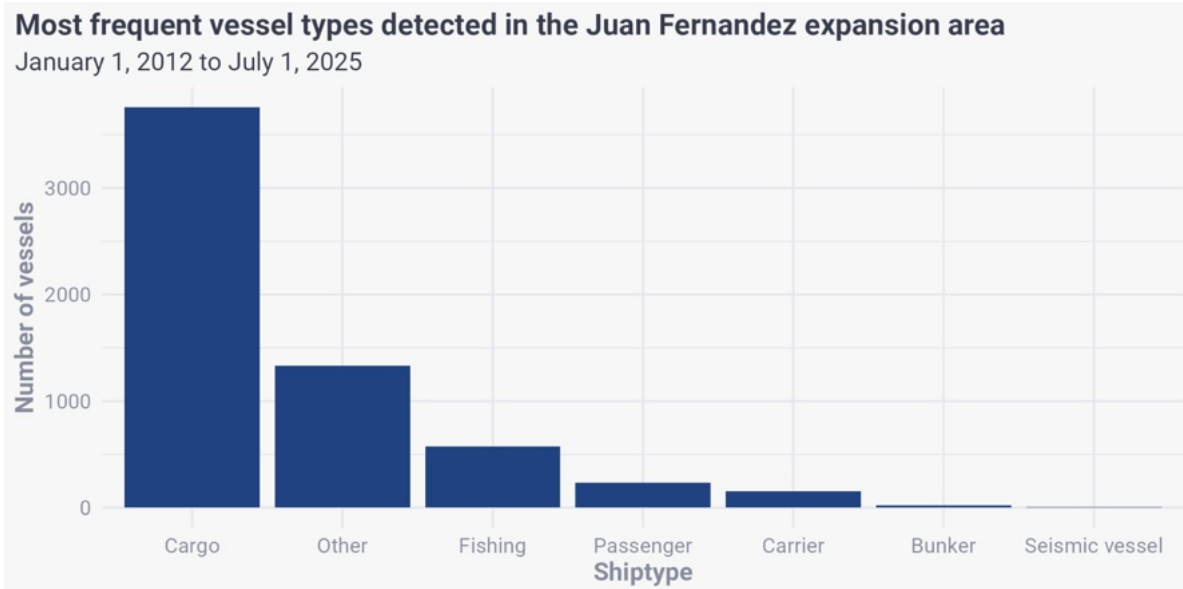


Figure 12. Number of distinct vessels, derived from AIS data, by ship type detected within the Juan Fernández expansion area, between January 1, 2012, and July 1, 2025

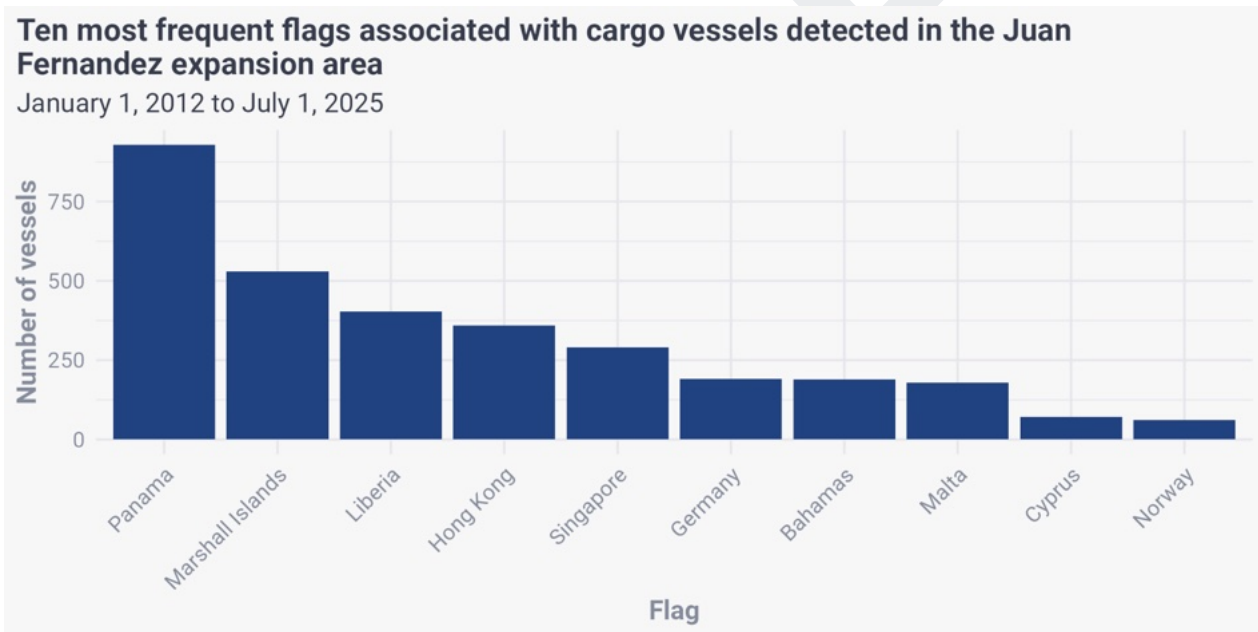


Figure 13. Number of **cargo** vessels, derived from AIS data, associated with each of the ten most commonly detected flags within the Juan Fernández expansion area, between January 1, 2012, and July 1, 2025

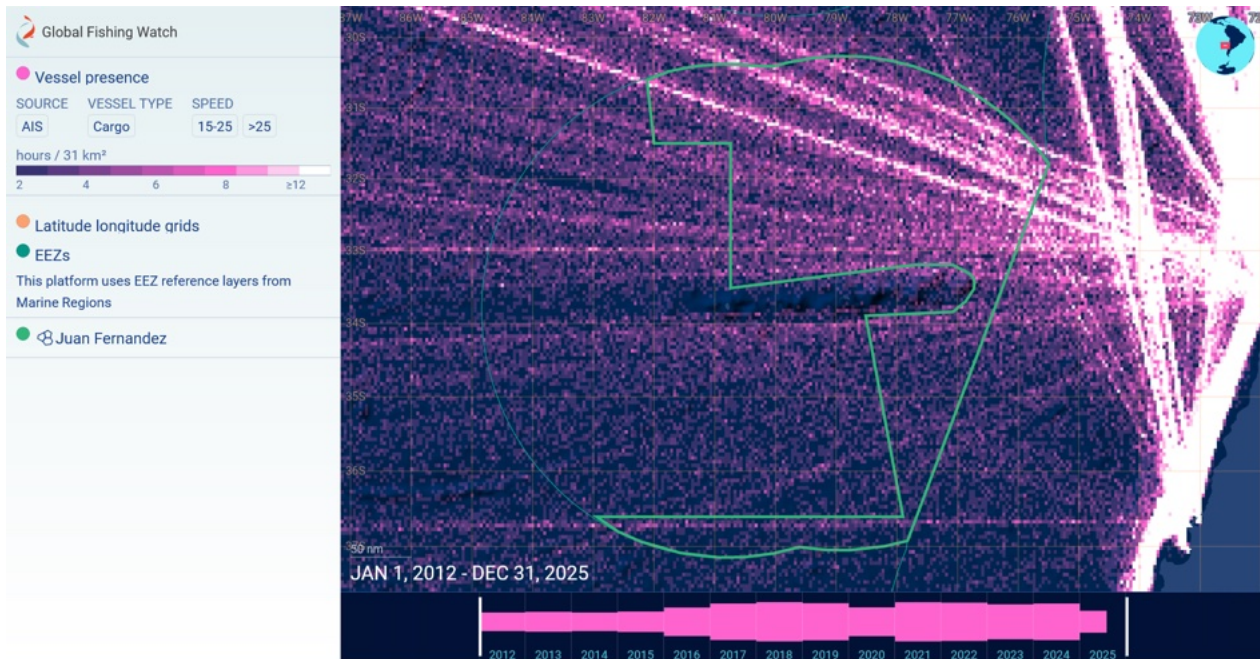


Figure 14. Aggregated detections of **cargo** vessels moving at speeds of 15 knots or higher in the Juan Fernández expansion area between January 1, 2012, and July 1, 2025. Access the Global Fishing Watch map workspace [here](#). Note that most of them are vessels transiting to/from Asia to/from Chilean ports.

