



North Pacific Fisheries Commission

NPFC-2025-TCC08-IP09

NPFC 2024 Vessel Monitoring System Overview

Abstract:

This report presents data from the Vessel Monitoring System (VMS) for 2024, including a summary of monthly activities by Member/CNCP and an identification of data gaps encountered throughout the year. It also describes the way forward developed in the intersession to address inconsistencies in reporting of zone entry and exit. Furthermore, this report provides a comparative analysis of transshipment locations in 2024 using data from VMS and other reported sources presents some considerations for the incorporation of AIS data into VMS analyses.

Note: All data reflecting Russia's 2024 effort is to be considered preliminary as their annual report is not yet published.

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1. Introduction

This report presents VMS data for 2024, providing a monthly summary of activities within the Convention Area by Members. It includes an overview of vessel activity, and the number of reports received via VMS for each Member. Additionally, by comparing authorization data and periods, the report identifies the number of unique vessels that operated in the Convention Area after the expiration of their authorization periods. The report also provides a summary of data interruptions observed over various time periods.

This report also addresses the challenges of determining zone entry and exit for vessels operating within the Convention Area. It outlines an algorithm developed by the Secretariat to estimate these movements when zone entry/exit reports are unavailable, and presents three options developed by the SWG Operations for notifying exit and entry that are to be presented to TCC as a proposed amendment to the VMS measure.

The accurate identification of vessels within the Convention Area is critical to ensure the effective functioning of the VMS. However, challenges persist due to mismatched identifiers and synchronization issues between registry data and VMS reports. This report outlines the difficulties encountered, their underlying causes, and proposes some solutions to streamline operations and improve data reliability.

The report also reviews VMS data in the context of reported transshipment times and locations, both prior to and following the implementation of the new provisions related to modifying Advance Notifications on July 24, 2024. Finally, some suggested solutions are posed to address the issues highlighted in this report.

2. Overview in 2024

The VMS presents an opportunity to cross-check the number of active vessels in the Convention Area against the number that are authorized in the Vessel Registry. For this analysis, only vessels with available VMS data were included. Table 1 below shows the number of unique vessels sending VMS data, by month for each Member. The number of vessels reporting positional data monthly ranged from a low of only eleven vessels in February to a high of 456 vessels in September.

Table 1. The number of unique vessels by month for each Member

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
China	54	10	22	186	217	239	260	282	284	235	196	158
Japan	0	1	2	2	25	27	29	78	91	86	60	0
Korea	0	0	0	0	3	4	4	5	5	5	5	0
Russia	0	0	0	2	8	7	2	2	2	3	3	6
Chinese Taipei	0	0	0	0	3	9	47	69	70	67	0	0
Vanuatu	0	0	0	0	0	0	0	2	4	4	2	1
Total	54	11	24	190	256	286	342	438	456	400	266	165

Paragraph 17 of the VMS CMM (2024-12) requires Members to report their positions manually every four hours following a data transmission failure extending beyond four hours. (Data gaps generated by these transmission failures are generally quickly updated after the system is restored). Table 2 shows the number of manual reports received by month in 2024 for each Member.

Table 2. The number of manual reports by month for each Member

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
China	10	0	156	174	691	719	304	398	137	281	351	633
Japan	0	0	0	0	8	0	63	6	8	4	0	0
Korea	0	0	0	0	0	0	0	0	0	0	0	0
Russia	0	0	0	0	0	0	0	0	0	0	0	0
Chinese Taipei	0	0	0	0	0	0	146	118	159	115	0	0
Vanuatu	0	0	0	0	0	0	0	0	0	0	0	0
Total	10	0	156	174	699	719	513	522	304	400	351	633

Paragraph 8 of the VMS CMM requires that all NPFC registered vessels report their positions whenever they are present in the Convention Area (CA). Given the overlaps with the WCPFC CA and the SPRFMO Vessel Registry, it sometimes happens that a WCPFC carrier vessel operating inside their CA or a SPRFMO vessel in transit to that CA, may send positions while in the NPFC CA. It can also happen that authorization periods for NPFC vessels are inadvertently allowed to expire, with the result that the vessel appears to be operating without authorization.

Table 3 below shows the number of unique vessels that reported positions within the NPFC CA after the expiration of their authorization period in 2024 by month and by Member. Although the data could suggest potential instances of unauthorized fishing, further investigation is conducted to confirm whether the vessels were simply transiting under another RFMO authorization or whether factors like vessel speed or trajectory indicate legitimate activity. Such cases appear relatively rare—most months show no instances, while September recorded a maximum of five vessels. Given that discrepancies may still exist between the Secretariat's data and Member records, continued collaboration among all parties is crucial for resolving any outstanding issues.

Table 3. The number of unique vessels reporting positions while in unauthorized status 2024

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
China	1	0	0	0	0	0	0	0	4	0	0	0
Japan	0	0	0	0	0	0	0	0	0	2	1	0
Korea	0	0	0	0	0	0	0	0	0	0	0	0
Russia	0	0	0	0	0	0	0	0	0	0	0	0
Chinese Taipei	0	0	0	0	0	0	0	0	0	1	0	0
Vanuatu	0	0	0	0	0	0	0	0	1	0	0	0
Total	1	0	0	0	0	0	0	0	5	3	1	0

3. Zone Entry / Exit

Algorithm Used to Determine Entry/Exit

The Secretariat faces challenges in monitoring vessels operating near the Convention Area boundary due to variations in how fields within the NAF message are used. Different Members may record vessel details in these fields inconsistently, complicating the interpretation of entry and exit declarations. Moreover, disparities in reporting formats and data availability hinder effective monitoring, as simply identifying data gaps of longer than one hour may not reliably indicate that a vessel has permanently departed—vessels may temporarily exit and re-enter without contravening regulations.

To address this, an algorithm was developed that predicts a vessel's travel path and future position based on its reported location, speed, and direction. This method helps detect when a vessel exits and re-enters the Convention Area and identifies potential non-compliance by

estimating a vessel's position before and after one hour using linear extrapolation. The algorithm assumes that vessels travel at speeds below 20 nautical miles per hour and incorporates a safety margin within the Convention Area to improve accuracy. Figure 1 illustrates five potential non-compliant scenarios, while Annex 1 provides a detailed explanation of the algorithm's procedure.

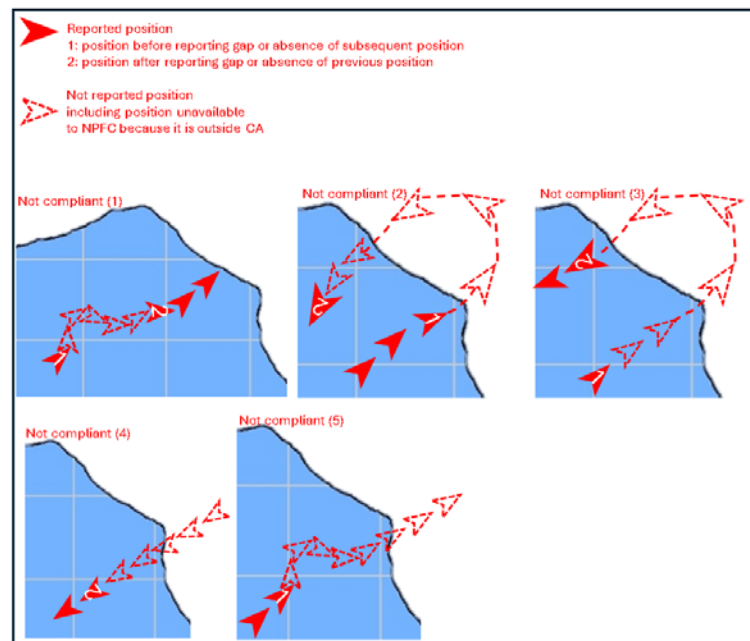


Figure 1. Potential non-compliant scenarios

Proposed Options for Notifying Vessel Entry/Exit

At COM08 (paragraph 78 of TCC07 Final Report) in 2024, it was decided to investigate options for notifying entry into and exit from the Convention Area. During the intersession, the SWG Operations developed three options that will be submitted to TCC08 for consideration. These options are proposed as an annex to the current VMS measure, and a new paragraph in the VMS CMM is also proposed to provide the Commission with the flexibility to select the most appropriate option.

