ARTISONAL
Innovation for Future

REPORT

LOW-COST SATELLITE MONITORING SYSTEM FOR ARTISANAL FISHERIES

August 2023

ABOUT ARTISONAL

ARTISONAL (www.artis0nal.wixsite.com) is an organization that aims to contribute to the sustainability of fisheries by adding an inclusive and social approach. Works with innovation, using technology as a powerful ally for managing distant water and coastal fisheries and encouraging data transparency and collaboration between researchers, government, industry, and direct actors among fishermen and shipowners.

ABOUT THE AUTHOR

Eloy Aroni, representative of ARTISONAL, has experience in distant-water and coastal fisheries, increasing capacities at the level of governments, industry, and fishers. As well as in projects to adapt fishing technologies for surveillance, monitoring, traceability, and fisheries management.

ACKNOWLEDGEMENTS

The author extends special thanks to Elsa Vega, president of the National Artisanal Fishing Society (SONAPESCAL); Carlos Yenque, project coordinator representing SONAPESCAL; Henry Juarez, president of the Association of Artisanal Fishermen of Parachique (APADEXPO); Percy Bayona, expert in artisanal fisheries; and to all the fisherman and shipowners who participated by providing data, ideas and guidance during this project.

TECHNOLOGICAL PARTNERS

ARTISONAL would like to thank its technology partners, whose software and systems were essential to the project's success: Andrew Loretta, Maritime Business Development Director at Orbcomm; Werner Meier, representative of Surmapp; and Grigoris Pigikoglou, Product Manager at MarineTraffic.

EXECUTIVE SUMMARY

Artisonal, in collaboration with the National Artisanal Fishing Society (SONAPESCAL), carried out the pilot project to test the MT5000-Orbcomm satellite equipment in the deep-sea artisanal fleet (squid and mahi-mahi) between April and July 2023. A satellite device with the world's first trimodal AIS system, designed specifically for artisanal and small-scale fleets. The equipment was installed on nine vessels distributed in the ports of Paita, Yacila, Parachique, and Pucusana, with a transmission rate of less than 30 minutes. The results recorded 15 fishing trips (150 positions per day) up to 200 nautical miles from the coast. The project demonstrated that the MT5000 satellite equipment (Type: AIS-Trimodal) fulfilled the requirements of the Peruvian government's vessel monitoring systems (VMS) for artisanal vessels in terms of numbers of broadcasted, emergency button, internal battery, mobile application, and costs adjusted to the economy of the artisanal fisherman. The project concluded that, when implementing a monitoring system for artisanal fleets, the Peruvian government must prioritize crew safety over inspection, particularly in artisanal fisheries such as squid and mahi-mahi, which must travel beyond 200 nautical miles. Consequently, the duality of the system Integrated AIS-Trimodal MT5000 satellite equipment functions as a vessel monitoring system (VMS) and a collision prevention system on high seas (AIS). Therefore, the Peruvian government can provide an additional alternative of satellite equipment adapted to Peru's artisanal fleets' economic and fishing conditions.

TABLE OF CONTENTS

EXECUTIVE SUMMARY **2**
TABLE OF CONTENTS **2**
BACKGROUND **3**
“AIS” TECHNOLOGY **4**
AIS SATELLITE EQUIPMENT - MT5000 5
PILOT PROJECT **9**
SQUID AND MAHI-MAHI ARTISANAL FLEET 9
METHODOLOGY 11
INTEGRAL MONITORING SYSTEM (IMS) 12
(1) MT5000-Orbcomm satellite equipment: 12
(2) Mobile application: 12
(3) Monitoring platform: 12
TRAINING 12
RESULTS **14**
LIST OF VESSELS 14
DATA AND STATISTIC 15
VESSEL TRACKING DATA 15
FISHER'S VOICES 18
Crew members 19
Shipowners 19
CONCLUSIONS **22**
RECOMMENDATIONS **23**

BACKGROUND

The Vessel Monitoring Systems (VMS) emerged to monitor and control industrial fleets worldwide. The coastal governments have used this system to control fishing within their jurisdictional waters, establishing fishing seasons and restricted access zones and combating illegal fishing.

The vessel monitoring system (VMS) in Peru began in early 2000, with the establishment of the Vessel Satellite Tracking System Center (SISESAT)[1] attached to the Ministry of Production (PRODUCE), beginning the surveillance and control of larger scale or industrial vessels destined for fishing resources such as anchovy, hake, jack mackerel, and tuna.

The inclusion of small-scale and artisanal vessels in the Peruvian SISESAT system emerged as part of the formalization process of vessels aimed at fishing species for direct human consumption (CHD)[2] such as artisanal and smaller-scale vessels under the fishing management regulations in the region of Tumbes (ROP of Tumbes)[3]; and artisanal vessels part of the Artisanal Fisheries Formalization System (SIFORPA)[4] and under Fishing Cooperatives[5]. In 2019, the Ministry of Production (PRODUCE) established standards for acquiring **class B and C satellite equipment**[6] specific for small-scale and artisanal fleets.

However, the process of acquiring satellite devices for artisanal fisheries such as giant squid (Dosidicus giant) and mahi-mahi (Coryphaena hippurus) has been delayed due to the low supply of satellite providers (**currently only 2 providers**). Furthermore, according to the Ministry of Production, the ISO/IEC certification[7] and the high value of the bond per vessel are some of the reasons that limit the entry of more satellite providers. This situation is causing the prices of equipment and monthly payments to be considered high by the fishermen and shipowners.

The current regulations of the Peruvian government about satellite monitoring systems must reflect the current conditions of artisanal fisheries. Moreover, the government and civil society must promote adapting these technologies into artisanal fisheries. Because of a legal and technological gap, the company ARTISONAL and the National Artisanal Fishing Society (SONAPESCAL) signed an agreement to carry out a pilot project to evaluate the feasibility of implementing a low-cost AIS-Trimodal satellite tracking device in artisanal squid and mahi mahi fisheries.

---

[1] Supreme Decree No. 026-2003-PRODUCE — Regulation of the Satellite Tracking System (SISESAT)
[2] Supreme Decree No. 005-2017-PRODUCE — Regulation of Fisheries Management of the Anchovy Resource for Direct Human Consumption
[3] Fishing RegimeSupreme Decree 020-2011-PRODUCE". Regulation of Fisheries Management of Artisanal and Small Scale Extractive Activities in the maritime area adjacent to the Department of Tumbes.
[4] LEGISLATIVE DECREE N° 1392. Legislative Decree that promotes the formalization of artisanal fishing activity.
[5] Decreto Supremo Nº 003-2018-PRODUCE — Disposiciones generales para el fortalecimiento de la pesca artesanal en las cadenas productivas.
[6] Resolución Ministerial Nº 433-2019-PRODUCE — Especificaciones Técnicas Mínimas para el equipamiento de Sistema de seguimiento satelital para embarcaciones pesqueras (SISESAT).
[7] MINISTERIAL RESOLUTION Nº 00327-2022-PRODUCE — Supreme Decree that modifies the regulations of the satellite tracking system for fishing vessels (SISESAT), approved by Supreme Decree N°001-2014-PRODUCE.

“AIS” TECHNOLOGY

The Automatic Identification System (AIS) is a system that transmits a ship's position to other ships in order to avoid collisions in international waters. The International Convention for the Safety of Life at Sea (SOLAS Convention)[8] establishes that ships of more than 300 gross tons that travel in open seas must use AIS. However, many national governments have mandated that fishing vessels outside IMO regulation use AIS, primarily in fisheries where fishing vessels must travel beyond domestic waters (outside 200 nautical miles).

Furthermore, many governments and intergovernmental agencies, such as Regional Fisheries Organizations (RFOs), are developing AIS regulations for their own waters. For instance, on May 31, 2014, all fishing vessels flying the European Union flag over 15 meters[9] in length must be equipped with AIS, and as of March 1, 2016, all US-flagged fishing vessels over 20 meters in length must be equipped with AIS.

Ground stations and satellites of the AIS system receive information from vessels such as MMSI (Maritime Mobile Service Identity), IMO (International Maritime Organization), ship type, position (latitude and longitude), date, and other data. This information is transmitted to other vessels and government shore stations. In this way, data on a ship's movements can be collected even from the most remote areas of the ocean.