Apparent fishing activity

Figure 15 shows all apparent fishing activity detected by AIS-transmitting vessels between January 1, 2012, and July 1, 2025. While there were several likely false positive detections, vessels transiting in straight lines through the area, a cluster of apparent fishing activity during June to August 2015 in the southeastern portion more closely resembled typical fishing activity patterns.

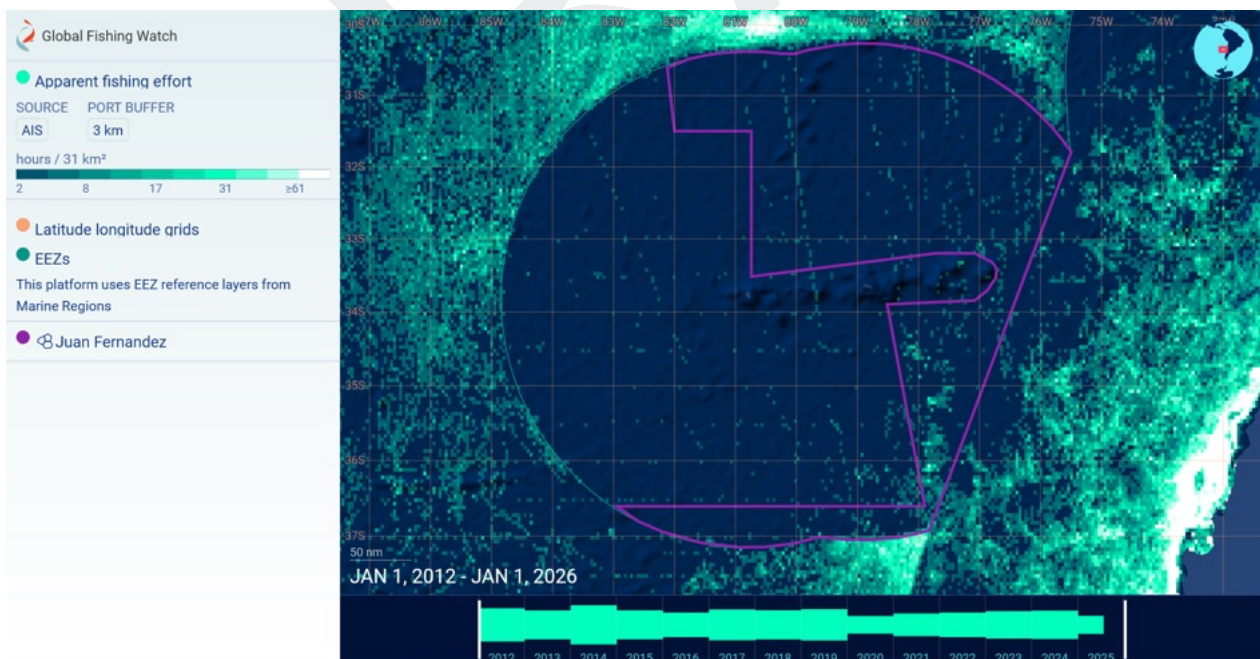


Figure 15. Apparent fishing effort, derived from AIS data, within the Juan Fernández expansion area (purple) between January 1, 2012, and July 1, 2025. See the Global Fishing Watch map [workspace](#) for more information

Restricting the analysis to vessels detected with at least one hour of apparent fishing activity in the Juan Fernández expansion area, a total of 97 fishing vessels, flagged to 9 countries, were identified, accounting for 1,680 hours of fishing activity over the 13 years of the analysis. This is considerably more than the activity detected in the Nazca-Desventuradas expansion area, though still relatively low compared to adjacent waters outside the expansion area.

The majority of these vessels were Chinese-flagged with an undetermined gear type, followed by Chilean-flagged vessels, most of which appeared to be using purse-seine gear (Figure 16).

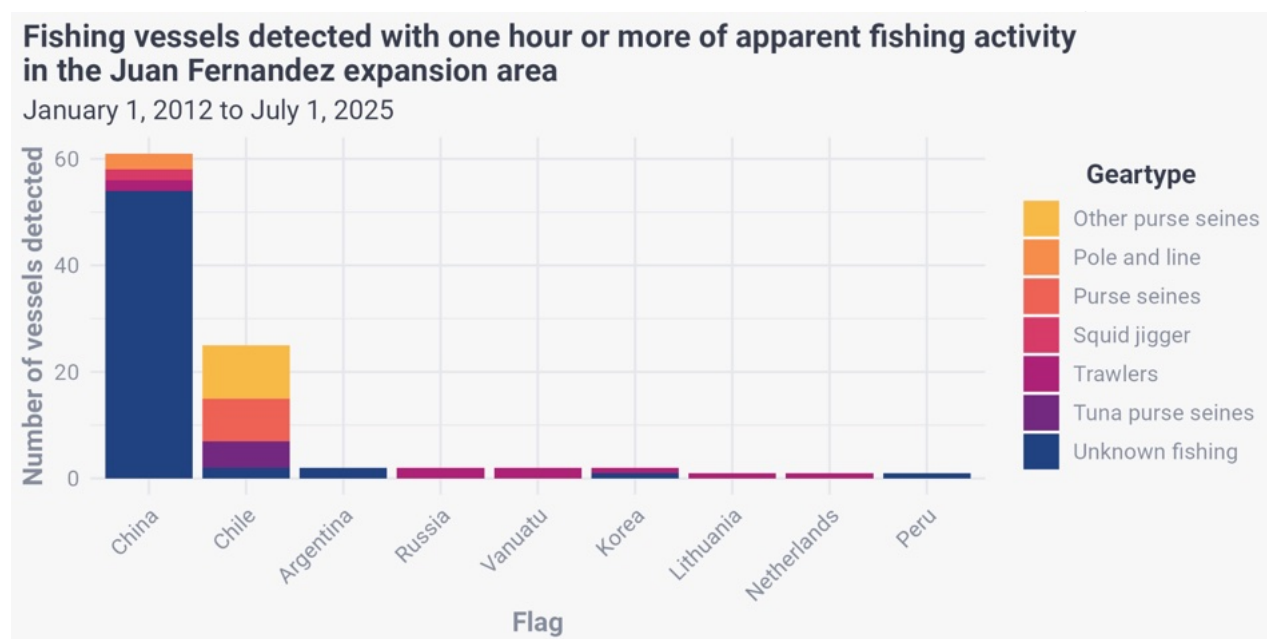


Figure 16. Number of fishing vessels, derived from AIS data, by flag and gear type detected with at least one hour of apparent fishing activity within the Juan Fernández expansion area, between January 1, 2012, and July 1, 2025

VMS data additionally highlighted apparent fishing activity in the eastern extent of the Juan Fernández expansion area, with 50 vessels detected fishing for at least one hour each, totaling 6,935 hours of apparent fishing activity (Figure 17). As Figure 18 shows, VMS-derived fishing activity was only detected in the area between 2019 and 2022 (as it was stated above, GFW started receiving Chile's VMS data in 2019).