Option 1. Automated Notifications Upon Entry and Exit

Automated notification each time a vessel enters or exits Convention Area

Option 2. Implementation of a 20-Nautical-Mile Buffer Zone

Establishment of a buffer zone extending 20 nautical miles from the boundaries of the Convention Area. This would create a zone similar to SPRFMO (within which all vessels on their Vessel Register operating within a 100-nautical mile radius of their Convention Area are required to report their positions through the VMS as if they were operating within the Convention Area)'s buffer zone. NPFC buffer zone would extend 20 nautical miles from the boundaries of the Convention Area. All vessels in NPFC Registry would report when inside the buffer zone, according to a) or b) below:

- a) Report ALL positions inside the buffer zone, whether inside an EEZ OR on high seas, OR
- b) Report ALL positions from the high seas inside the buffer zone, BUT when entering the Convention Area from inside an EEZ, report only the LAST position prior to and the FIRST position after entering/exiting the Convention Area. Similarly, when exiting the Convention Area, report LAST position prior to exiting and FIRST position after exiting the Convention Area.

Option 3. Access to Last and First Positions Upon Entry and Exit

The Secretariat shall be notified whenever a fishing vessel flying their flag enters to or exits from the Convention Area either by:

- a) reporting LAST position prior to, and FIRST position after entering and exiting the Convention Area, OR
- b) reporting the first position inside the CA with an automated declaration of entry in the "Type of Message" field of the NAF format and reporting the first position after exiting the Convention Area with an automated declaration of exit in the "Type of Message" field of the NAF format.

These three options provide a structured and adaptable framework for improving VMS reporting while ensuring operational feasibility for Members. The inclusion of the new paragraph in the VMS CMM further empowers the Commission to select the most suitable option from the annex, thereby enhancing the overall flexibility and effectiveness of the reporting framework.

4. Data Interruptions

Following discussions with the service provider, the NPFC identified multiple issues affecting the VMS and FMC systems. While vessels are expected to report at regular intervals of 1 hour, malfunctions in the FMC and the VMS data warehouse have resulted in irregular reporting intervals, such as 62, 114, 116, 118, 120, 122, 172, 174, and 180 minutes. These anomalies introduce potential biases in data analysis and may lead to inaccurate assessments regarding vessel compliance.

Figures 2, 3, and 4 illustrate the distribution of reporting intervals and the impact of excluding intervals likely caused by system malfunctions. Figure 2 presents the distribution of time differences between consecutive VMS reports, highlighting instances of irregular reporting potentially linked to system failures. Figure 3 shows the distribution after filtering out intervals attributed to system malfunctions, providing a more accurate representation of vessel reporting patterns. Figure 4 further refines this analysis by displaying a histogram of reporting intervals after the exclusion of system-induced anomalies.

Analysis of the data indicates that approximately 95% of reporting interruptions were under two hours before filtering out intervals associated with system malfunctions, and under three hours after their exclusion. Consequently, the Secretariat's assessment focused on interruptions exceeding two hours. To enhance data accuracy, the Secretariat implemented a revised algorithm to identify and remove data points associated with system faults.

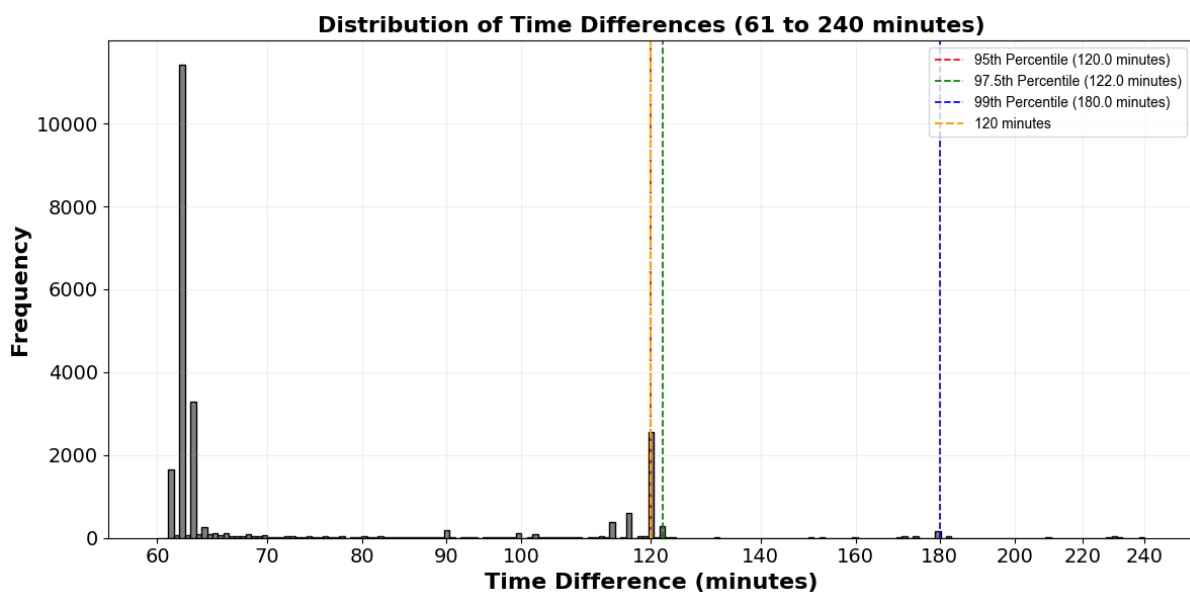


Figure 2. Distribution of time intervals between consecutive VMS reports, highlighting irregular reporting patterns potentially caused by system malfunctions.