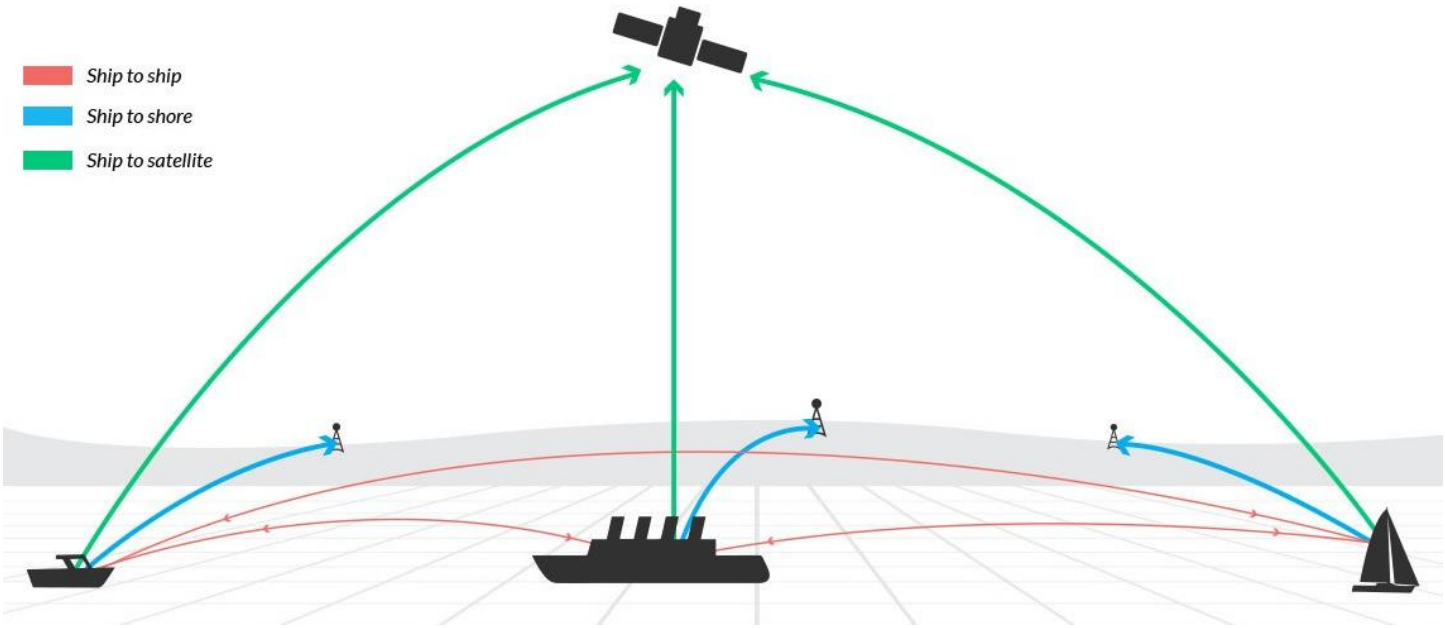


Figure 1. Interconnection of the AIS system through terrestrial and satellite stations and between ships.
Source: NATO

[8] SOLAS Convention — International Convention for the Safety of Life at Sea
[9] COMMISSION DIRECTIVE 2011/15/EU — Directive establishing a community monitoring and information system on maritime traffic in the European Union.

Is it possible for the skipper/captain of an artisanal vessel to modify the information transmitted to the AIS system?

The AIS system was implemented to provide security at sea for vessels transiting international waters. Over time, this open system has made it possible to identify events related to illegal fishing. For example, they discovered irregular patterns in the AIS system[10] in the distant-water squid fleet operating in the Southeast Pacific. It is essential to mention that these alterations are feasible when the AIS equipment is connected directly to a display system, such as a vessel's onboard computer. It is impossible to alter the information transmitted by the AIS system if the AIS satellite equipment is not connected to any onboard interface.

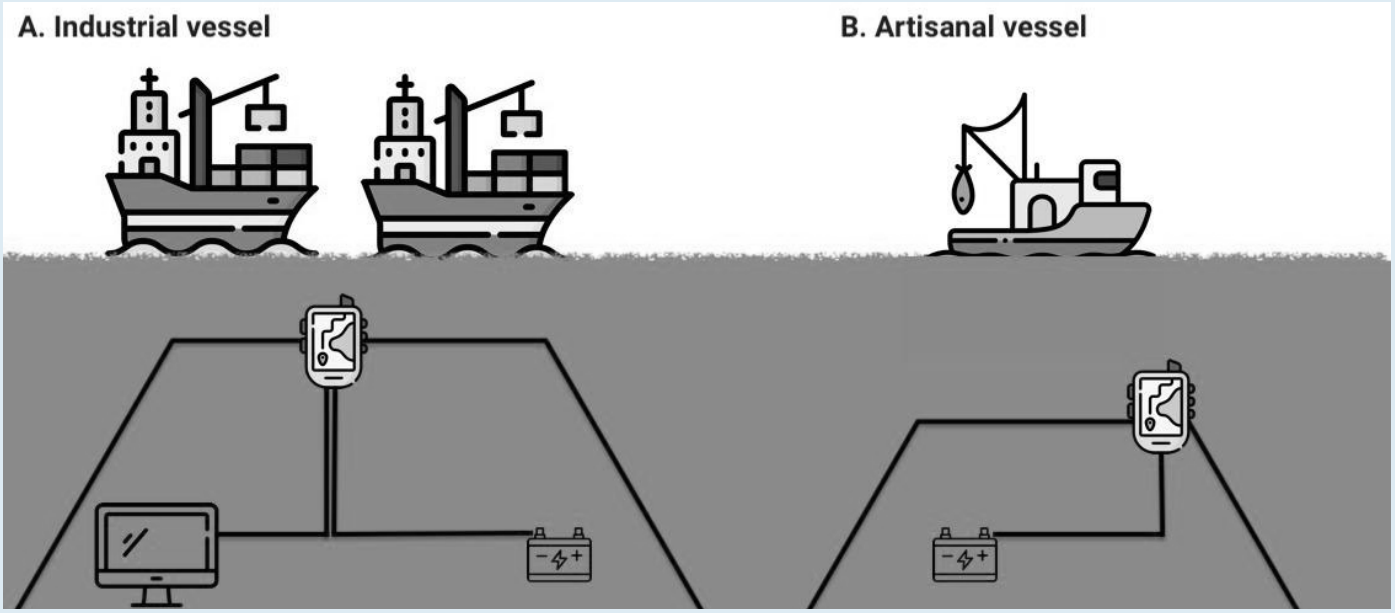


Figure 2. The AIS system connection system onboard an industrial (left) and artisanal vessel (right).

The AIS satellite equipment installed inside an industrial vessel is connected to both a computer and a power source (battery). Meanwhile, in the artisanal vessel, the satellite device is only connected to the power source. Inside the industrial vessel, an AIS display interface allows the skipper to change the information transmitted by AIS. However, on artisanal boats with no onboard computer, the equipment transmits its positions autonomously, and the skipper cannot modify the information transmitted by AIS.

AIS SATELLITE EQUIPMENT - MT5000

The MT5000 is a satellite device designed to help operators of smaller-scale and artisanal fishing fleets, maritime authorities, and organizations in charge of monitoring and controlling fishing and non-fishing vessels. An economical satellite equipment designed by the international company ORBCOMM to adapt to smaller fishing vessels in terms of cost and safety for the crew members. The adaptation process incorporates new functionalities of traditional AIS equipment for fishing management by governments.

[10] Analysis of the Southeast Pacific Distant Water Squid Fleet — GFW-2021-FA-SQUID 2020

Table 1. Features of the Orbcomm MT5000 satellite equipment.

AIS-TRIMODAL The MT 5000 is an **AIS-Class B** that transmits messages through terrestrial and satellite stations. In addition, it connects to the private satellite network **M2M** from ORBCOMM, making it the first satellite tracker type **AIS-Trimodal** of ships in the world.	**CONNECTIVITY ON HIGH SEA** Meets AIS requirements for navigation in International waters. Allowing artisanal fleets to fish on the high seas increases **crew safety** and reduces the risk of accidents. Additionally, it improves search and rescue operations.	**CONNECTIVITY - API** The MT5000 satellite positioning data is platform-independent and **easily integrated** into the vessel monitoring systems (VMS) of governments, customers, partners, and companies through an **API**.
EMERGENCY BUTTON Locating a distressed vessel is crucial to reducing maritime accident consequences. The MT5000 has an **emergency button**, which emits an S.O.S signal. Moreover, a safety clip prevents the button from unintentionally snagging.		**GEOCERCAS- BAN AREAS** The ease with which administering authorities can set geofences (EEZs) and ban areas or restricted areas (MPAs). An **alert** on the device also informs crew members if the vessel has entered specific or restricted areas.
PING RATE GPS position updates every **60 seconds**. Regardless of service cost, transmission rates can be easily set to 5, 10, 20, 30 minutes.	**INTERNAL BATTERY** Battery rechargeable lithium/ manganese batteries last an **internal energy of 4 days**, have a charging time of 4.5 hours, and have the possibility of integrating with a solar cell (optional).	**FLOATABILITY** The equipment cover allows **buoyancy**, and the internal battery allows continued transmission on the sea surface. Immersion is up to **10 meters deep**.