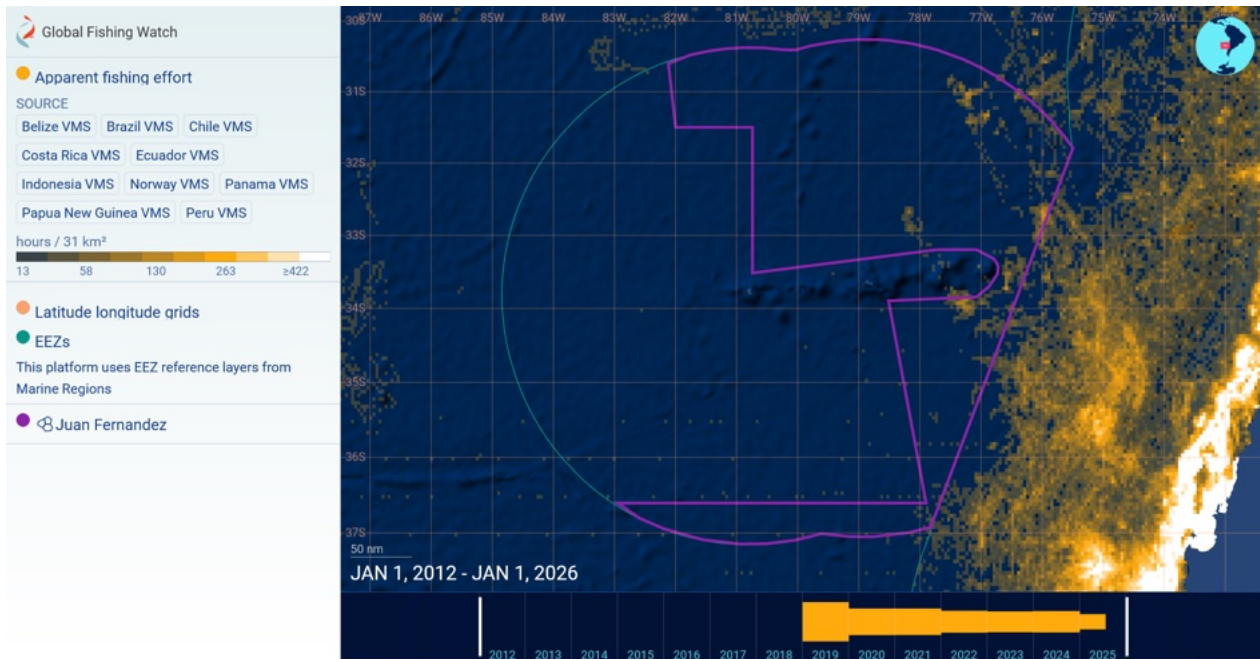


Figure 17. Apparent fishing effort, derived from VMS data, within the Juan Fernández expansion area (purple), between January 1, 2012, and July 1, 2025. See the Global Fishing Watch map [workspace](#) for more information

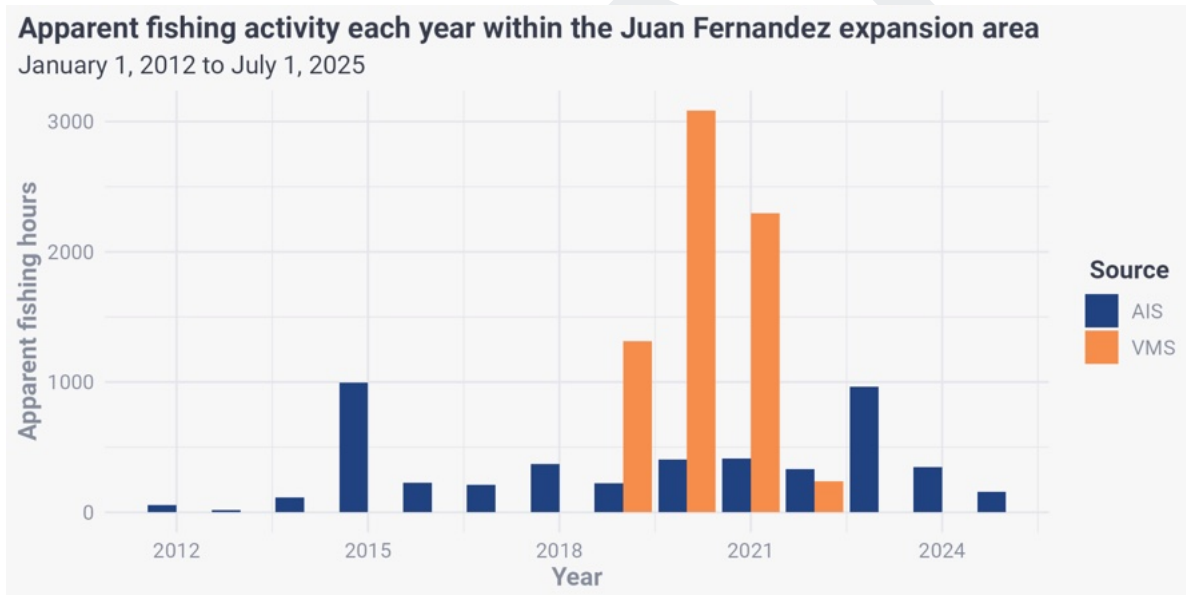


Figure 18. Apparent fishing activity derived from AIS (blue) and VMS (orange) data in the Juan Fernández expansion area between January 1, 2012, and July 1, 2025. Note that Chilean VMS data was first published on the Global Fishing Watch map in 2019.

High seas corridor

Vessel presence

Between January 1, 2012, and July 1, 2025, a total of 6,209 vessels associated with 86 flags were detected within the high seas corridor between the Nazca-Desventuradas and Juan Fernández expansion areas. Vessel traffic has not noticeably increased or decreased during the period of interest, except in 2023 when there was a relatively higher amount of activity (Figure 19). Similar to the expansion areas, there was a

relatively high density of vessel traffic traveling north to south and south to north through the eastern half of the corridor (Figure 20).

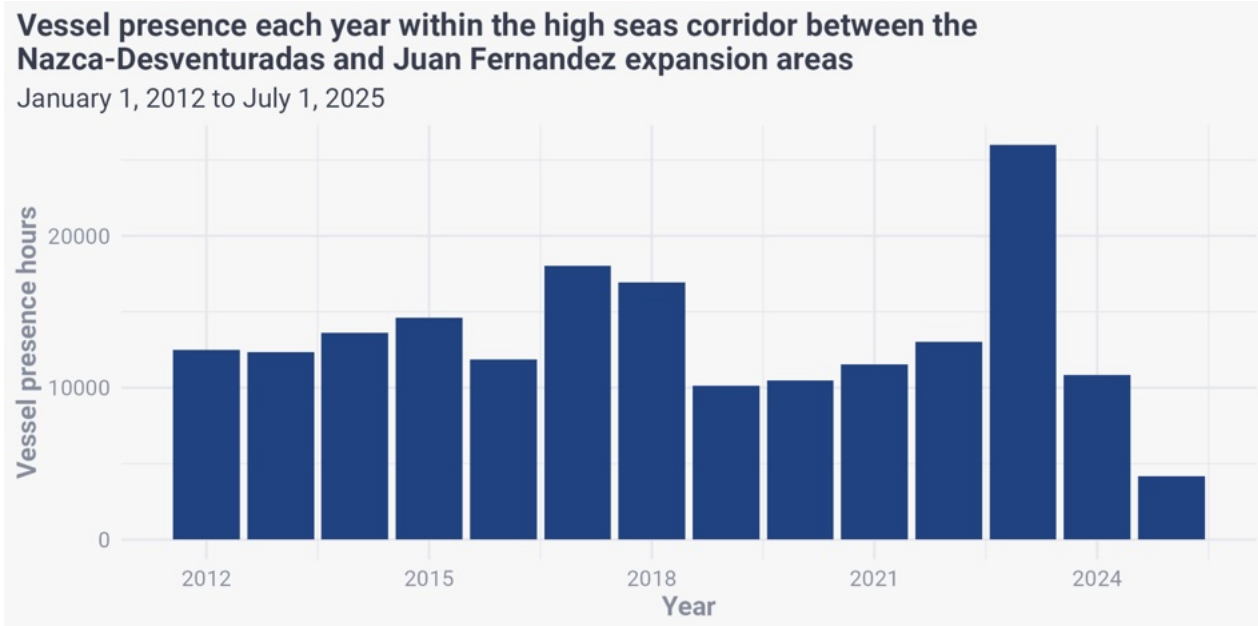


Figure 19. Overall vessel presence each year, derived from AIS data, in the high seas corridor between Nazca-Desventuradas and Juan Fernandez expansion areas from January 1, 2012, to July 1, 2025

