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U.S. Coast Guard

Tracking Fishing Vessels Around the Globe

New technologies boost capabilities and functionality of monitoring systems to allow full integration with fisheries management plans

Overview

Two decades after satellite-based vessel monitoring systems (VMS) began taking on an increased role in fisheries management—because of their ability to track the location and monitor the activities of fishing vessels around the world—new technologies are allowing these systems to be fully integrated into fisheries management plans. Today, VMS have become a critical tool in the global fight against illegal, unreported, and unregulated (IUU) fishing, which accounts for up to US$23.5 billion worth of seafood every year.

The systems provide a greater level of monitoring, control, and surveillance (MCS) than is possible with more conventional aerial and surface technologies. They have been increasingly required by fisheries managers around the world because they furnish a high degree of detailed and verifiable information. When VMS are installed

permanently on a fishing vessel, each unit has a unique identifier that can be used in conjunction with GPS to calculate a vessel's position and send the data to authorities at routine intervals.

Initially, flag States responsible for registering and licensing their vessels used VMS to track the activities of domestic fleets, while coastal states used the systems to monitor foreign-flagged vessels licensed to fish in their exclusive economic zones (EEZs). More than 30 years ago, the U.N. Convention on the Law of the Sea provided the legal basis for such a setup when it gave coastal states primary responsibility for managing all living marine resources within the zones that run 200 nautical miles from their shores. In 1995, the U.N. Fish Stocks Agreement specifically called for flag States to develop policies to mandate and implement VMS while taking into account subregional, regional, and global arrangements.[1] Now, most regional fisheries management organizations (RFMOs) mandate that vessels authorized to fish within their waters be outfitted with VMS.

States are increasingly entering into multilateral data-sharing agreements that provide "peer-to-peer" VMS information exchanges. Some also seek broader, multiparty arrangements, such as the agreement among members of the Pacific Islands Forum Fisheries Agency (FFA) to provide near-real time sharing of VMS data among members for all foreign-flagged vessels licensed to fish within their collective waters in the western Pacific Ocean.

These systems have become increasingly sophisticated, with the capability of being integrated with other management tools. Enhanced features now offered by service providers to complement the original tracking capability of VMS include:

- **Electronic catch reporting (e-logs).** Facilitate near-real time catch reporting to allow fishery managers to more easily correlate catch and effort data with VMS position information and inspection reports.
- **Integrated catch documentation schemes.** Track and trace fish from the point of capture through the supply chain, essentially tracking from hook to plate, by recording and certifying information that identifies where, when, and by whom the fish were caught.
- **Observer programs.** Onboard observers independently collect information at sea, for example, tracking bycatch, catch composition, and gear configuration data. When coupled and verified with VMS, this information is critical for responsible fisheries management.
- **Catch share or quota monitoring.** Catch shares, or quotas, allocate a specific area or percentage of a fishery's total catch to an individual, community, or association. VMS can help hold participants accountable by providing near-real time information on vessel position as well as catch reporting via e-logs.

As a key element in gathering needed information, VMS are required in most commercial domestic and high seas fisheries worldwide and help authorities monitor thousands of fishing vessels. However, to be effective, the data must be monitored regularly and shared appropriately for both enforcement and scientific purposes. To this end, RFMOs and other regional organizations, such as the FFA in the Pacific, increasingly choose to manage a centralized data-secure VMS on behalf of multiple members to collect information from vessels. That centralization improves the timeliness and technical capabilities of VMS and boosts cost efficiencies.

This brief spells out the components of effective VMS and the options available, and it looks at best practices for putting these systems into place. VMS should be required for all vessels, especially those authorized to fish in areas beyond national jurisdiction or in another state's EEZ. The units should be equipped with two-way reporting to allow communication between vessels and authorities. The VMS technologies should be approved and tamper-proof and the systems should be able to operate continually with backups in place. The data should be sent to all relevant authorities, and vessels that fail to comply with reporting requirements should face penalties.

Meeting these criteria would ensure that the systems implemented are effective and take advantage of fast-improving technologies. And that would allow authorities to better monitor the world's fisheries and reduce illegal fishing.