.: EEZ: Exclusive Economic Zone *MPAs: Marine Protected Areas* *API: Application Programming Interface*

The AIS system was originally developed to prevent collisions between ships in international waters. However, several governments are already implementing it within their jurisdictional waters. In some countries, such as the European Union, it is necessary for fishing vessels over 15 meters in length to use AIS. In Mauritania, the government requires 12 to 24-meter fishing vessels to carry an AIS-Class B transponder. Both examples demonstrate that the government made the final decision to integrate AIS into the vessel monitoring system (VMS), especially in the case of small-scale and artisanal fleets.

In Peru, the authorities never thought an artisanal wooden vessel could sail 850 nautical miles from the coast in international waters. Some cases where vessels leave Peru's jurisdictional waters include squid and mahi mahi fishing, a region where AIS equipment is critical for accident prevention. The fact that vessels 10 to 13 meters can go fishing so far from the coast requires updating the Peruvian government's requirements for using AIS.

Just as technology must adapt to the conditions of artisanal fishing, it is necessary to move in the same direction in regulations in national and international waters. Governments and Regional Bodies must prioritize safety over inspection, monitoring, and control issues regarding artisanal fisheries. It is necessary to update international navigation regulations, taking into account an environment in which not only large vessels transit through open waters but also artisanal vessels.

How is AIS-Trimodal technology?

The conventional AIS system combines data from terrestrial and satellite stations. Meanwhile, an AIS-Trimodal system incorporates a third satellite network from ORBCOMM's private network, M2M. The integration enables better satellite coverage and decreases gaps between positions transmitted by ships. It also offers managers precise data on vessel trajectories. The MT5000 satellite transponder integrates information from satellite AIS and terrestrial AIS, as well as the worldwide and private network of Orbcomm's two-way data satellite constellation (OG2). As a result, the MT5000 is the world's only trimodal satellite equipment.

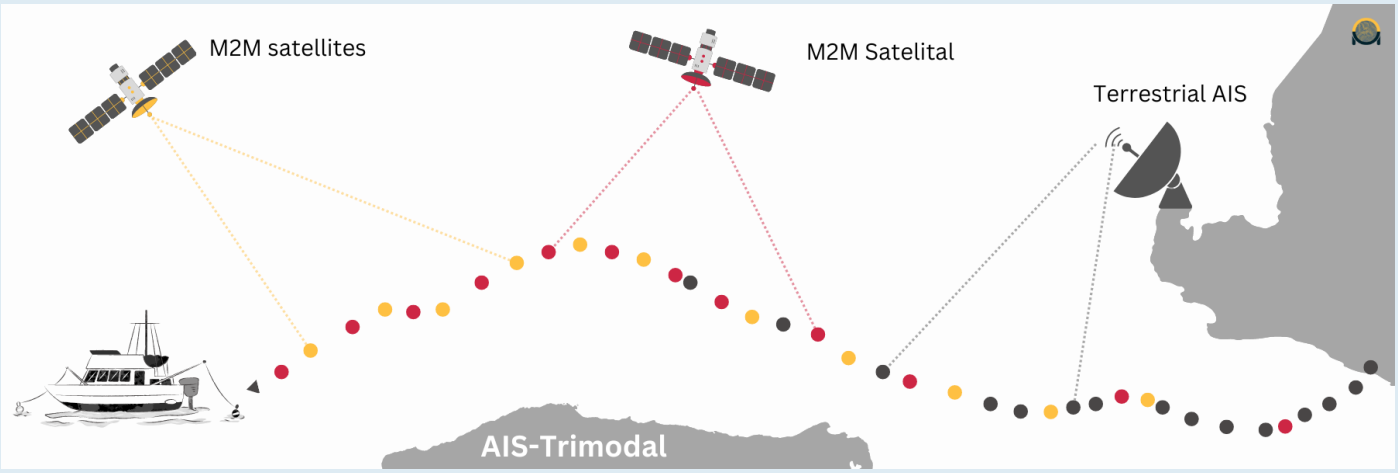


Figure 3. Composition of an AIS-Trimodal system, Satellite AIS, Terrestrial AIS, and OG2 (M2M) Satellite system.

The positions of an AIS satellite device are transmitted to terrestrial receivers when a vessel leaves the port and heads toward the fishing area. Satellite stations begin to collect position data from vessels as they move away from the coast. However, suppose a fishing vessel has the MT5000 satellite equipment on board. In that case, it will also be able to access the satellite coverage of the private M2M Orbcomm network, which allows a trajectory without information gaps between positions and precise management of transmission ratios in AIS data.

The users, such as fishermen and shipowners (vessel owners), can benefit from real-time information that helps them with port logistical operations by maintaining an adequate transmission ratio. One-hour position ratios, for example, make shipowners' monitoring duties onerous because they must wait an hour for the next position report. Also, high transmission rates (greater than one hour) could make it difficult to use historical data for research within the Peruvian Sea Institute (IMARPE), increasing errors in issues related to algorithms and fishing models. Indicators that directly benefit fishing authorities, such as the Ministry of Production, in the management of fisheries.

Governments can use satellite technology to overcome the significant challenges of introducing artisanal fishermen into traceability systems. However, the technology must provide immediate benefits to users (fishermen and shipowners) by facilitating fishing operations, logistics in port, and catch commerce, in addition to providing an inspection component for fishing authorities. This way, we can ensure fishermen can incorporate technology into their lifestyle and fishing activities.

The MT5000 satellite equipment prioritizes on-board safety features, including an emergency button. In addition to its capacity to float in the sea and its four-day internal battery, the device can continue transmitting autonomously in case of accidents at sea. Furthermore, the satellite support of the AIS-Trimodal system ensures a constant flow of vessel positions.


REGISTERED
EST. 1973
BILLABONG

PILOT PROJECT

SQUID AND MAHI-MAHI ARTISANAL FLEET

In artisanal fishing in Peru, the giant squid fishery *(Dosidicus gigas)* is considered the first most important artisanal fishery in terms of capture volume, followed by the mahi-mahi/dolphinfish fishery *(Coryphaena hippurus)*. Both resources are captured by an artisanal multi-species wooden fleet composed of approximately 4,000 vessels, using hand lines as fishing gear to capture giant squid and surface longlines for mahi mahi. They generated an average catch of 500,000 tons of squid and 40,000 tons of mahi-mahi per year[11].

This fleet consists of wooden vessels 10 meters in length and carrying between 6 to 8 crew members. Under various scenarios, the fleet operates on an **owner-skipper-crew** model. (1) Shipowners who own a single vessel and serve as skippers. (2) Shipowners who own multiple vessels and hire crew members. (3) Shipowners who own small fleets between 6 and 10 vessels. Furthermore, shipowners and fishermen are divided into cooperatives[12] and artisanal fishermen associations (OSPAs).

The Ministry of Production (PRODUCE) is currently formalizing the artisanal fleet, which requires installing a TYPE C satellite tracking device (Table 2). Despite the Ministry of Production's adjustments, only 989 artisanal vessels have installed the satellite equipment. The main reason is that only two providers authorized by the Ministry of Production offer satellite equipment, which shipowners consider expensive. A situation that creates a barrier to the entry of artisanal fleets into the Peruvian vessel monitoring system (SISESAT).

In this respect, the primary goal of this study is to assess the capabilities of AIS-Trimodal satellite technology for monitoring artisanal vessels. For example, consider the deep-sea artisanal fleet for fishing resources such as squid and mahi-mahi.