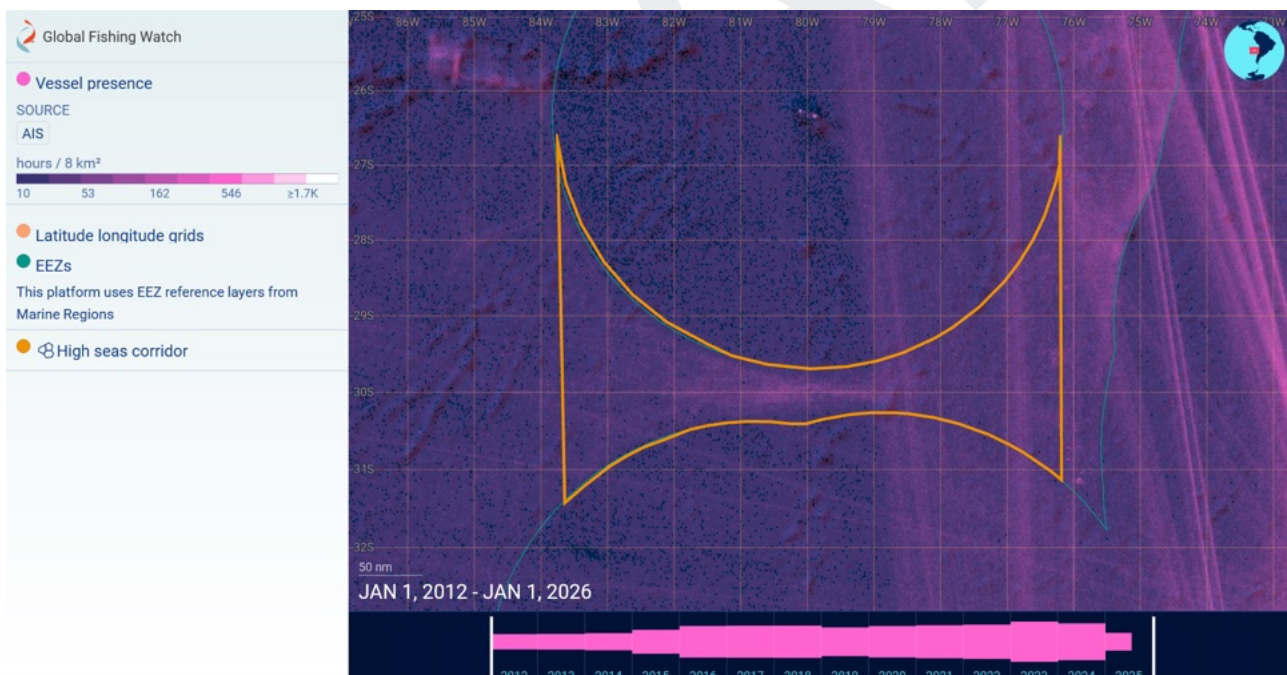


Figure 20. Vessel presence, derived from AIS data, within the high seas corridor (orange) between Nazca-Desventuradas and Juan Fernández areas, between January 1, 2012, and July 1, 2025. See the Global Fishing Watch map [workspace](#) for more information

In addition, a notable concentration of vessels was observed in the central part of the corridor, where vessel movements did not follow the clear transit patterns seen elsewhere, suggesting other types of activity. Due to the continuity of major shipping lanes through all three areas, cargo vessels were again the most commonly detected vessel type in this high-seas area (Figure 21). Furthermore, 1,256 cargo vessels were detected moving faster than 15 knots through this area (Figure 22).

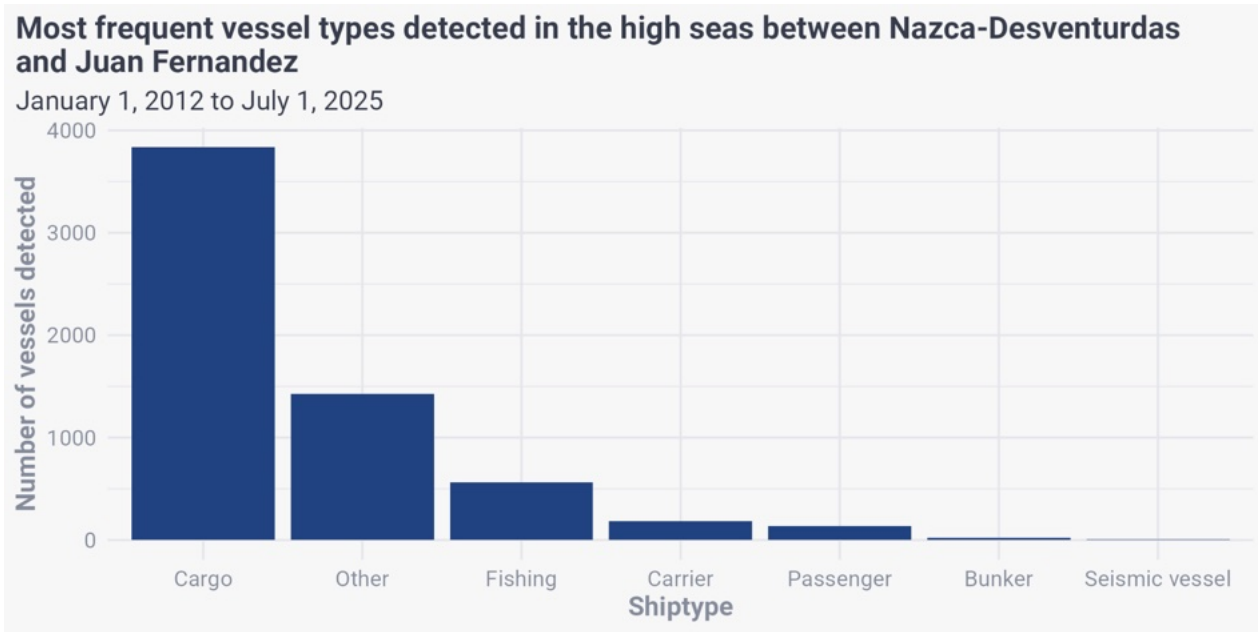


Figure 21. The number of distinct vessels of each shiptype, derived from AIS data, detected within the high seas corridor between the Nazca-Desventuradas and Juan Fernández expansion areas between January 1, 2012, and July 1, 2025