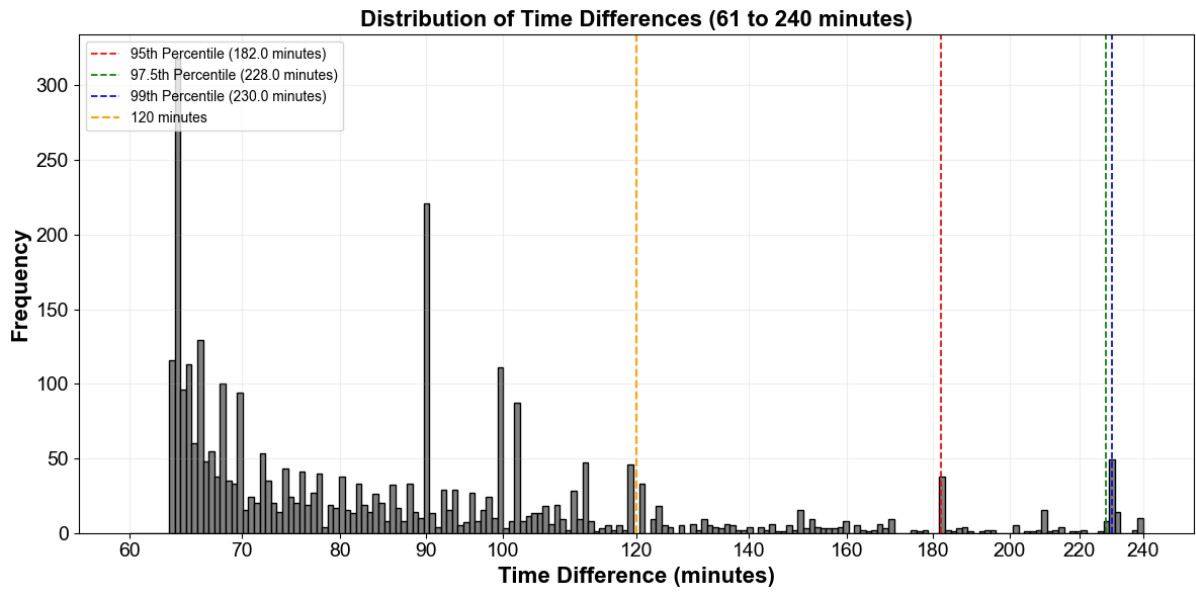


Figure 3. Distribution of time intervals between consecutive VMS reports after filtering out intervals likely caused by system malfunctions, providing a refined dataset for analysis.

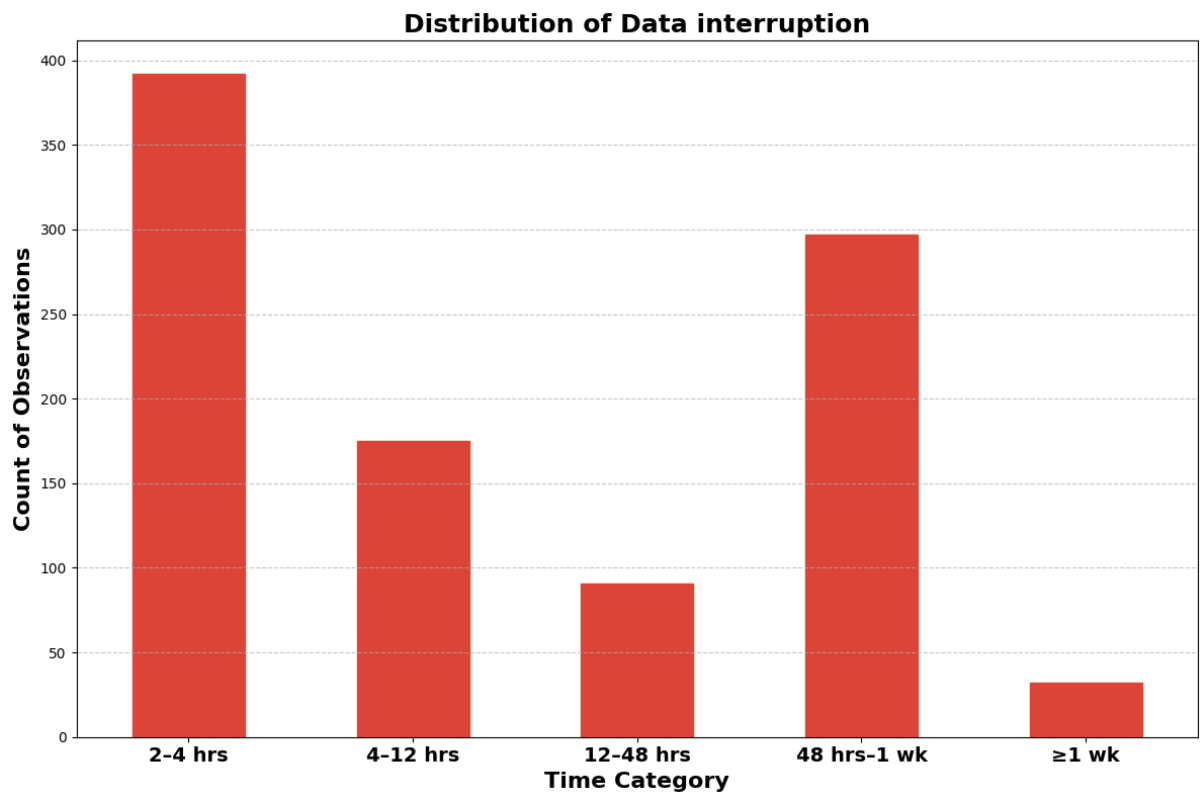


Figure 4. Histogram of time intervals between consecutive VMS reports after the exclusion of system-induced anomalies, illustrating the adjusted distribution of reporting frequencies.

In 2024, the percentage of data interruptions exceeding a two-hour interval remained below 5% for all Members, and all Members maintained interruption rates below 1%.

In accordance with Paragraph 10 of CMM 2024-12, which stipulates that FMCs must automatically transmit data to the Secretariat within 60 minutes, the Secretariat conducted a review of VMS data categorized as "Regular reports" rather than "Manual reports." This distinction was made because manual reports are sometimes transmitted after a vessel's fishing activity concludes, often due to VMS device malfunctions or satellite communication issues.

5. Comparison of the location between the reported location of transshipment and VMS data

Transshipment documentation is a critical component of maritime operations, as it must accurately record the specific locations and times when vessels load and unload cargo. This is essential for both logistical tracking of vessel activities and regulatory compliance within the Convention Area, where vessels are mandated to report their locations hourly via the VMS. However, discrepancies can arise when vessels either fail to report through the VMS or submit transshipment documentation with inaccurate location and or timing information. To enhance the accuracy and reliability of location reporting, the Secretariat has conducted a comprehensive review, comparing the information in transshipment declarations with the VMS data of both the offloading vessel (OV) and receiving vessel (RV) within the Convention Area. This review initially flagged discrepancies where the reported location differed by more than 20 nautical miles over a two-day period¹. As of July 24, 2024, a new provision (paragraph 17 of CMM 2024-03) is in place, which now flags discrepancies of more than 50 nautical miles over a three-day period. Additionally, any instances where the VMS data does not align with the reported location in the transshipment declarations, either for the same or nearest time period, are also flagged as "Unmatched", potential discrepancies.

Initially, transshipment events were flagged for discrepancies whenever the reported location differed by more than 20 nautical miles over a 24-hour period (one day). However, effective July 24, 2024, the new provision expanded the criteria to discrepancies exceeding 50 nautical miles over a 72-hour period (three days). Each offloading and receiving vessel's declaration was compared with VMS data, which can result in an unequal number of offloading and

¹ Although the 2023 provision stipulated a 20 NM/24-hour window, the analysis reviewed a 48-hour period, starting 24 hours prior to the planned event and extending to 24 hours afterwards.

receiving vessel events because transshipment reports are recorded separately for offloading and receiving vessels, and inconsistencies in reporting times, data availability, or documentation errors can lead to discrepancies between the two datasets.