Table 2. Technical specifications of satellite equipment according to type of fishing fleet. Source: PRODUCE

TYPE A - Industrial	TYPE B - Small-scale	TYPE C - Artisanal
- Two-way communication - **48-hour energy autonomy** - Integration of virtual fences - **Transmission rate**: every **10 minutes** and every 2 hours in port. - Technical failures and geographic alerts	- One-way communication - **48-hour energy autonomy** - **Transmission rate**: every **15 minutes** and every 4 hours in port. - Technical alerts (**emergency button**)	- One-way communication - **Energy autonomy of 78 hours** - **Transmission rate**: every **60 minutes** and every 12 hours in port. - Technical alerts (**emergency button**)

[11] Fisheries and Aquaculture Statistical Yearbook 2021 — Ministry of Production.
[12] Supreme Decree No. 006-2016-PRODUCE — Strengthening artisanal fishing and production chains.

A deep-sea artisanal fishery

Fishing gear: Handline and Longline **Hull**: Wood **Length**: 8-14 meters **Crew**: 6-8 people

Figure 4. Artisanal vessels anchored in the bay of Paita, Piura. Credit: © Eloy Aroni

GIANT SQUID

Fishing gear: Handline.
A fisherman manually operates a handline.
Spatial coverage: The light attraction area of the spotlights has a radius of 6 meters and a depth of up to 10 meters. Fishing takes place during the day and night.
Fishing season: All year
Fishing trips:
North between 30-120 nautical miles | 8-10 days of travel
South between 60-250 nautical miles | 15-20 days of travel

MAHI-MAHI

fishing art: Surface longline.
Spatial coverage: The set has about 15 nautical miles with a mother line and equidistant lines, with approximately 1700 hooks. The setting and collection of the line are carried out in a manual way.
Fishing season: October 1 and April 30.
Fishing trips:
60-150 nautical miles | 10-15 days of travel
150-300 nautical miles | 20-30 days of travel
300-800 nautical miles | 30-40 days of travel

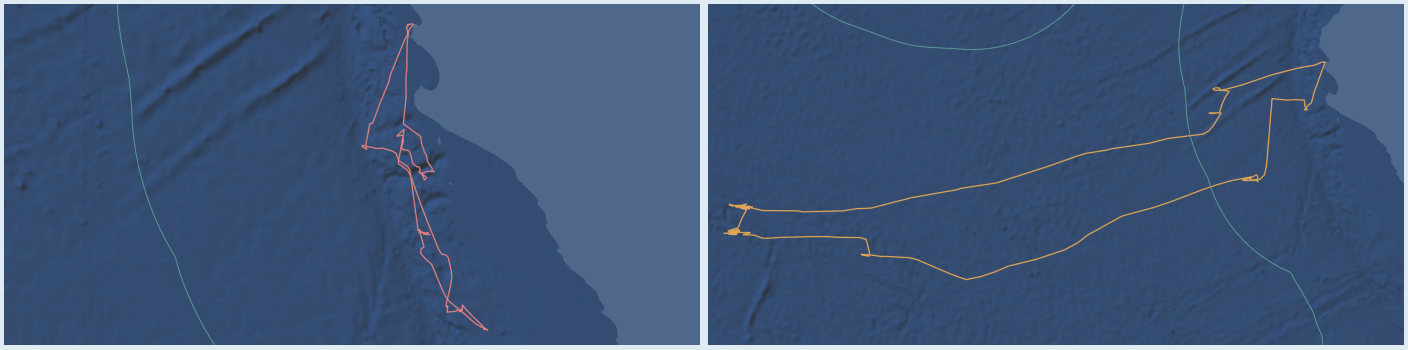


Figure 5. Trajectories of the artisanal wooden vessel VIRGEN DEL CISNE IV (PT-66149-CM) of 13 meters on a 14-day fishing trip to catch squid between 30 and 80 nautical miles off the coast (left). And a 30-day fishing trip to catch mahi-mahi until 850 nautical miles from the coast (right). Source | Global Fishing Watch

METHODOLOGY

PILOT PROJECT: Test of the MT5000 in the artisanal fleet (squid and mahi-mahi)

The main objective of the pilot project is to evaluate the functionality and adaptation of the low-cost satellite device MT5000 in the artisanal fleet (squid and mahi mahi) in the ports of Paita, Yacila, and Parachique in the Piura region, as well as a test in the port of Pucusana, in Lima. The vessels selected for the pilot test were divided into two categories. The first small vessels were 8 to 10 meters, where the satellite equipment was connected directly to the battery. The second group consisted of vessels with power control panels and a length of between 10 and 14 meters. The vessels for the pilot project were given by the fishermen and shipowner groups that are members of the National Artisanal Fishing Society (SONAPESCAL).

The study was carried out on the coasts of the province of Piura, located in northern Peru, due to the importance of the squid resource in the area. For May and July 2023, the artisanal fleet's fishing zone was between 20 and 80 nautical miles in front of the port of Bayovar. Paita, Yacila, and Parachique ports were where the catch was unloaded, and the MT5000 satellite equipment was distributed.

The MT5000 satellite equipment was previously calibrated with a transmission rate of 30 minutes between positions. However, current regulations establish that artisanal boats must have a transmission rate of every 60 minutes. For this project, we decided to work with a transmission rate of less than 30 minutes to demonstrate the benefits of having lower ratios. On the other hand, current regulations do not require users (fishermen and shipowners) to use a mobile application. However, the "Integral Monitoring System" (Figure 7) proposed for this project includes a mobile application for users and a monitoring platform for administrators (PRODUCE).

Figure 6. Study area of the MT500 pilot project in northern Peru.

INTEGRAL MONITORING SYSTEM (IMS)

(1) MT5000-Orbcomm satellite equipment:

The temporary Maritime Mobile Service Identification (MMSI) number "871" was assigned to the satellite device. We gave it a preliminary name, "EP Artesanal 1-DMO", and the equipment was mounted on the ship's wheelhouse.

(2) Mobile application:

Users, including fishermen and shipowners, may view the course of vessels in real-time using the Marine Traffic app, which is available for Android and iOS smartphones.

(3) Monitoring platform:

The web interface integrates all of the data sent by the vessels, allowing the administrator to monitor and control the fleet. Orbcomm receives satellite data from the MT5000 and connects it to Marine Traffic through an API before sending it to the mobile app and web platform.

TRAINING

The training component primarily targeted shipowners and crew members. All crew members, including the captain, were first instructed to utilize the "emergency button" and understand the colors of the equipment's front icons (battery, GPS, alarm). In the second stage, the training was focused on shipowners, users in port (responsible for the boats), and certain personal family members. This training addressed topics such as navigation in the mobile application, filters and layers activation, the area of interest, reading the current position, and analyzing vessel trajectory.

Figure 7. The ARTISONAL monitoring system comprises the MT5000-Orbcomm satellite equipment, mobile application, and the administrator's monitoring platform. Source: Artisonal


YACILA
PARIS
SAINT-GERMAIN

RESULTS

LIST OF VESSELS

The low-cost MT5000-Orbcomm satellite equipment was installed on a total of 9 artisanal vessels with coverage of 15 fishing trips. In some cases, five fishing trips per boat were recorded, such as in the case of the ESTRELLITA DE JESUS II, and in others, just a fishing trip, as in the case of the vessel BENDICIÓN DEL SEÑOR II. The average duration of fishing trips was 10 days. And the average length of the boat was between 8 to 14 meters in length (Table 3).

The DIANA MARITA II vessel, destined for squid fishing, had the most extended trip in northern Peru, with 13 days of navigation off the coast of Piura. In the south, the MADELEY I boat destined for swordfish fishing (*Xiphias sword*) recorded 29 days of navigation, reaching up to 130 nautical miles off the coasts of the regions of Ica and Arequipa (Figure 9).

On the other hand, four ships, DIANA MARITA I and II, JAZZER JIREH, and BENDICIÓN DEL SEÑOR II, left the port of Paita with the satellite equipment on board. Each boat recorded only one fishing trip. The boats that left Yacila Bay, the ESTRELLITA DE JESUS II and JORDAN EMMANUEL, recorded five and three trips, respectively. Finally, two ships, the RENSO and the AARON SMITH III, left the Parachique artisanal dock, while one vessel, the MADELEY I, departed Pucusana Bay (Figure 9).

Table 3. List of artisanal vessels that participated in the project MT5000.