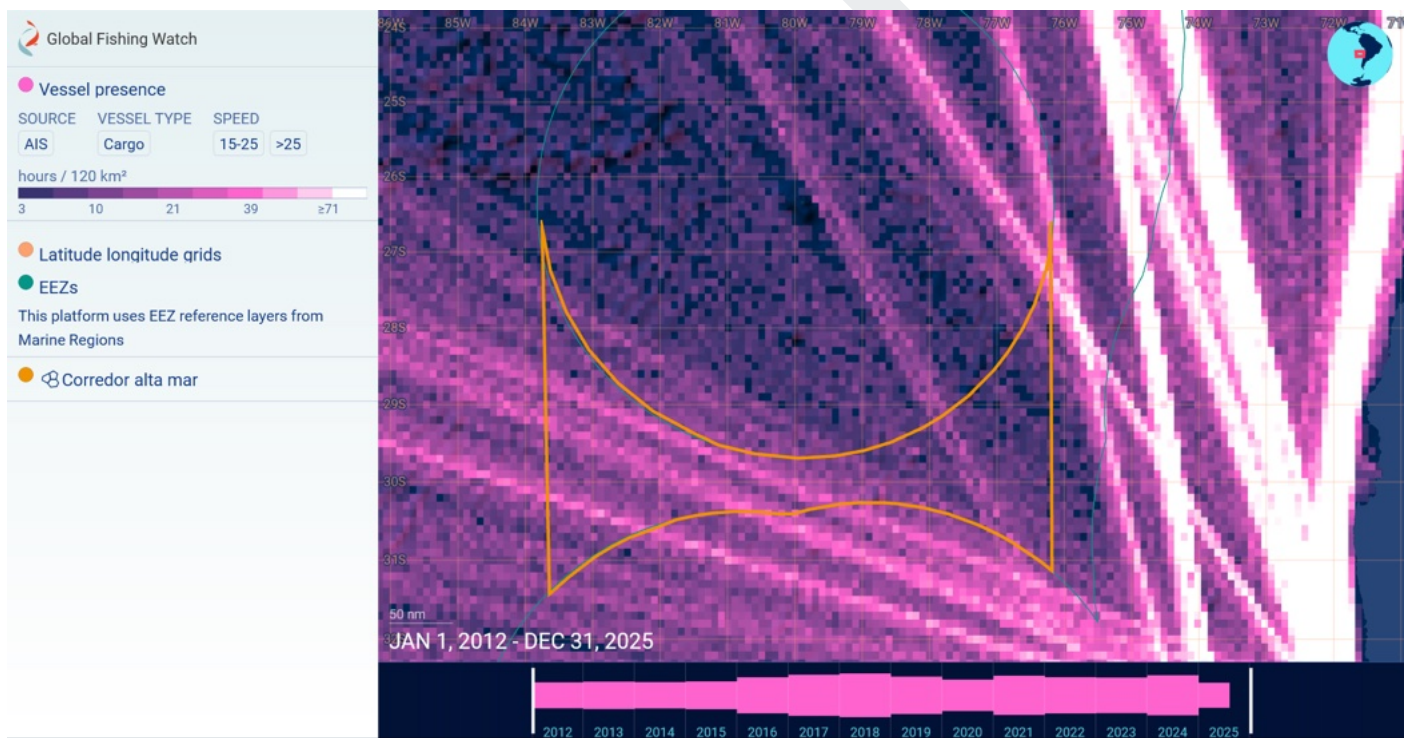


Figure 22: Aggregated detections of cargo vessels, derived from AIS, moving at speeds of 15 knots or higher in the high seas pockets between Nazca-Desventuradas expansion area and the Juan Fernández expansion area between January 1, 2012, and July 1, 2025. Access the Global Fishing Watch map workspace [here](#).

The distribution of cargo vessel flags was broadly similar to that observed within the high seas pockets, with Panama, the Marshall Islands, and Liberia being the three most common flags among cargo vessels. Chinese-flagged vessels accounted for 84% of the fishing vessels detected in the area.

Apparent fishing activity

Figure 23 shows all apparent fishing activity detected by AIS-transmitting vessels between January 1, 2012, and July 1, 2025. A prominent cluster of apparent fishing activity is visible in the center of the corridor, aligning with the high density of vessel presence in Figure 23.

Restricting the analysis to vessels detected fishing for at least one hour in the area, a total of 133 fishing vessels, associated with 19 different flags, were recorded, accounting for 42,604 hours of apparent activity. This level of activity is considerably higher than that observed in either MPA expansion areas.

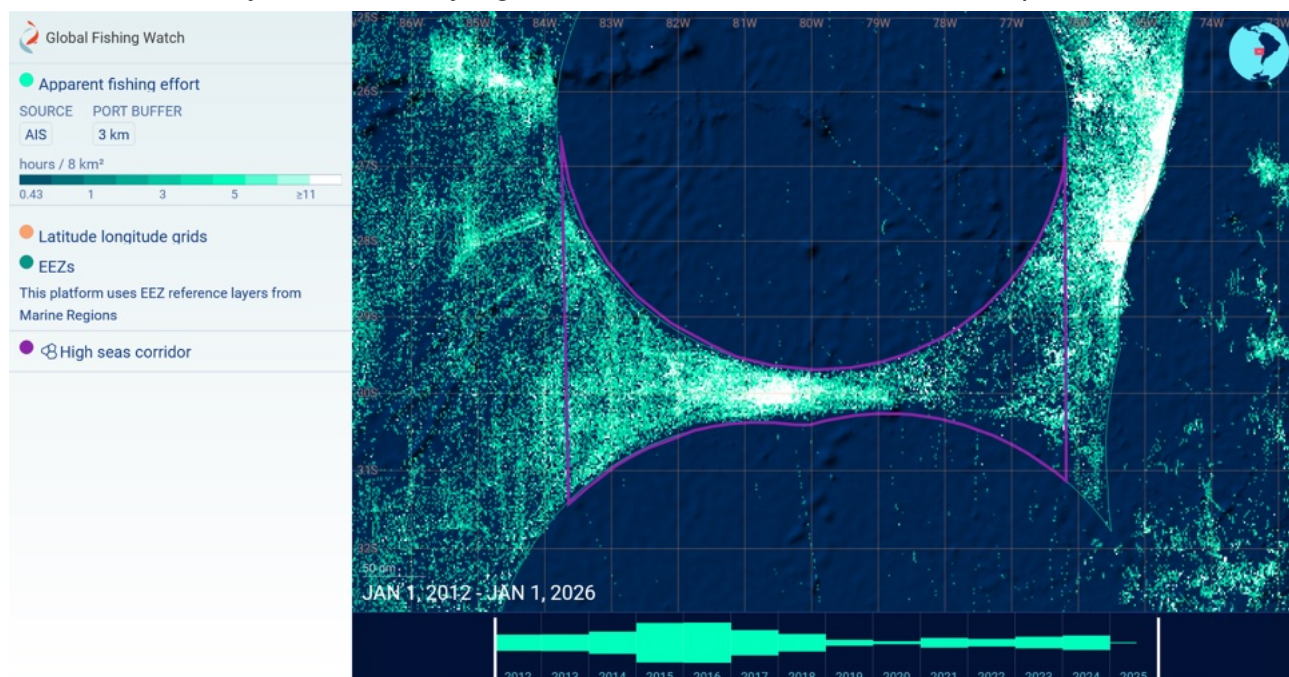


Figure 23. Apparent fishing effort, derived from AIS data, within the high seas corridor (purple), between the Nazca-Desventuradas and Juan Fernández expansion areas, between January 1, 2012, and July 1, 2025. See the Global Fishing Watch map [workspace](#) for more information

The majority of these vessels were Chinese-flagged, using squid jigger or unidentified fishing gear, followed by Spanish and Japanese-flagged longline vessels (Figure 24). Only two Chilean-flagged fishing vessels were detected fishing in this area for an hour or more, based on AIS data alone.

Relatively lower levels of apparent fishing activity were detected using VMS data (Figure 25), compared to AIS data (Figure 23), with only 28 vessels detected fishing for a total of 1,415 hours in the high seas corridor. As with previous analyses, this count includes only vessels with at least one hour of apparent fishing activity in the area.

This discrepancy is likely due to the higher presence of non-Chilean fishing vessels detected via AIS, particularly the intensive fishing activity by Chinese-flagged vessels (Figure 24). These findings suggest that the high seas corridor between the two MPAs is more important to international fishing fleets than to national (Chilean) fleets. Figure 26 shows the comparative trends in apparent fishing activity derived from AIS and VMS each year from 2012 to 2025.