Before the 2024 provision took effect, there were 776 offloading vessel events, and 776 receiving-vessel events reported for fishery products. There were 19 unmatched “start” events and 25 unmatched “end” events on the offloading side, while receiving vessels had 30 unmatched “start” and 31 unmatched “end” events.

After July 24, 2024, there were 1305 offloading-vessel events, and 1305 receiving-vessel events reported. Of these, the number of unmatched “start” and “end” events was lower than in the earlier period, with 16 unmatched “starts” events and 14 unmatched “end” events for offloading vessels, and 13 unmatched “start” events and 14 unmatched “end” events for receiving vessels.

Regarding OTA transshipments, Table 4 presents events before the new provision came into force, while Table 5 summarizes activity after implementation of the 2024 measure.

Table 4 presents the number of OTA events recorded before July 24, totaling 929, with 399 instances of unmatched events on the receiving side.

Table 5 illustrates the impact of the revised criteria on OTA activities, showing an increase in transshipment events to 5,250, with 2,936 unmatched events on the receiving side following the implementation of the new provision.

Table 4. The number of events and unmatched events based on VMS data (OTA) from 1 January to 23 July 2024

	# of Events (OV)	# of Events (RV)	RV
China	904	920	398
Korea	0	0	0
Russia	11	0	0
Chinese Taipei	14	9	1
Vanuatu	0	0	0
Total	929	929	399

Table 5. same as Table 4, but from 23 July to 31 December 2024

	# of Event (OV)	# of Event (RV)	RV
China	5063	5250	2912
Korea	0	18	1
Russia	205	0	0
Chinese Taipei	69	84	20
Vanuatu	25	10	3
Total	5362	5362	2936

This division of the data into two timeframes—before and after July 24, 2024—highlights how the change in the discrepancy threshold (from 20 NM/24 hours to 50 NM/72 hours) significantly impacts the interpretation of unmatched transshipment events and may influence compliance assessments across different fleets.

The analysis of transshipment documentation compared to VMS data identified discrepancies in the reported locations and times of transshipment events within the Convention Area. The criteria for flagging discrepancies significantly influence the number of events requiring further investigation. Under the initial criteria — differences exceeding 20 nautical miles within a 24-hour period — more events would have been flagged compared to the revised criteria, which identifies discrepancies greater than 50 nautical miles over a 72-hour period. Additionally, if no VMS data is found within the specified two - or three-day window surrounding a transshipment event, the event is classified as “not found” under the new provision, triggering a flag for further investigation.

The distribution of these discrepancies is presented in Tables 6 and 7. Table 6 shows that for fishery products, 7,847 out of 8,170 total comparisons (approximately 96%) had discrepancies of less than 10 nautical miles, indicating a high degree of accuracy in reporting. However, 82 events recorded discrepancies of 50 nautical miles or more, which would be flagged under the new criteria. Similarly, Table 7 highlights that for OTA transshipment events on the receiving vessel’s side, 1,222 out of 6,291 total comparison (approximately 19%) had discrepancies of less than 10 nautical miles, while 3,140 events showed discrepancies of 50 nautical miles or more, meeting the threshold for flagging under the revised measure.

Table 6. The number of unmatched transshipments reports by Member, showing discrepancies between reported transshipment locations and VMS data for fishery products in 2024.

		>= 10	>= 20	>= 30	>= 40		
	< 10	NM	NM	NM	NM	>= 50	Not
	NM	< 20	< 30	< 40	< 50	NM	found
		NM	NM	NM	NM		
China	7847	111	43	13	32	82	42
Korea	0	0	0	0	0	0	0
Chinese Taipei	40	0	1	0	1	0	0
Vanuatu	56	0	0	0	0	0	0
Total	56	0	0	0	0	0	0

Table 7. The number of unmatched transshipments reports by Member, showing discrepancies between reported transshipment locations and VMS data for OTA receiving vessels in 2024.

		>= 10	>= 20	>= 30	>= 40		
	< 10	NM	NM	NM	NM	>= 50	Not
	NM	< 20	< 30	< 40	< 50	NM	found
		NM	NM	NM	NM		
China	1192	600	431	413	368	3116	50
Korea	10	5	0	2	0	1	0
Chinese Taipei	18	33	10	8	2	20	2
Vanuatu	2	2	1	1	1	3	0
Total	1222	640	442	424	371	3140	52

6. NPFC VMS Data Sharing Security Protocol

Annex 2 of the VMS CMM (2024-12) contains the NPFC Data-Sharing and Data -Security Protocol for Vessel Monitoring (VMS) System. The protocol outlines provisions for data access, use and sharing while ensuring the safety and security of VMS data. The Members and the Secretariat have obligations to ensure that VMS data is securely stored and shared appropriately. Paragraph 8 outlines an obligation to report annually on compliance with the Protocol:

8. *The Executive Secretary will report to the Commission annually on the compliance with this Protocol, including any breach thereof.*

Annex 2 presents the obligations from the Protocol and offers some explanation about how the protocol is being implemented in the NPFC.

7. VMS Issues

A number of issues have emerged since the implementation of the VMS in 2022 that negatively impact the operation of the system. Some issues are minor and can be resolved quickly and easily while others require more complex solutions. Some of the challenges and difficulties are outlined below, along with some solutions and proposed solutions that have been identified.

“Unknown” Vessels in the NPFC VMS

Below is a concise overview of how “unknown” vessels have arisen in the VMS, the implications for NPFC, and a plan to prevent and resolve these occurrences.

The NPFC VMS automatically updates a vessel table each day, drawing on data from the NPFC Vessel Registry. When a position report arrives from a Member’s FMC, the VMS software searches the vessel table to find a matching identifier (e.g., IRCS, Registration Number, or IMO Number). If no match is found, the software creates an “unknown” vessel entry and associates subsequent position reports to it. Consequently, these “unknown” vessels exist in the system due to discrepancies between the information in the NPFC Vessel Registry and the details contained in VMS position reports.

The Secretariat reviews “unknown” vessels to ensure that all are properly registered and accurately tracked. An “unknown” vessel in the VMS suggests there may be an issue: either a mismatch between the Registry and Member FMC data or an unregistered vessel reporting to the NPFC.

Several typical factors lead to “unknown” vessel entries:

1. Typographical Errors

Minor spelling inconsistencies in vessel names or identifiers (e.g., confusing letters “U” and “V,” or zeros and capital “O”) can create mismatches.

2. Timing of Identifier Updates

- a. **Case A:** The identifier is updated first in the NPFC Vessel Registry, causing the NPFC VMS to recognize the new identifier. If the Flag continues sending reports with the old identifier, the VMS creates an unknown vessel using the old identifier.
- b. **Case B:** The identifier is updated first at the Member FMC. When VMS reports arrive under the new identifier, they do not match the old information in the NPFC Vessel Registry, resulting in an unknown vessel. Later updates to the NPFC Vessel Registry are blocked by this unknown vessel entry, requiring Secretariat intervention.

3. Synchronization Issues

Even if the submitted identifier matches what is in the NPFC Vessel Registry, technical or system limitations can block synchronization between the Registry and the VMS (e.g., duplicate identifiers in the system).

In all these scenarios, Secretariat steps include investigating the mismatch, merging unknown entries with the correct vessel records, transferring historical position data, and deleting outdated or duplicative entries.