N° Trip	Vessel name	Length (meters)	Port	Departure date	Duration at sea	Distance from coast (miles)
1	ESTRELLITA DE JESUS II	8.0	Yacila	2023-05-18	9 days	82 nm
2	ESTRELLITA DE JESUS II	8.0	Yacila	2023-05-31	9 days	91 nm
3	ESTRELLITA DE JESUS II	8.0	Yacila	2023-06-13	8 days	110 nm
4	ESTRELLITA DE JESUS II	8.0	Yacila	2023-06-26	10 days	63 nm
5	ESTRELLITA DE JESUS II	8.0	Yacila	2023-07-09	11 days	70 nm
1	JORDAN EMMANUEL	8.4	Yacila	2023-05-19	9 days	60 nm
2	JORDAN EMMANUEL	8.4	Yacila	2023-06-01	9 days	71 nm
3	JORDAN EMMANUEL	8.4	Yacila	2023-06-11	8 days	70 nm
1	DIANA MARITA II	14.1	Paita	2023-05-18	13 days	78 nm
1	DIANA MARITA	14.1	Paita	2023-05-19	12 days	60 nm
1	JAZZER JIREH	10.0	Paita	2023-05-19	12 days	58 nm
1	BLESSING OF THE LORD II	10.8	Paita	2023-05-31	10 days	76 nm
1	RENSO	12.1	Parachique	2023-06-01	9 days	70 nm
1	AARON SMITH III	11.0	Parachique	2023-06-01	8 days	72 nm
1	MADELEY I	10.0	Pucusana	2023-06-23	29 days	130 nm
TOTAL: 9 artisonal fishing vessels and 15 recorded trips.						

DATA AND STATISTIC

During the pilot project tests, the nine fishing vessels carrying the MT5000-Orbcomm satellite equipment broadcasted approximately 16,000 positions—an average of 150 per day (6 positions per hour). The 100% of transmitted positions were received by Orbcomm's private OG2 satellite network and satellite AIS source. Thanks to the number of positions transmitted for the day, users and administrators could see a precise trajectory of the fishing vessels' trips.

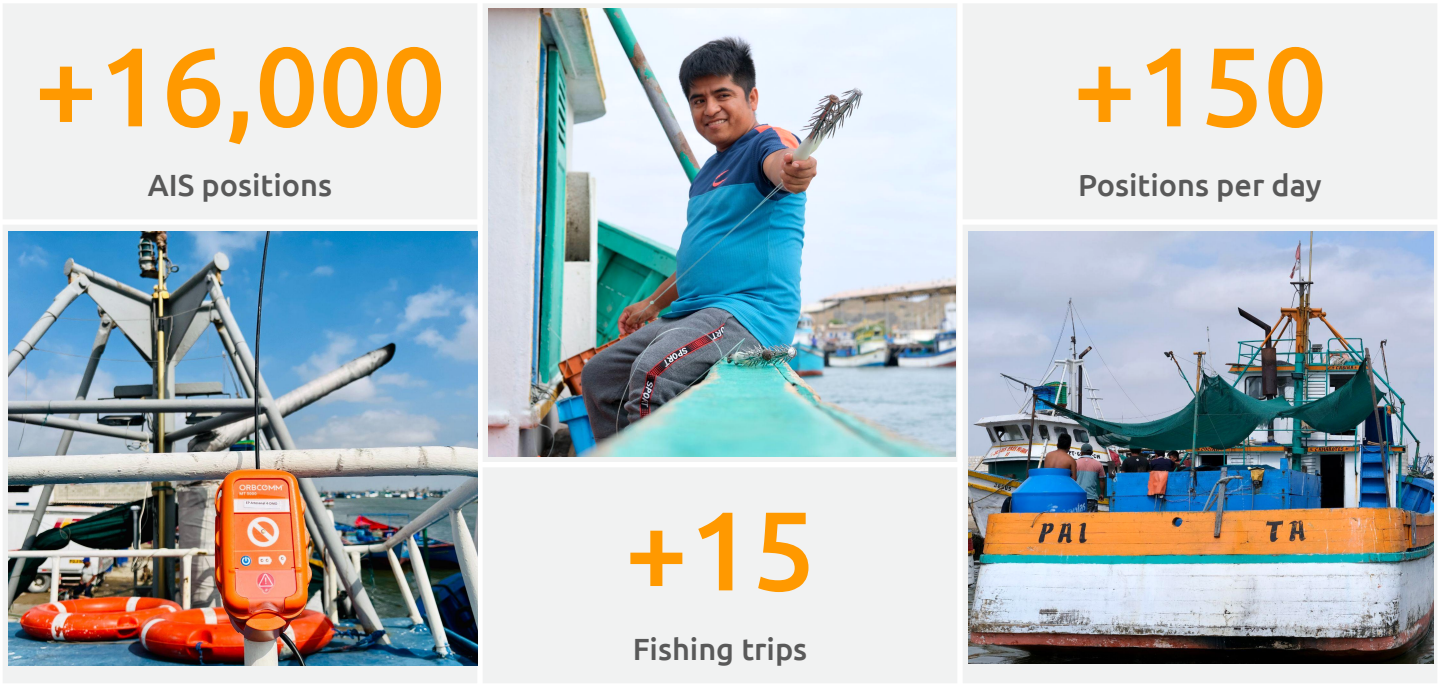
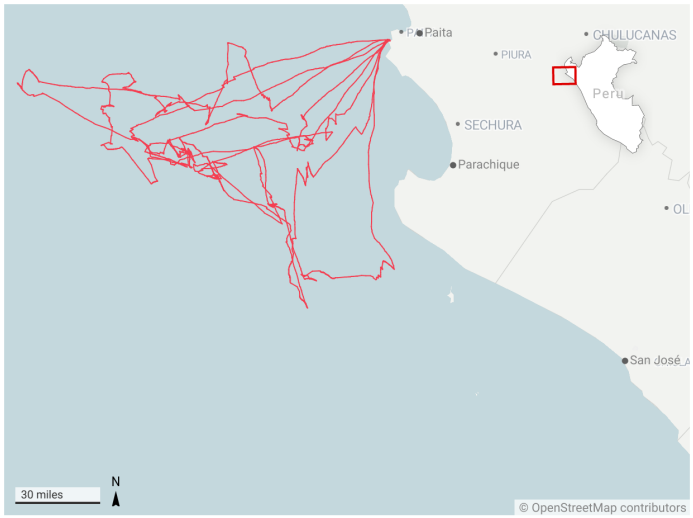


Figure 8. Numbers and statistics from AIS data

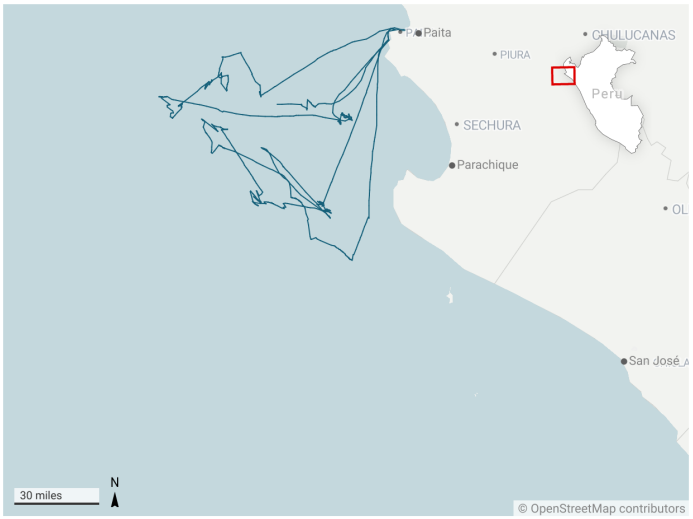
VESSEL TRACKING DATA

As part of the pilot project, 15 fishing trips were recorded. The trajectories confirmed that the fishing areas of the deep-sea artisanal fleet oriented to catch squid were located off the coast of Piura and Lambayeque during May and July 2023. For example, the ESTRELLITA DE JESUS II vessel of The Association of Artisanal Shipowners of Yacila recorded five fishing trips extending 10 and 110 nautical miles off the coast of Piura (Figure 9). Each vessel's fishing trip returned to the same port of origin. The time spent in port was 3-5 days. The satellite equipment remained operational during their port stay, transmitting at the same transition rate of fewer than 30 minutes.