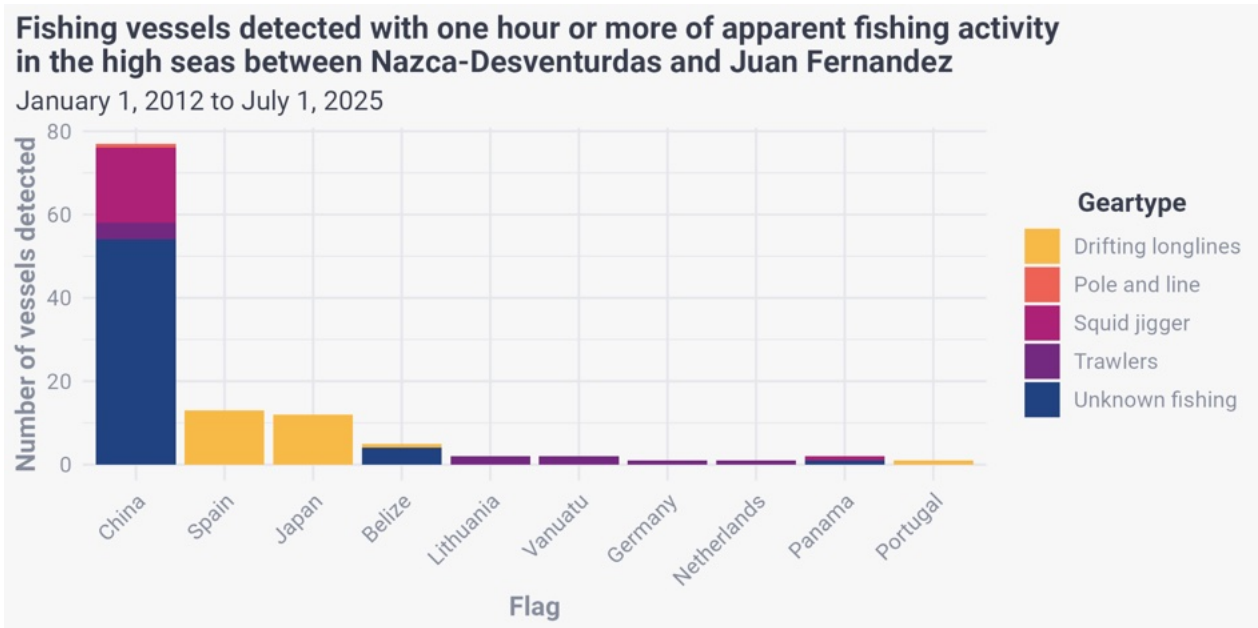


Figure 24. Number of fishing vessels, derived from AIS data, by flag and gear type detected with at least one hour of apparent fishing activity within the high seas corridor between the Nazca-Desventuradas and Juan Fernández expansion areas, between January 1, 2012, and July 1, 2025

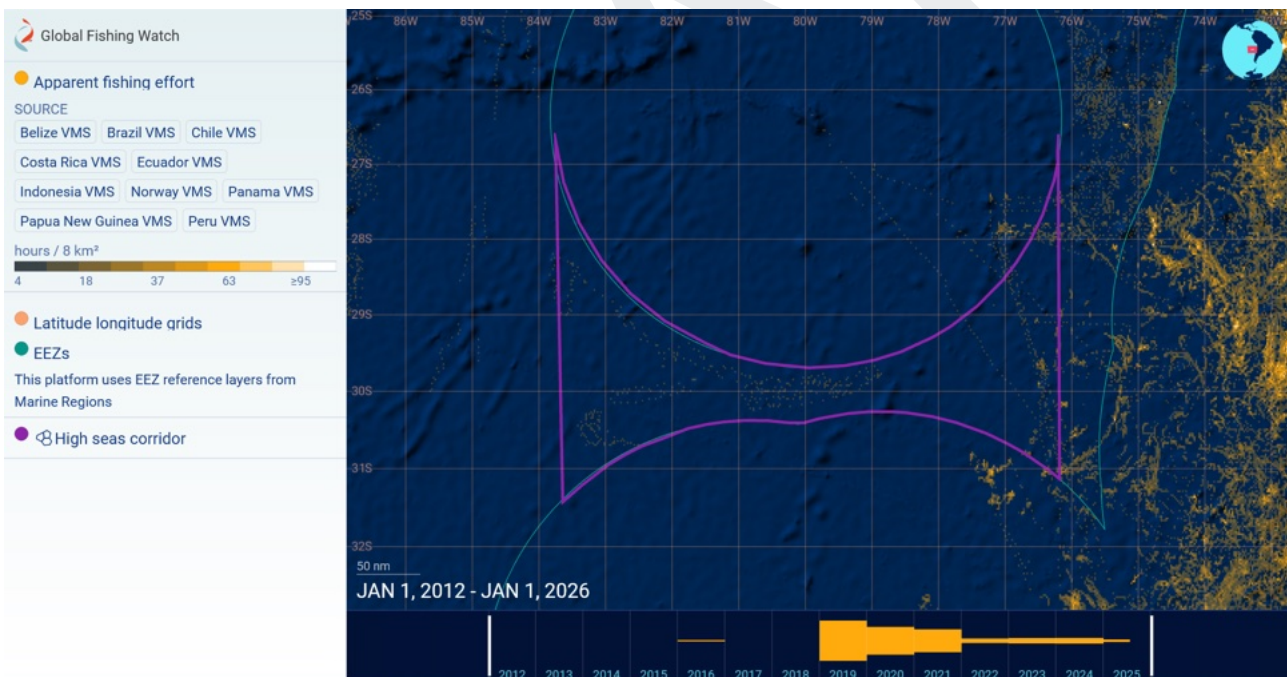


Figure 25. Apparent fishing effort, derived from VMS data, within the high seas corridor (purple) between the Nazca-Desventuradas and Juan Fernández expansion areas, between January 1, 2012, and July 1, 2025. See the Global Fishing Watch map [workspace](#) for more information

Apparent fishing activity each year in the high seas corridor between the Nazca-Desventuradas and Juan Fernández expansion areas

January 1, 2012 to July 1, 2025

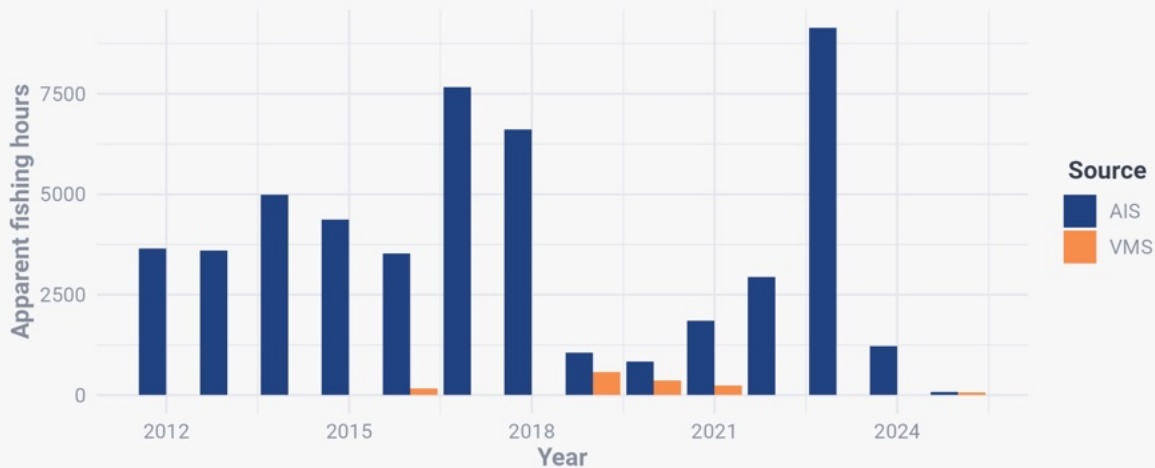


Figure 26. Apparent fishing activity derived from AIS (blue) and VMS (orange) data in the high seas corridor between the Nazca-Desventuradas and Juan Fernández expansion areas between January 1, 2012, and July 1, 2025. Note that Chilean VMS data was first published on the Global Fishing Watch map in 2019

Vessels targeting swordfish and jack mackerel

In addition to the analysis described above, we examined the fishing activity of vessels known to target swordfish and jack mackerel to assess potential overlap with the proposed expansion areas. This analysis was based on a list of vessels provided by the team working with PBOL in Chile on this matter. A total of 74 vessels were detected, fishing for 8,377 hours across the three areas (Figure 27). Most of this activity (8,087 hours) was recorded by VMS. The highest apparent fishing activity was detected in the Juan Fernández expansion area (6,821 hours), followed by the high seas corridor (943 hours) and the Nazca-Desventuradas expansion area (612 hours). Fishing activity by these vessels peaked between 2019 and 2021, particularly in the Juan Fernández expansion area (Figure 28).