The presence of “unknown” vessels indicates a potential gap: either a technical/system issue or a vessel reporting to the NPFC VMS without proper registration. If left unaddressed, these records can undermine the accuracy of vessel monitoring, complicate monitoring efforts, and create confusion about which vessels are actively operating.

Recommendations to Prevent Unknown Vessels

1. Accuracy in Registry Updates

Carefully verify details when registering or updating vessel information in the NPFC Vessel Registry.

2. Orderly Identifier Changes

Whenever possible, update the NPFC Vessel Registry before using a new identifier in VMS reports to avoid creating an unknown vessel. Use the “update” feature to maintain a clear change history.

3. Leverage the IMO Number

The IMO Number is more stable than Radio Call Signs or Registration Numbers. Including it in VMS reports (via the /IM/ field) helps ensure the vessel remains correctly identified even if other identifiers change.

4. Provide Multiple Identifiers in VMS Reports

If only one identifier is used and it does not match the Registry, the Secretariat has few options to investigate. Including the vessel name (/NA/ field) or other identifiers can expedite resolution if mismatches occur.

In summary, “unknown” vessels in the NPFC VMS often result from technical errors or mismatched identifiers between the NPFC Vessel Registry and Flag FMC reports. Timely resolution is essential to maintain reliable monitoring, uphold compliance, and ensure a clear operational picture of all vessels in the NPFC Convention Area. By double-checking data entries, updating the Registry first, and consistently employing stable identifiers like the IMO Number, Members can significantly reduce the occurrence of “unknown” vessels and facilitate faster Secretariat investigations when they do occur.

Mismatched Identifiers

A significant issue involves discrepancies in vessel identifiers, such as radio call signs, internal registry numbers, and IMO numbers. These mismatches often arise when updates are made inconsistently across databases or when vessels fail to report updated information in real time. For example, radio call sign changes may be reflected in position reports before being updated in the vessel registry, resulting in the auto-creation of duplicate or unknown vessel records.

Incomplete Data

Some vessels report limited information—such as missing IMO numbers or flag codes—which can challenge accurate identification and tracking. This issue affects various vessel types, including fishing vessels, and is compounded by the fact that the inclusion of these details is not currently mandated in vessel reporting. Addressing these data gaps is essential to enhancing the overall quality and reliability of vessel information.

SSL Certificate Issues

A valid SSL (Secure Sockets Layer) certificate is essential to ensure the secure transmission of VMS data. Certificate validity periods range from one to multiple years so that Member

certificates are renewed at varied times. In the first two years of VMS implementation (2022-2023), certificate expirations routinely disrupted data transmissions and a process was identified in 2024 to standardize the renewal process. The current process for SSL certificate renewal gives Members a choice of using their own or a certificate issued annually by the NPFC VMS service provider. In either case, a specific process must be followed to avoid any gaps in VMS data transmission. The process may be accessed at the following link: <https://www.npfc.int/manual-renewal-membercncps-vms-ssl-certificate>. The adoption of either solution will improve system stability and mitigate disruptions caused by certificate expirations.

Proposed Solutions

Centralized Master Registry and Unique Identifier System

To address the issue of mismatched vessel identifiers, it is recommended to establish a cross-RFMO master registry as the authoritative source for vessel information. Under this framework, each vessel would be assigned a globally unique, immutable identifier—ensuring consistency even when mutable attributes change. The system would incorporate automated synchronization protocols to facilitate real-time updates across all platforms, complemented by robust validation routines and data quality checks to promptly identify and rectify discrepancies. Additionally, clearly defined update procedures and dedicated communication channels would be established to further reinforce data integrity and consistency across the RFMO's databases.

Standardized Use of IMO Numbers

The adoption of IMO numbers as the primary unique identifier for vessel position reporting is anticipated to substantially reduce mismatches. As a stable and globally recognized identifier, the IMO number provides a reliable means to ensure consistent and accurate vessel identification across multiple databases.

Standard Operating Procedures (SOPs)

The Secretariat is in the process of developing SOPs to manage alerts and updates related to vessel data, with the objective of streamlining operations. In response to feedback noting the unlikelihood of an auto-creation alert originating from a vessel outside the Convention Area, the procedure has been simplified as follows:

For example, upon receiving an auto-creation alert, an investigation should be initiated to verify the origin of the data and accurately identify the vessel.

Improved Member Awareness

Members should be informed about the implications of mismatched identifiers and encouraged to update their registry information promptly. Training and guidance documents can ensure Members understand the importance of accurate reporting.

Technical Enhancements

Enhancing synchronization mechanisms between the vessel registry and VMS systems will reduce technical errors. For example, ensuring that fields such as IMO numbers are mandatory in position reports can improve data consistency. Addressing these challenges requires a coordinated approach involving technical improvements, procedural enhancements, and active Member engagement. By adopting IMO numbers as the primary identifier, standardizing procedures, and improving synchronization mechanisms, the NPFC can minimize errors and improve the efficiency of MCS operations. These steps will not only reduce administrative workloads but also ensure a more robust and transparent reporting system that supports sustainable fisheries management.

8. Using AIS data as supplementary dataset

During TCC 07, Members agreed to explore the use of Automatic Identification System (AIS) data as a supplementary data source to enhance the Secretariat's capacity for vessel tracking and analysis—particularly in scenarios where VMS data may be unavailable due to technical issues.

8.1. Benefits of Using AIS as a Supplementary Dataset to VMS

Initial VMS analysis reveals significant VMS data interruptions, defined as gaps exceeding one hour between consecutive records, that are frequently resolved after some investigation. These interruptions, occurring exclusively within the Convention Area—where VMS data is confined—have proven challenging to investigate due to their volume and the resource-intensive nature of manual follow-ups. Many of these data gaps appear linked to vessel entries and exits from the Convention Area, and even with an algorithm developed to detect these transitions, notable gaps persist. In contrast, AIS data is available both within and outside the Convention Area. This broader coverage enables the Secretariat to monitor vessel movements

comprehensively, allowing for a more detailed investigation of interruptions related to zone transitions.

Additionally, since some Member EEZs are adjacent to the Convention Area, the reliance on VMS data may raise concerns regarding data ownership and jurisdiction. As publicly accessible data, AIS positional information significantly reduces the risk of accessing VMS data that extends into adjacent EEZs.

Moreover, the current CMM requires vessels to manually report VMS data if transmissions fail for over four hours. However, manual reporting is vulnerable to device malfunctions and human error. AIS data can serve as a reliable backup to capture vessel behavior when manual reporting systems fall short.

Finally, the NPFC Convention Area overlaps with areas managed by other RFMOs, and the limitation of VMS data to the NPFC CA restricts the ability to accurately differentiate between vessels in transit and those engaged in fishing activities. The integration of AIS data can enhance vessel tracking and activity analysis, supporting more effective and improved inspections.

8.2. Evaluating AIS Data Integration: Feasibility, Cost, and Implementation Options

At TCC07, the Secretariat was instructed to investigate free and costed options to access AIS data. Free access to AIS data is available through several publicly available websites by simply creating an account. Such access will typically allow users to set parameters, such as specific zones, and vessel types and download a set of data to be analyzed. This access may be especially useful when tracking an individual, or a small number of vessels; however, expansion beyond such use would be prohibitively labor intensive for the Secretariat.