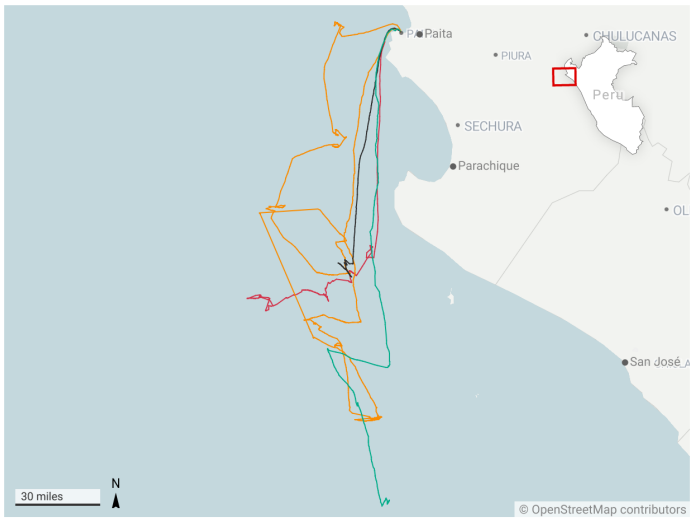
Finally, the results obtained with transition rates less than thirty minutes showed that 80% of the positions were between 0 and 10 minutes, 15% between 10 and 20 minutes, and 5% between 20 and 30 minutes. AIS data is flexible in configuring transition rates according to the requirements of those managed (Figure 9). Moreover, the variation in these rates does not imply increased costs for users to use the satellite service, unlike conventional VMS systems.



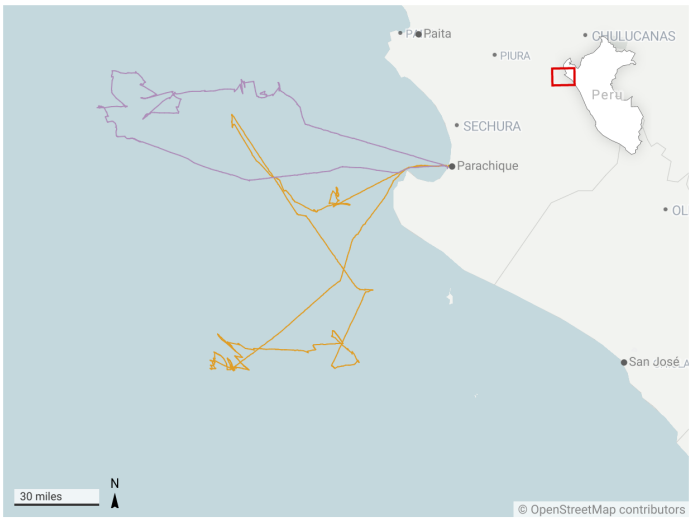
ESTRELLITA DE JESUS II



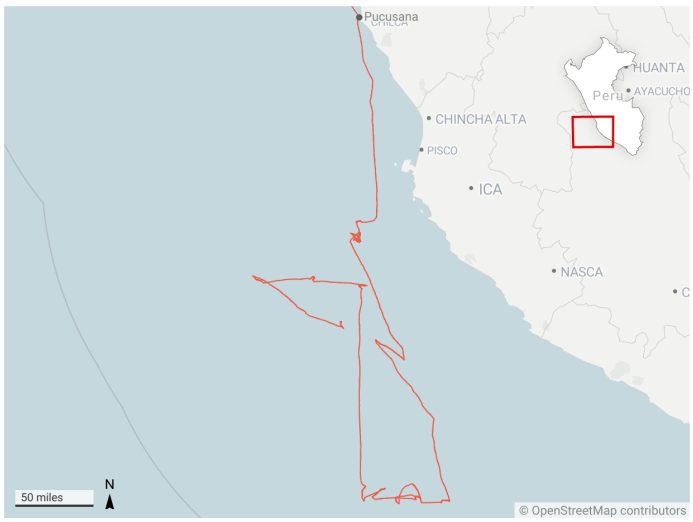
JORDAN EMMANUEL



DIANA MARITA II — DIANA MARITA — JAZZER JIREH — BENDICION DEL SEÑOR II



RENSO — AARON SMITH III



MADELEY I — 200 millas náuticas

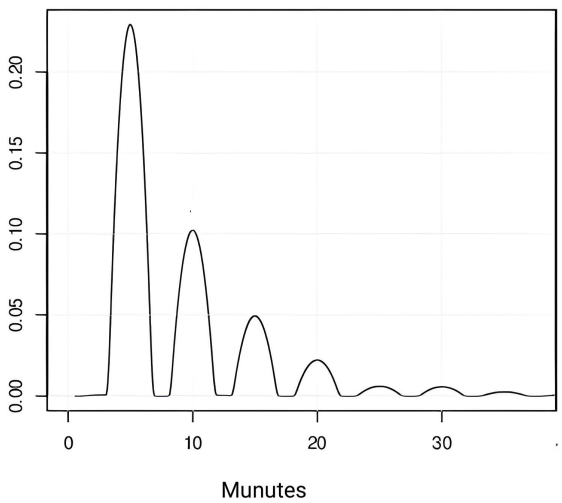


Figure 9. Vessel tracking data of the nine vessels and the density of the ping rate (minutes).

The data transmitted by the vessels included information on date and time, position (latitude and longitude), speed, and heading. Speed data (knots) were classified using a color scale from yellow to red. This classification is based on the speed range of a vessel. The artisanal deep-sea vessels reached a maximum speed of 6 knots. Therefore, speeds close to "0" are represented in red and indicate *loitering events* or stopped, and *fishing events* between red and orange have a speed of less than 1 knot. Yellow represents *transit events* with speeds greater than 2 knots. This classification helps users and administrators determine whether a vessel is fishing or in transit.

The data provides more than simply positions.

The data from the satellite positions of the vessels allow the fishing authorities to control the fishing fleets. However, research institutes also use this information to develop fishing models to determine the type of event (fishing or transit) a vessel performs. Therefore, this information helps users, administrators, and research institutes. The data's classification makes it easier for users (fishermen, shipowners, and family members) to read and interpret it, allowing them to make decisions promptly from land.

The third fishing trip of the vessel "ESTRELLITA DE JESUS II" describes one of the direct benefits for users. Using the mobile application, the user on land can know the real-time location of the ship. However, they can also quickly identify the vessel's current event type. Know if the vessel has arrived at the fishing area, is moving towards another fishing area, or has begun its return to port to unload the resource. In conclusion, for a technology to be adopted successfully, managers, shipowners, and fishermen must benefit from vessel monitoring systems.