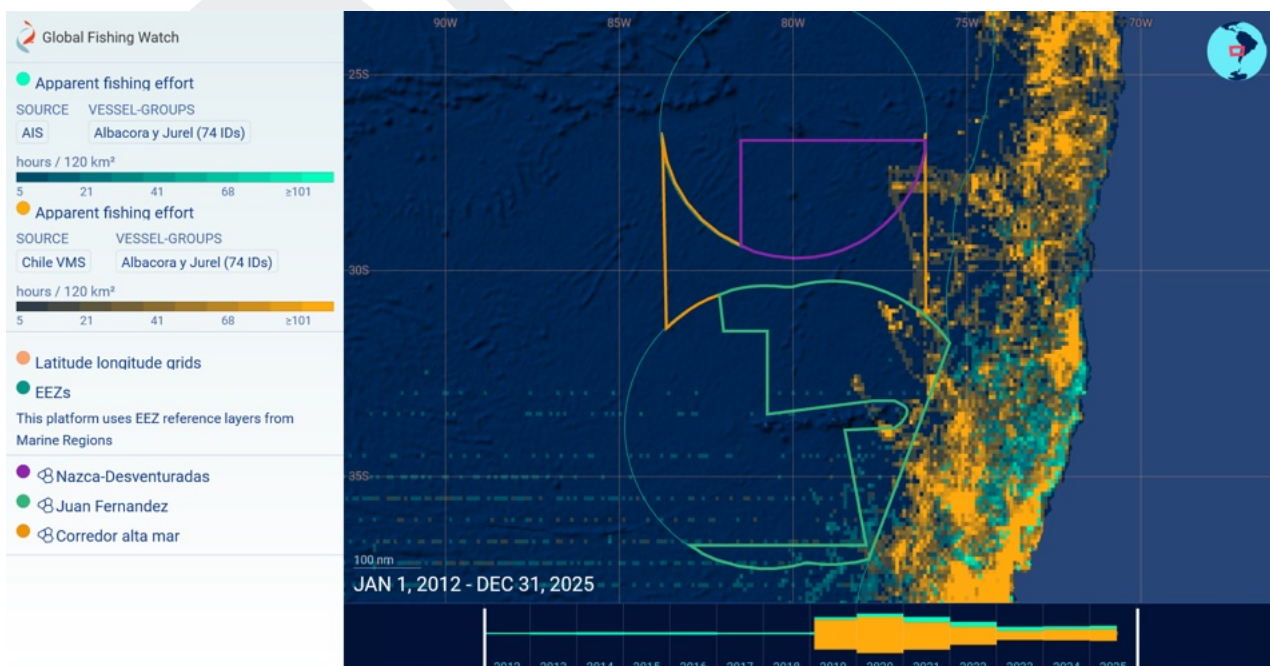


Figure 27. Apparent fishing effort, derived from both AIS and VMS, within the Nazca-Desventuradas expansion area (purple), the Juan Fernández expansion area (green), and the connecting high seas corridor (orange), between January 1, 2012, and July 1, 2025. See the Global Fishing Watch map [workspace](#) for more information

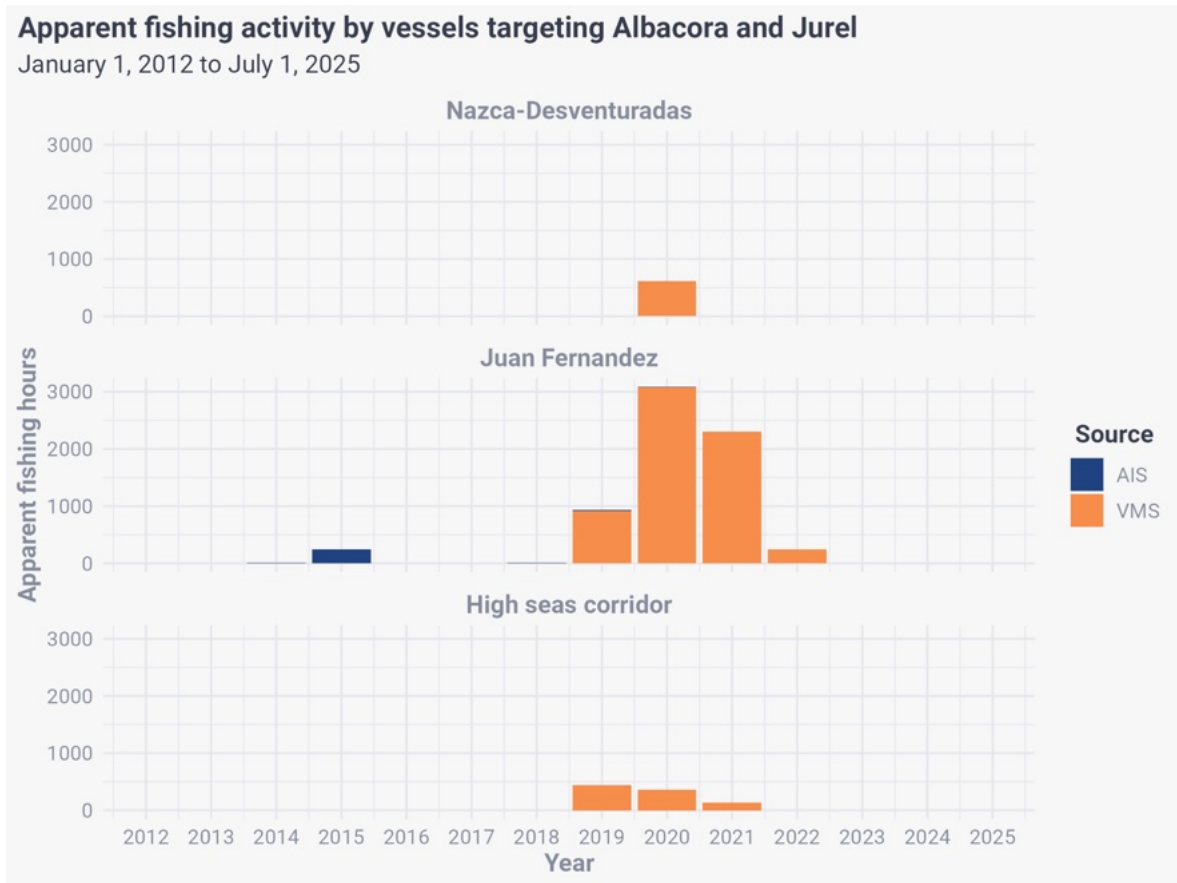


Figure 28. Total apparent fishing activity by vessels targeting swordfish and jack mackerel in each area of interest, by year, from 2012 to 2025

Note that the straight-line patterns of apparent fishing activity seen in the Juan Fernández area suggest that some of the activity corresponds to annual scientific surveys for jack mackerel (Figure 28).