The optimal way to view AIS data would be as an “overlay” on the current VMS THEMIS platform. The Secretariat engaged the VMS service provider to examine the feasibility of purchasing such an “overlay”. Several options were considered, with cost estimates provided (valid to 31 December 2024) as follows for access to hourly positions:

Access (near real-time) to ALL vessels in the NPFC Vessel Registry that are present in the Convention Area could be overlaid on the THEMIS platform for \$8645 US annually. The yearly cost to present ALL vessels in the Convention Area on the same basis would climb to \$30,250 annually. Near-real-time access is not currently a viable option and given that the analyses conducted by the Secretariat are typically historical, involving a review of the previous year, the most appropriate access would likely be historical.

AIS data is considered “historical” after 7 days and the cost to access historical AIS data declines over time. As of 31 December 2024, access to 2023 data would cost \$11,665, 2022 AIS data would cost \$7500 and 2021 would be \$5,000.

In order to assist an assessment of the value and practicality of integrating AIS data, the service provider supplied access to AIS data for six randomly selected vessels (one from each active Member) from the NPFC Vessel Registry for a period of one month. This allowed the Secretariat to sample an integrated approach to combine AIS and VMS data to assess overall consistency between the datasets.

8.3. Assessment Algorithm and Key Metrics

To evaluate the consistency between AIS and VMS datasets, a robust assessment algorithm has been developed. This algorithm incorporates several processing steps to provide a comprehensive evaluation of data quality and alignment. The analysis is based on two primary metrics:

- **Spatial Consistency:**

Spatial consistency is measured as the percentage of paired records in which a VMS position is matched with an AIS position within a predefined threshold of one nautical mile. To achieve this, the algorithm synchronizes timestamps with a 15-minute tolerance and calculates the geodesic distance between reported positions. As a result, the maximum time difference between VMS and AIS records in this comparison is 30 minutes. Spatial consistency values typically range between 70% and 100%, reflecting the reliability of both systems when properly calibrated and synchronized.

- **Correlation of Movement Characteristics:**

In addition to spatial consistency, the algorithm evaluates the agreement in vessel movement by computing correlation coefficients for speed and heading. These coefficients range from -1 to 1 , with values near 1 indicating a strong positive correlation. The algorithm calculates speed and heading only for consecutive records that are close in time (within 2 hours) to avoid misleading correlations due to outdated and infrequent data. High correlation coefficients suggest that trends in vessel speed and direction are similarly captured by both AIS and VMS.

8.4. Comparative Analysis Results

The outcomes of the comparative analysis are summarized in Table 8, which provides an overview of key performance metrics for each target vessel. These metrics include the percentage of spatial consistency, the average, minimum, and maximum distances (in nautical miles) between AIS and VMS positions, and the correlation coefficients for speed and heading.

The global analysis—restricted to vessel positions within the defined Convention Area—reveals that, out of 4,402 matched records, 3,604 (81.87%) fall within one nautical mile. This is a significant finding, as it demonstrates that even when the dataset encompasses both stationary and actively moving vessels, the average positional difference remains low, thereby underscoring the high level of consistency between the two systems. Considering that a maximum temporal difference of 30 minutes is allowed when comparing AIS and VMS data, the observed distance metrics reflect a strong level of data consistency. For example, even if a vessel’s speed is exceeding 15 knots—where positional differences might naturally be greater—the measured distances remain within acceptable limits (e.g., not exceeding 7.5 nautical miles). Additionally, the global speed and heading correlation coefficients are 0.77 and 0.70, respectively, demonstrating robust agreement between the two datasets.

Table 8 details the performance metrics for the six target vessels. Specifically, Vessel A exhibits 85.37% spatial consistency, with speed and heading correlations of 0.93 and 0.64, respectively. Vessel B shows a spatial consistency of 57.58%, with a speed correlation of 0.30 and a heading correlation of 0.68. Vessel C achieves 76.66% spatial consistency, with excellent correlations for both speed (0.98) and heading (0.83). Vessel D records 83.39% spatial consistency, with speed and heading correlations of 0.83 and 0.60. Vessel E demonstrates 57.14% spatial consistency, accompanied by speed and heading correlations of 0.91 and 0.93. Finally, Vessel F attains 86.63% spatial consistency, with speed and heading correlations of 0.98 and 0.81. Overall, the average distances between AIS and VMS positions for each vessel remain within one nautical mile, underscoring a consistent alignment between the two systems. Furthermore, the observed maximum distances support the reliability of using AIS as a supplementary dataset when VMS data are unavailable.

Table 8. Comparative Analysis of AIS and VMS Data

Vessel	Spatial consistency (%)	Average distance (NM)	Minimum distance (NM)	Maximum distance (NM)	Speed correlation	Heading correlation
A	85.37	0.41	0.00	3.07	0.93	0.64
B	57.58	0.94	0.02	2.51	0.30	0.68
C	76.66	0.58	0.01	5.02	0.98	0.83
D	83.39	0.46	0.00	3.24	0.83	0.60
E	57.14	0.87	0.00	2.29	0.91	0.93
F	86.63	0.45	0.01	2.82	0.98	0.81

8.5. Figures and Visual Analysis

The figure accompanying this analysis further illustrates these findings. For example, Figure 5 presents the directional map for Vessel “A”. In this map, red markers and arrows indicate VMS data, while blue markers and arrows represent AIS data. The arrows are scaled proportionally to vessel speed and oriented according to heading, effectively depicting the vessel’s operational area and movement trajectory. The overlay of the Convention Area boundaries provides additional context by emphasizing the region where the AIS and VMS data are compared. Importantly, the visualization includes AIS data both inside and outside the Convention Area, which could also assist in confirming entry and exit notifications. The added layer of AIS also allows an opportunity to improve mapping of transshipments.