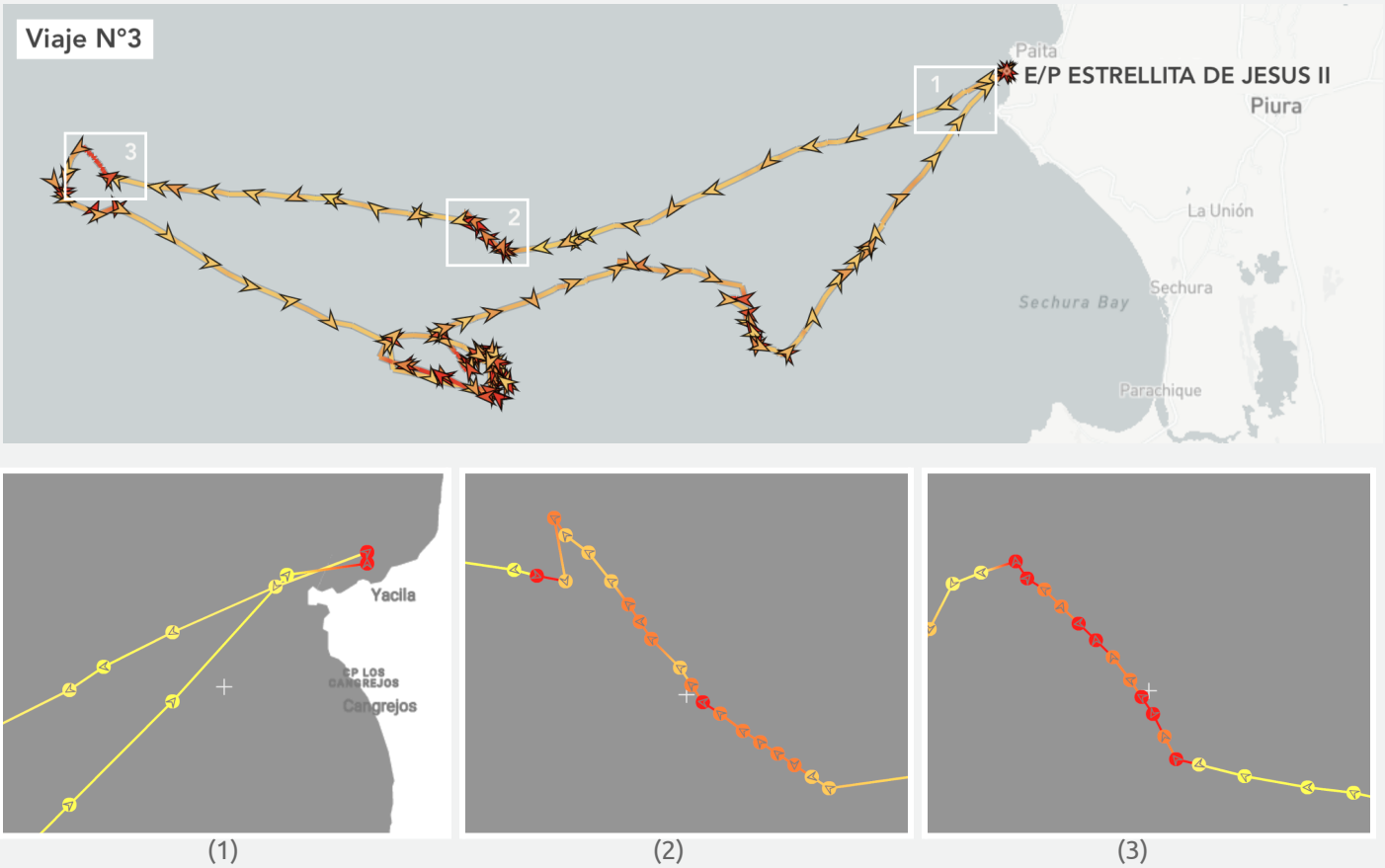


Figure 10. The trajectory of the artisanal vessel ESTRELLITA DE JESUS II (PT-32293-BM). The color scale represents the types of events: (1) stopped in port, (2) and (3) fishing.

FISHER'S VOICES

"Before, I used to go fishing as a skipper, but now I stay on land directing my boats. I no longer need to radio daily to ensure everything is okay there. Now, with the satellite equipment, I just check my cell phone and see where my boat is."

↓

"In artisanal fishing, it is common for the boat to drift (loitering) due to engine failure. It takes several days to find it. But now, I can see my boats from my cell phone. And, if the boat has engine failures, I quickly send another boat to tow it."

→

"I support my father in planning the boat departures, and the crew's families on land ask or are worried if they do not return after several days. We want to know if everything is okay with them. They ask us."

←

"I am a skipper; sometimes, the squid is very far away, and we go away for over 20 days. Some friends have lost their lives at sea going far away. We always go to the ocean with God's blessing. Today, before leaving, I told my wife and children that we carry this satellite tracking equipment and have that panic button in case of an emergency."

↓

"We need to know when the boat returns, see the price of the squid, and talk to the fish buyer. Everything is accessible from the cell phone; the app gives me the location, and I can know when it will arrive and have everything ready to download the catch."

→

"I have more than 20 years of experience in fishing. And I had heard about the satellite equipment, which monitors industrial fleets so they do not enter within 5 miles. We are artisans, and this equipment is more for our safety and the peace of mind of our family members at home."

←

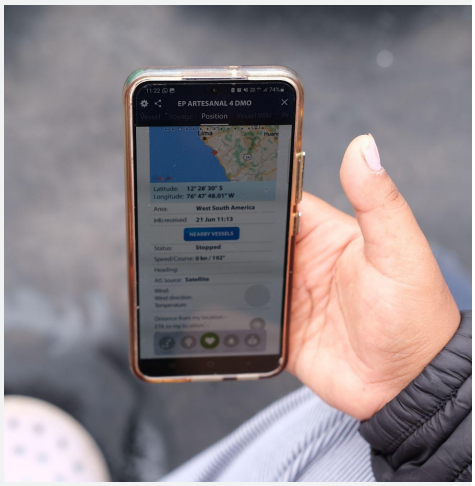


Figure 11. Comments from fishermen and shipowners of artisanal vessels.

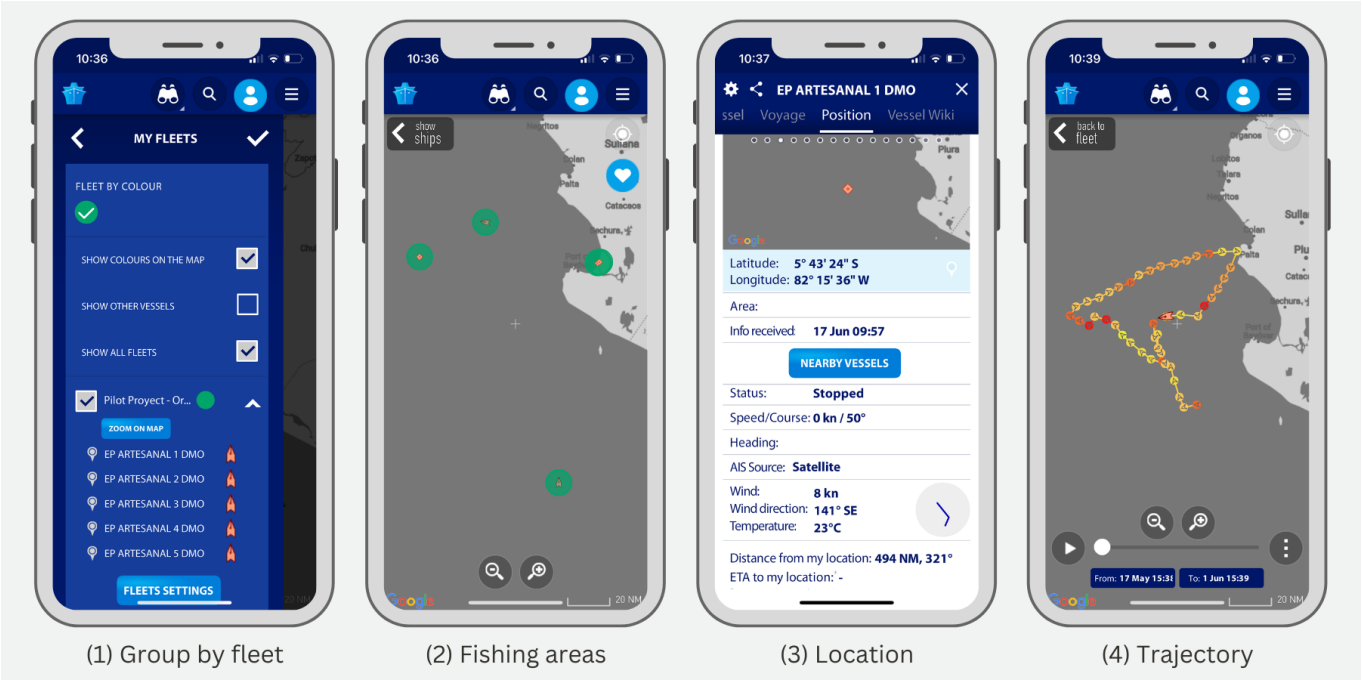
Crew members

Training was carried out on board the artisanal vessels in the presence of the captain and crew. The session began by transmitting basic concepts about the importance of satellite monitoring systems for artisanal fisheries, focusing on safety aspects at sea. There were also simulation routines for using the "panic button" in emergencies.

Shipowners

The shipowners, persons responsible for the vessels, and immediate family members received training on the use and interpretation of the functionalities of the mobile application. The instructors turned to a shipowner and close family members, such as wives or children. When shipowners remained on land, they were given direct training or a designated person (fleet bay).
Among the functions of the mobile application most highlighted by shipowners were the following:

(1) Group by fleet: A shipowner with more than two vessels is one of the main characteristics defining deep-sea artisanal fleets. The application allowed them to better control their vessels by grouping the boats as their fleet.
(2) Fishing areas: The spatial distribution of the vessels allowed the shipowners to better control the fishing areas by going directly into the fishing area where one of their boats was already fishing, which reduced the search time for the resource.
(3) Location: The tools most used by the shipowners were knowing the location (latitude and longitude), the type of event of the vessel, and some oceanographic variables such as sea temperature.
(4) Trajectory: The color range of the positions allowed owners to determine the type of event the vessel was in and then, based on the boat's fishing grounds history, plan their next trip.



(1) Group by fleet (2) Fishing areas (3) Location (4) Trajectory

Figure 12. The main functionalities of the mobile application.