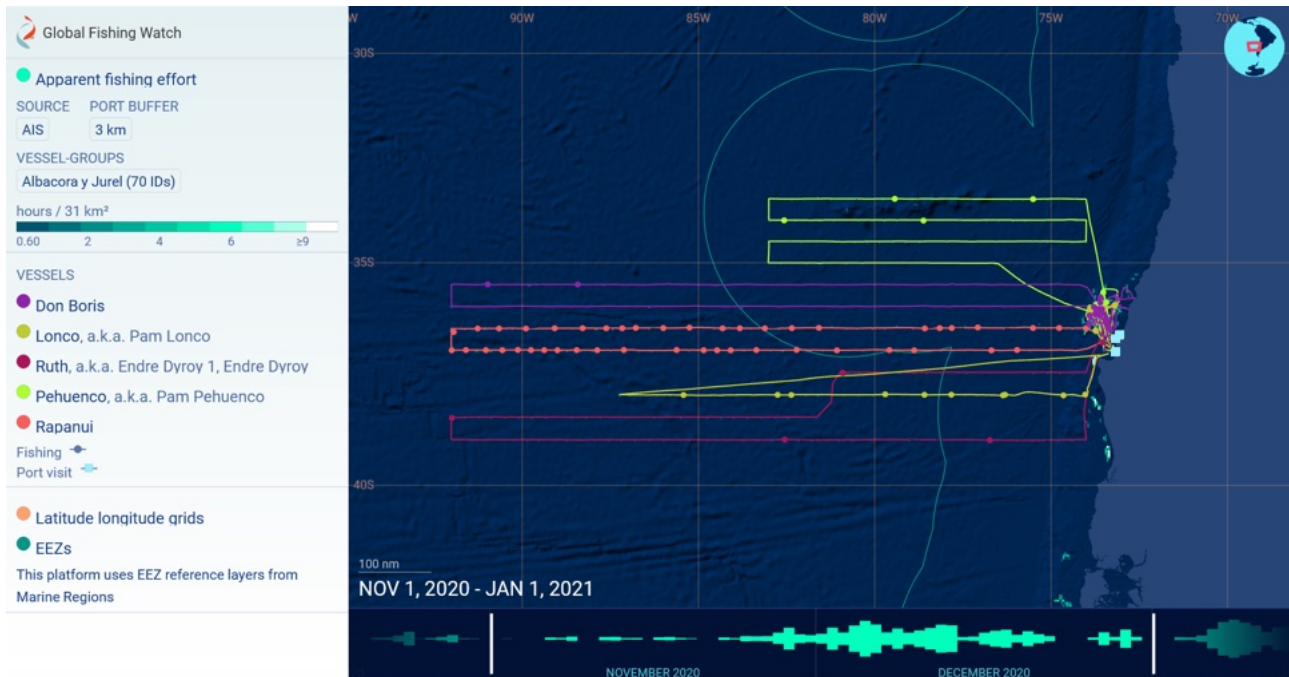


Figure 29. Tracks of vessels consistent with scientific sampling activity. See the Global Fishing Watch map [workspace](#) for more information

Conclusions

This analysis provides a detailed overview of vessel activity across three key areas in the Southeast Pacific: the proposed expansion zones of the Nazca-Desventuradas and Juan Fernández Marine Protected Areas (MPAs), which lie within Chile's exclusive economic zone (EEZ), and the high seas corridor that connects them. From 2012 to 2025, vessel detections using AIS and VMS data revealed contrasting usage patterns across these zones, highlighting notable differences between national and international fleets.

In both proposed MPA expansion areas, vessel traffic was dominated by cargo ships in transit, with north-south (and south-north) movement patterns being the most common. In the Nazca-Desventuradas area, very little fishing activity was detected. A small number of vessels were recorded with apparent fishing effort, though many of these exhibited straight-line tracks more indicative of transiting than fishing, suggesting potential false positives from the fishing detection model. In Juan Fernández, apparent fishing activity was somewhat higher but remained limited overall, particularly when compared to adjacent waters. Activity in this area was concentrated in the southeastern portion, with most fishing vessels flagged to China, though a small number of Chilean vessels were also present.

The high seas corridor between the two MPAs stood out in stark contrast, with significantly higher levels of apparent fishing activity. This area was intensively used by international fleets, especially Chinese-flagged squid jiggers, as well as Spanish and Japanese longliners. Total apparent fishing effort in the corridor was approximately 26 times greater than that observed within the Juan Fernández expansion area, underscoring its importance to distant-water fleets. Only two Chilean-flagged fishing vessels were detected fishing in this corridor, reinforcing the conclusion that this area is of primary interest to international fleets rather than national ones.

In addition, the analysis examined fishing activity by Chilean vessels known to target swordfish and jack mackerel to assess potential overlap with the proposed expansion zones. A total of 74 vessels were detected fishing in these three areas, with the highest level of fishing detected in the Juan Fernández expansion area, although no apparent fishing activity was detected by these vessels in these areas since 2022. Furthermore, several vessels exhibited straight-line tracks through the area consistent with annual scientific surveys, particularly during 2015, which should be considered when interpreting apparent fishing effort in the region.

Together, these findings highlight the need for differentiated approaches to management and conservation. While the proposed MPA expansion zones currently face low levels of direct fishing pressure, the high seas corridor between them emerges as a hotspot of international fishing activity. Can it be because the High seas outside of both MPAs benefit from the "spillover" effect of protecting the existing MPAs? More fish are available there because their breeding, feeding grounds are protected in the MPAs and they spill over the borders of the EEZ? Maybe another study can look into it to highlight the benefits of MPAs for fisheries. This also underscores the importance of coordinated governance and effective monitoring mechanisms in international waters to ensure ecosystem protection and the responsible use of marine resources.

Recommendations

The results of this analysis reveal distinct patterns of vessel activity across Chile's EEZ and adjacent international waters, with important implications for marine conservation, monitoring, and fisheries governance. To support decision-making, we propose the following recommendations:

1. **Strengthen conservation and management within Chile's EEZ.** The low levels of fishing activity detected within the proposed expansion areas of the Nazca-Desventuradas and Juan Fernández MPAs suggest that expanding protections in these areas is operationally feasible. Specifically:
 - a. *Advance the formal designation and implementation* of the proposed MPA expansion zones, incorporating up-to-date data on vessel activity.
 - b. *Maintain and enforce existing restrictions on industrial fishing* within these zones.
 - c. Address potential risks associated with transiting cargo vessel traffic.
 - d. *Clarify and monitor scientific fishing activity*, such as research surveys for jack mackerel, to ensure proper differentiation from commercial fishing in tracking data and detection models.
2. **Enhance surveillance and data integration for Chilean fleets.** Given the relatively small footprint of Chilean fishing vessels in the analyzed area, but their strategic importance to national fisheries:
 - a. *Improve the integration of AIS and VMS datasets*, particularly to better characterize fishing effort in areas where one source may be incomplete.
 - b. *Increase granularity and standardization of vessel metadata*, including target species, gear type, and activity type (e.g., research vs. commercial), to improve fishing detection and interpretation.
3. **Prioritize regional governance of the high seas corridor.** The high-seas corridor between the two MPAs is subject to relatively intense international fishing pressure, especially from distant-water fleets. This warrants urgent attention and coordinated action:
 - a. *Promote international cooperation* through regional fisheries management organizations (e.g., SPRFMO), the BBNJ agreement, and other relevant frameworks, to improve vessel tracking, monitoring, control, and surveillance (MCS) in the area.
 - b. *Advocate for transparency requirements*, such as mandatory AIS usage or public VMS sharing (as Chile does), for foreign fleets operating in adjacent international waters.
 - c. *Explore further the proposal of the corridor as a candidate for future high seas conservation measures*, especially given its adjacency to two nationally marine protected areas.
4. **Use data-driven evidence to inform future expansion and enforcement.** This analysis underscores the value of high-resolution satellite data and machine learning models to inform marine spatial planning and enforcement strategies. To build on these insights:
 - a. *Maintain and expand public access to Chilean VMS data and registries*, enabling continued analysis and cross-validation of activity in national and adjacent waters.
 - b. *Support the development of decision-support tools* that combine spatial data on vessel activity with ecological, legal, and socioeconomic layers to guide adaptive management.
 - c. Consider using these findings to guide future Monitoring, Control, and Surveillance (MCS) strategies, identifying priority areas for cost-effective patrolling and targeted surveillance.
 - d. Utilize the information on vessel flags to engage with the respective flag States, particularly if new management measures are implemented, to support future compliance and enforcement efforts.