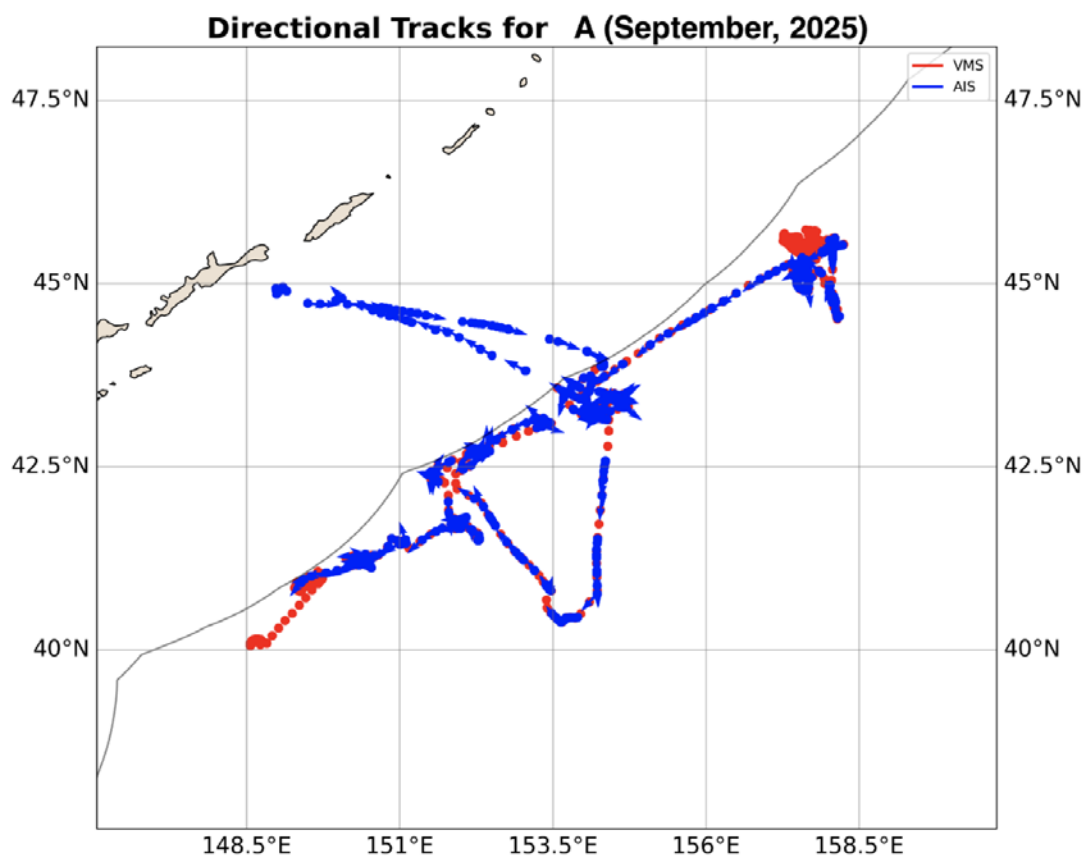


Figure 5. Directional map of Vessel “A”

8.6. Conclusion

The integrated approach—synchronizing AIS and VMS data through aligned timestamps, standardized location metrics, and comprehensive movement calculations—demonstrates that high data consistency and robust correlations in vessel behavior can be achieved. Despite the limited sample of six vessels over one month, the initial findings underscore the considerable

potential for incorporating AIS data to reinforce the existing dataset and establish a reliable, quantitative framework for vessel tracking analysis.

In addition, the integration of these two data sources enhances the Secretariat's ability to quickly verify and resolve anomalies in the VMS dataset. By utilizing AIS data on an as-needed basis, the Secretariat can efficiently cross-check irregularities, thereby ensuring more accurate monitoring of vessel activities. This rapid response mechanism can serve as an important safeguard against data disruptions.

Furthermore, the potential for integrating historical AIS data into the VMS platform represents a promising avenue for future enhancements. Given that near real-time data acquisition is currently cost-prohibitive, the use of historical data—available at significantly lower costs—offers a practical alternative for conducting comprehensive retrospective analyses. Such analyses can help identify long-term trends and provide critical insights into vessel movement patterns, thereby facilitating a deeper understanding of regional maritime activity.

With the consent of Members, the Secretariat proposes to access free AIS data as needed and to further explore the feasibility of integrating this dataset within the existing VMS platform. The Secretariat respectfully recommends that the TCC consider the potential benefits of incorporating historical AIS data into future analyses to enhance vessel tracking capabilities and improve overall analysis of fishing activities in the Convention Area.

9. Summary

Over the past three years, the NPFC VMS has progressed into a robust and reliable tool for tracking activities in the Convention Area. Cooperation from Members has been vital in addressing both anticipated and unexpected challenges, resulting in prompt resolutions to most issues. Notably, data interruptions have remained below five percent across all Members, and the use of manual reporting has further helped bridge any data gaps. These developments, coupled with refinements in vessel entry/exit detection and transshipment monitoring, reflect a strong commitment to maintaining transparent and effective oversight.

Moving forward, the Secretariat will continue to enhance vessel identification procedures, strengthen data security measures, and explore additional data sources such as AIS. Emphasizing globally recognized identifiers, timely updates to vessel registries, and efficient communication channels will preserve the momentum built thus far.

Annex 1. VMS Compliance Detecting Algorithm Explanation

1. Calculate vessel speed and heading when only location data is available

2. Identifying Gaps (Irregular Reporting)

- A. G (Regular) Reports: We focus on standard location reports (labeled “G”) to ensure the vessel is sending position updates as required (e.g., every hour).
- B. Time Gaps: We look at the time difference between each consecutive “G” report. If a gap is larger than a set threshold (e.g., more than 1 or 2 hours), we flag this as an irregular reporting event.
- C. U (Manual) Reports: For certain long gaps (e.g., more than 4 hours), having extra “U” (Manual) reports within the gap can make it compliant. No “U” reports might make it potential non-compliant.

3. Buffering the Convention Area and Checking Locations

- A. Convention Area: We have a shapefile representing our “Convention Area”—the region where vessels must report location more frequently.
- B. Buffering: We expand (or “buffer”) this boundary by a chosen distance (e.g., 20 nautical miles). This creates two zones: Convention Area and Buffer-only area
- C. Location Checking: For each position, we see if it falls inside the Convention Area, within the buffer ring, or outside altogether. This helps us decide if reporting was required.

4. Predictive Checks

Some rules require us to predict where the vessel would have been at certain times if it did not send a report:

- A. Speed + Heading: We calculate an expected future position (e.g., “where would the vessel be 1 hour after the gap started?”).
- B. Inside or Outside?: If we predict the vessel should have been inside the Convention Area but no report exists, that’s potential non-compliance. If we predict the vessel was in the buffer or outside, the gap may be acceptable.

Annex 2 – NPFC Data- Sharing and Data-Security protocol for Vessel Monitoring System (VMS) Data

NPFC Data- Sharing and Data-Security Protocol		
Para #	Text	Secretariat comment
4	<i>All VMS data shall be considered confidential.</i>	VMS data is classified as confidential and can only be accessed by authorized Members upon request.
5	<i>It is the responsibility of each Commission Member, and the Secretariat, to take all necessary measures to comply with this Protocol when transmitting and receiving VMS data.</i>	The Secretariat implements appropriate measures to comply with this Protocol when transmitting and receiving VMS data, including the use of two-way SSL certificate exchanges between the Member's FMC and NPFC VMS.
6	<i>Prior to accessing VMS data, authorized contractors shall be informed that VMS data is confidential and shall sign the Confidentiality Agreement (attached as Appendix 1) stipulating that they have been informed that the VMS data is confidential and that they have reviewed, are familiar with, and agree to the procedures to protect confidential VMS data set forth in the Confidentiality Agreement.</i>	Access to VMS data is restricted to Members, Secretariat staff, and service providers who have signed the Confidentiality Agreement.
7	<i>Where VMS data is transmitted by the Secretariat, with the approval of the Commission, to a party not already authorized to receive VMS data in accordance with this protocol, the Secretariat shall remain responsible for such data. The third party must receive written authorization from Secretariat to receive VMS data and shall be required to sign the Confidentiality Agreement (attached as Appendix 1). Breach of the Confidentiality Agreement constitutes breach of this Protocol, and will result in access to confidential VMS data being revoked, until corrective actions deemed</i>	Only authorized users who have signed the Confidentiality Agreement can access VMS data.