In artisanal fisheries: Safety on board is essential

Using conventional VMS and AIS, fishery authorities can view fishing vessels through ground-based satellite monitoring systems. However, when a vessel operates only the conventional VMS system to cross the 200-mile limit into international waters, it becomes invisible to other vessels, increasing the risk of accidents. In contrast, with the AIS-Trimodal system, other vessels can see the vessel, avoiding collisions at sea (Figure 13). Therefore, *should a fishing vessel have a VMS and AIS system when sailing on the high seas?*

For instance, the industrial tuna fleet uses VMS and AIS systems when fishing outside the jurisdictional waters of Peru. These fleets can assume the extent of the costs associated with operating both systems. However, artisanal fleets need more financial resources to cover the expenses of both systems.

In the particular case of the artisanal squid fleet, the South Pacific Regional Fisheries Management Organization[13] (SPRFMO) has decided not to include the IMO number in the registration of Peruvian-flagged artisanal squid vessels to operate SPRFMO's jurisdiction. This regulation needs to adjust to the reality of the artisanal fleet, which is increasingly expanding towards the high seas in search of fishing resources such as squid and mahi-mahi. If an artisanal vessel suffers an accident on the high seas, the Peruvian Coast Guard will take at least a day to reach the area. On the other hand, if the artisanal vessel operates an AIS-Trimodal system, the signal would send an automatic alert to nearby vessels and coast stations. In operations in the high seas, every minute plays an essential role in the success of the rescue.

The AIS-Trimodal system functions simultaneously as a vessel monitoring system (VMS) and a collision prevention system in high seas (AIS), becoming a perfect system for deep-sea artisanal fleets. Consequently, governments like Peru can implement this new satellite technology as an alternative within their artisanal fleets. A complete satellite system that would allow fishermen and shipowners to comply with the formalization process of the Ministry of Production (PRODUCE) and guarantee safe navigation both in jurisdictional waters and outside of them.

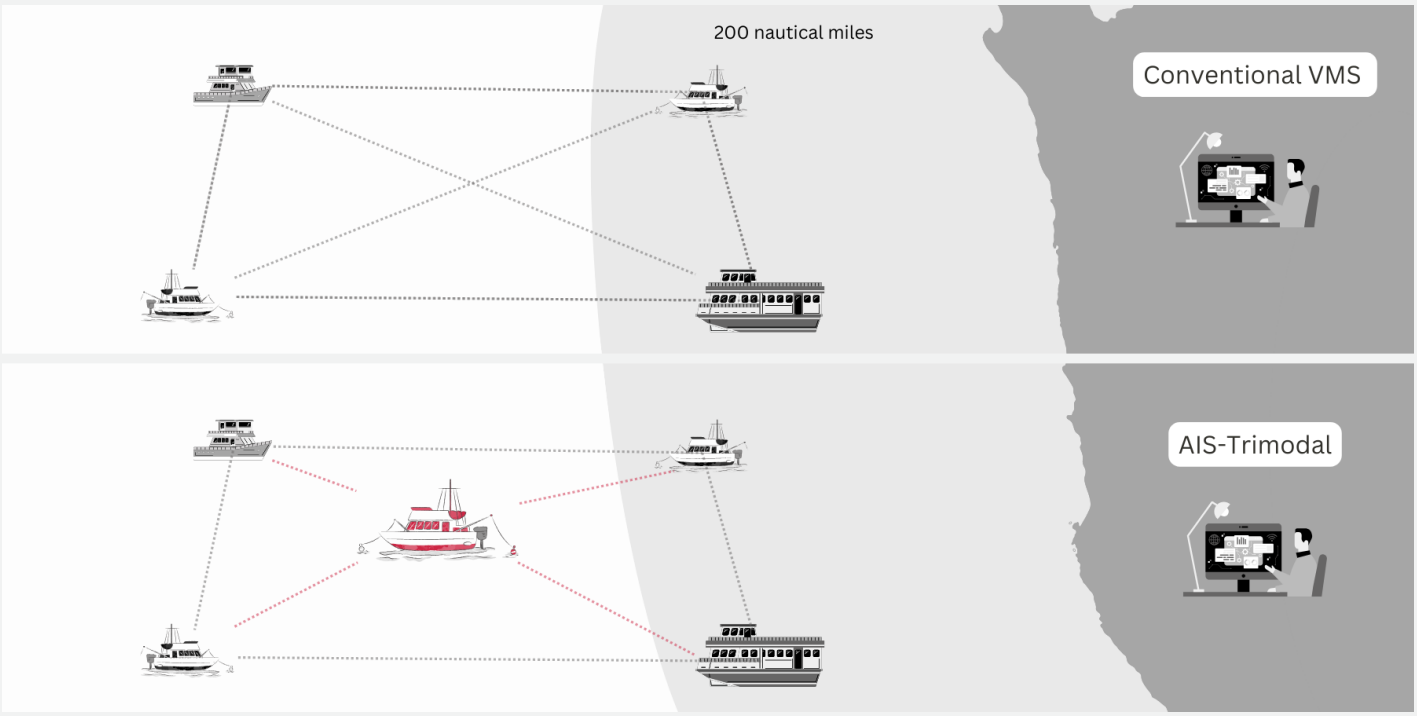


Figure 13. A comparison of a conventional VMS and AIS-Trimodal system.

[13] Annex to the proposed amendment to theCMM 05-2019 "Establishment of the Registry of the Commission of Vessels Authorized to Fishing in the SPRFMO Convention Area"


ORBCOMM
MT 5000

CONCLUSIONS

- The MT5000 satellite equipment (Type: AIS-Trimodal) complied with the Peruvian government's vessel monitoring systems requirements for artisanal vessels (Class C) in terms of the number of positions transmitted, emergency button, and costs adjusted to the reality of artisanal fishing..
- According to Peruvian fishing regulations, industrial fleets are prohibited from entering the five nautical miles, marine protected areas, (MPAs), and temporary closed areas (fishing bans). As a result, fisheries authorities must supervise and monitor compliance in real-time. In contrast, monitoring artisanal fleets focuses primarily on onboard safety rather than enforcement, and the artisanal fleet can fish freely throughout the Peruvian waters. Authorities must prioritize surveillance actions in the crew's distress signals due to accidents or engine failures, particularly in artisanal fisheries such as squid and mahi-mahi, which must travel beyond 200 miles.
- The MT5000-Orbcomm satellite equipment outperformed conventional VMS systems, particularly in artisanal squid and mahi-mahi fishery that conduct fishing trips outside Peruvian jurisdictional waters. The AIS-Trimodal technology can operate in national and international waters, allowing the shipowner to comply with Peruvian government regulations and international shipboard safety agreements.
- Finally, the Peruvian government must prioritize crew safety over inspection when developing a monitoring system for artisanal fleets. As a result, the AIS-Trimodal system integrated with the MT5000 satellite equipment acts as both a vessel monitoring system (VMS) and a collision prevention system (AIS). Therefore, the Peruvian government can provide an additional alternative of satellite equipment adapted to the economic and fishing conditions of Peru's artisanal fisheries.

RECOMMENDATIONS

- We recommend that the fishing authorities consider the results of the "*Pilot Project: Test of the MT5000 in the deep-sea artisanal fleet (squid and mahi mahi)*", carried out in collaboration with the associations of fishermen and shipowners that are part of the National Artisanal Fishing Society (SONAPESCAL).

- Concerning the transmission rate, although the current regulation requires a transmission every hour for artisanal vessels. We recommend evaluating the possibility of reducing this rate to 30 minutes. Moreover, this change must not affect the service's cost as the AIS-Trimodal system does. As a result, users could have up-to-date position information, and managers could better identify the vessel's fishing and transit events.

- Finally, we recommend extending the AIS-Trimodal MT5000 satellite equipment tests to other deep-sea artisanal fleets, coastal fisheries, and tourist activities on the Peruvian coast.
  - **a)** We recommend conducting tests on the southern region's artisanal squid fleet in Matarani, Quilca, and Ilo ports. In addition, carry out tests in other deep-sea artisanal fisheries such as shark, swordfish, and flying fish eggs.
  - **b)** Also, test in small-scale fisheries intended for anchovy fishing for direct human consumption or coastal fisheries such as artisanal gillnet and longline fleets.
  - **c)** Finally, within protected marine areas such as the Paracas National Reserve and the System of Islands, Islets, and Puntas Guaneras National Reserve, specifically in operators that provide tourist services aboard recreational boats to islands such as Ballesta and Palomino.

ARTISONAL

Innovation for Future

Av. Chorrillos 646 - N° 406 | Chorrillos, Lima 15063, Perú

artisonal.group@gmail.com

artis0nal.wixsite.com

+51 992 497 047

@artis0nal