	<i>appropriate by the Commission and the Secretariat have been taken. The third party will maintain the data provided to it in a manner no less stringent than the security standards established by the Commission.</i>	
8	<i>The Executive Secretary will report to the Commission annually on the compliance with this Protocol, including any breach thereof.</i>	This report represents the first such report by the Secretariat
9	<i>All VMS data collection, access, storage, use, and dissemination shall only be undertaken for the purposes of monitoring, control, and surveillance in the Convention Area, supporting search and rescue operations, and fulfilling the functions of the Commission, as established in Article 7(1) and (2) of the Convention, including scientific purposes as defined above, and subject to any additional relevant regulations, protocols, CMMs or policies approved by the Commission.</i>	VMS data can only be accessed by Members who have requested it for MCS activities.
10	<i>All authorized personnel having access to VMS data are prohibited from unauthorized use or disclosure of such data.</i>	All NPFC Secretariat staff and contractors are required to sign confidentiality agreements, agreeing to comply with protocols and respect data security
11	<i>All VMS data shall be protected against loss or theft, as well as unauthorized access, dissemination, copying, use, or modification, by security safeguards, in accordance with the Data Retention and Security Section of this Protocol.</i>	NPFC VMS data storage is not physically accessible to unauthorized individuals. Only authorized users can access VMS data and modify and delete are restricted.
12	<i>VMS data should only be accessed and/or used by authorized personnel in the Secretariat, authorized MCS entities and personnel, and authorized contractors, for the identified purposes in this Protocol or for other purposes identified by the Commission.</i>	VMS data can only be accessed by authorized personnel from the Secretariat.

13	<i>The Secretariat shall not make VMS data available to a Member where the Commission has established that the Member has not complied with this Protocol, or the CMM for VMS.</i>	The Secretariat grants Members access to VMS data exclusively for their monitoring, control, and surveillance (MCS) activities.
14	<p><i>For a Member who has an Inspection Presence in the Convention Area, VMS data shall be made available electronically in accordance with the following provisions:</i></p> <p><i>(a) Each Member shall identify a point of contact for VMS data;</i></p>	The Secretariat provides Members with electronic access to VMS data in accordance with the specified provisions. In 2024, three Members requested access to VMS data. Each of these Members provided a designated point of contact.
	<i>(b) Each Member who has an Inspection Presence in the Convention Area shall provide the Secretariat with the geographic area (in multiples of 10 degrees latitude and longitude with a north and south latitude boundary and an east and west longitude boundary) of the planned boarding and inspection or surveillance operations at least 72 hours in advance, when practicable;</i>	The three Members requesting VMS data access in 2024 provided the Secretariat with the required geographic area details and boarding/inspection plans at least 72 hours in advance, as stipulated.
	<i>(c) Each Member who has an Inspection Presence in the Convention Area shall only make VMS data available to authorities or inspectors, as defined in the CMM for High Seas Boarding and Inspection Procedures for the North Pacific Fisheries Commission (NPFC) responsible for fisheries monitoring, control, and surveillance activities in the Convention Area unless the data is being used in an investigation, or a judicial, or administrative proceeding, and subject to any relevant domestic laws and policies, and has requested VMS data in support of HSBI/MCS activities</i>	Members are responsible for ensuring that VMS data is accessed only by designated authorities or inspectors as defined in the CMM for High Seas Boarding and Inspection Procedures.
15	<i>Where the fishing vessel to which the VMS data pertains has been involved in an alleged violation of a CMM, the Convention, or</i>	The Secretariat has not received any requests from

	<i>domestic laws or regulations, the VMS data pertaining to the alleged violation may be retained, and the Secretariat will be notified, by Members who have an inspection presence in the Convention Area until appropriate proceedings, including investigations, and judicial or administrative proceedings, have concluded.</i>	Members to retain VMS data after an inspection has been completed.
16	<i>Should no VMS data be retained pursuant to paragraph 15, each Member who has an Inspection Presence in the Convention Area shall delete all VMS data received from the Secretariat within seven days following the completion of monitoring, control, and surveillance activities in the Convention Area. The Member shall also submit a written confirmation to the Secretariat of the deletion of the VMS data within seven working days following the completion of monitoring, control, and surveillance activities.</i>	Some Members have not provided the required written confirmation to the Secretariat regarding the deletion of VMS data within the specified timeframe.
17	<i>For the purpose of supporting search and rescue operations by a Commission Member, the Secretariat shall make VMS data available upon request from a Member.</i>	The Secretariat has not received any requests for VMS data to support search and rescue operations.
18.	<i>All VMS data transmitted to the Secretariat in accordance with the Convention and CMMs shall be retained by the Secretariat.</i>	The Secretariat retains all VMS data transmitted by Members in accordance with established protocols.
19.	<i>Each Commission Member shall retain VMS data for fishing vessels flying its flag for at least one year.</i>	No issues Noted
20	<i>Each Commission Member and the Executive Secretary shall ensure the security of VMS data in their respective electronic data processing facilities, particularly where the use of VMS data involves transmission over a network.</i>	NPFC VMS employs two-way SSL authentication, requiring certificate exchanges between the Member's FMC and NPFC VMS to ensure secure data transmission.
21	<i>Security measures must be appropriate to the level of risk posed by the transmission, processing, and storage of VMS data. At a</i>	Security measures for transmitting, processing, and

	<p><i>minimum, the following security requirements must be implemented prior to transmitting or receiving VMS data:</i></p> <p><i>(a) The Executive Secretary shall ensure that regional system access to VMS data under its control is protected such that all data that enters the system is securely stored and will not be accessed by or tampered with from unauthorized individuals by implementing, at minimum, the following measures:</i></p>	<p>storing VMS data are implemented according to risk levels, ensuring compliance with established protocols.</p>
	<p><i>i) physical access to the computer system which transmits, uses, and stores VMS data is controlled;</i></p>	<p>There is no direct physical access permitted to the computer system.</p>
	<p><i>ii) each user of the system is assigned a unique identification and associated password, and each time the user logs on to the system, he or she must provide the correct password;</i></p>	<p>NPFC VMS assigns each user a unique ID and password for secure access.</p>
	<p><i>iii) user access shall be audited annually for analysis and detection of security breaches; and</i></p>	<p>A list of user access is exportable and can be monitored by NPFC VMS.</p>
	<p><i>iv) each user shall be given access only to the data necessary for his or her task.</i></p>	<p>The Secretariat assigns user roles (Administrator, Operator, Reader) based on operational needs.</p> <p>User accounts can be managed according to specific validity periods and/or restricted by date, zone, and fleet of VMS data.</p>
	<p><i>(b) Data exchange protocols for electronic transmission of VMS data between Commission Members and the Secretariat shall be duly tested by the Secretariat and periodically reviewed by the Commission. Electronic transmission is subject to security procedures established in this Protocol</i></p>	<p>VMS data transmission from Commission Members to NPFC VMS is tested before initial use.</p> <p>Periodic testing is conducted upon SSL certificate renewal by either the Member's FMC or NPFC VMS.</p>

	<i>(c) Appropriate encryption protocols duly tested by the Secretariat and periodically reviewed by the Commission shall be applied by authorized contractors, including the use of cryptographic techniques to ensure confidentiality and authenticity.</i>	NPFC VMS employs HTTPS encryption to ensure secure data transfers.
	<i>(d) Security procedures shall be designed by authorized contractors addressing access to the system hardware and software, system administration and maintenance, backup, and general usage of the system. Each Commission Member, and the Executive Secretary, shall ensure proper maintenance of system security and restrict access to the system accordingly. Each Commission Member shall liaise with the Secretariat in order to identify and resolve any security breaches or issues.</i>	Service providers responsible for NPFC VMS system development and maintenance implement security procedures for access control, system administration, backups, and general usage. The Secretariat works with Members to address and resolve any security issues.