Abbreviations

ALC/MTU—automatic location communicator/mobile transmitting unit	**LES—**land Earth station
DNID—data network identity	**MCS—**monitoring, control, and surveillance
EEZ—exclusive economic zone	**MCSP—**mobile communication service provider
FMC—fisheries monitoring center	**RFMO—**regional fisheries management organization
GPRS—general packet radio services	**VHF—**very high frequency
IUU—illegal, unreported, and unregulated	**VMS—**vessel monitoring system
LEO—low Earth orbit	**VPN—**virtual private network

Primary uses of vessel monitoring systems

VMS are typically used for monitoring, control, and surveillance to assist fisheries managers and enforcement authorities in tracking the activities of licensed vessels. They increase the efficiency and effectiveness of conventional aerial and surface assets—which are commonly the most costly components of enforcement—by providing critical information to track area (spatial) or time (temporal) restrictions imposed by management bodies, such as RFMOs. Whether those management measures involve closed areas such as nursery grounds, broader closures as part of a marine protected area, or seasonal closures of a specific fishery, VMS can immediately tell authorities where and when vessels are operating.

What vessel monitoring systems can do

VMS functionalities have evolved to the point where fisheries managers can require vessels to provide electronic submission of observer data and catch reports in near-real time. That eliminates the considerable delays associated with paper reporting and greatly reduces the potential for false, intentionally manipulated, or inaccurate data.

VMS make it easier to enforce a range of fisheries management measures, including:

- **Area restrictions and closures.** Near-real time VMS tracking allows authorities to accurately monitor which vessels are operating in designated areas. If they have imposed catch or time limits in an area, VMS can be used to determine whether vessels leave as required.
- **Time management.** Fisheries authorities also can monitor, in near-real time, vessels that are subject to seasonal or time closures so that the vessels leave fishery grounds and return to port as appropriate.

A fisheries enforcement ship (on left) waits as authorities board a vessel observed fishing in national waters in the Philippine Sea. Vessel monitoring systems help track licensed fishing vessels to make it easier to conduct boardings at sea to ensure compliance with fisheries regulations.

- **Catch restrictions.** Combining VMS with additional catch reporting software can provide notification to a vessel when it has reached a catch limit and then be used to monitor vessels to ensure that they leave the fishery and return to port. This information can also be used in conjunction with area restrictions and time management to strengthen enforcement.
- **Quota tracking.** When coupled with electronic catch reporting, VMS can provide fisheries managers with near-real time information on whether catches are approaching or exceeding established quota limits.
- **Tracking seafood through the supply chain.** When combined with a catch documentation scheme, VMS can furnish information to validate vessel movements and activities. That can provide chain of custody information to the point of landing or transshipment and needed assurances to the market.

When properly configured and subject to appropriate operating procedures and penalties, VMS provide highly accurate data on a vessel's position that can help in developing improved stock assessments; scientists can cross-check VMS data with other management tools, such as vessel logbooks, catch data, and observer reports.

What vessel monitoring systems cannot do

A properly configured VMS can provide a range of useful information for fisheries management and enforcement, but there are limits to what it can do. Among those limitations are:

- **VMS cannot conclusively tell authorities if a vessel is fishing.** On their own, VMS cannot indicate if a vessel is fishing unless the units are linked to gear sensors or cameras that provide verification of activity. However, analysis of VMS data can indicate with a high degree of confidence whether vessel movements are consistent with fishing activity. Enforcement authorities then can respond to confirm the activity or investigate further to verify actions that do not comply with fishery measures.
- **VMS generally cannot be used as the sole evidence of IUU fishing in prosecutions, unless specifically allowed by the relevant government.** Increasingly, fisheries authorities seek to use VMS data in prosecutions, but the ability to do so depends on the specifics of a state's regulatory or legislative framework. As domestic legislation is updated and provisions are added to allow VMS data to serve as evidence of noncompliance, the successful use of such information in fisheries prosecution cases will increase.

- **VMS generally cannot be used by third parties (such as RFMOs or coastal states) as the sole evidence of noncompliance.** The ability of a party, other than a vessel's flag State, to use VMS data alone to prove noncompliance with RFMO requirements on the high seas remains problematic because the responsible flag State still must investigate to prove the alleged offense occurred. Third parties typically use VMS as a surveillance tool to help direct more conventional aerial and surface enforcement efforts to document potential noncompliance.

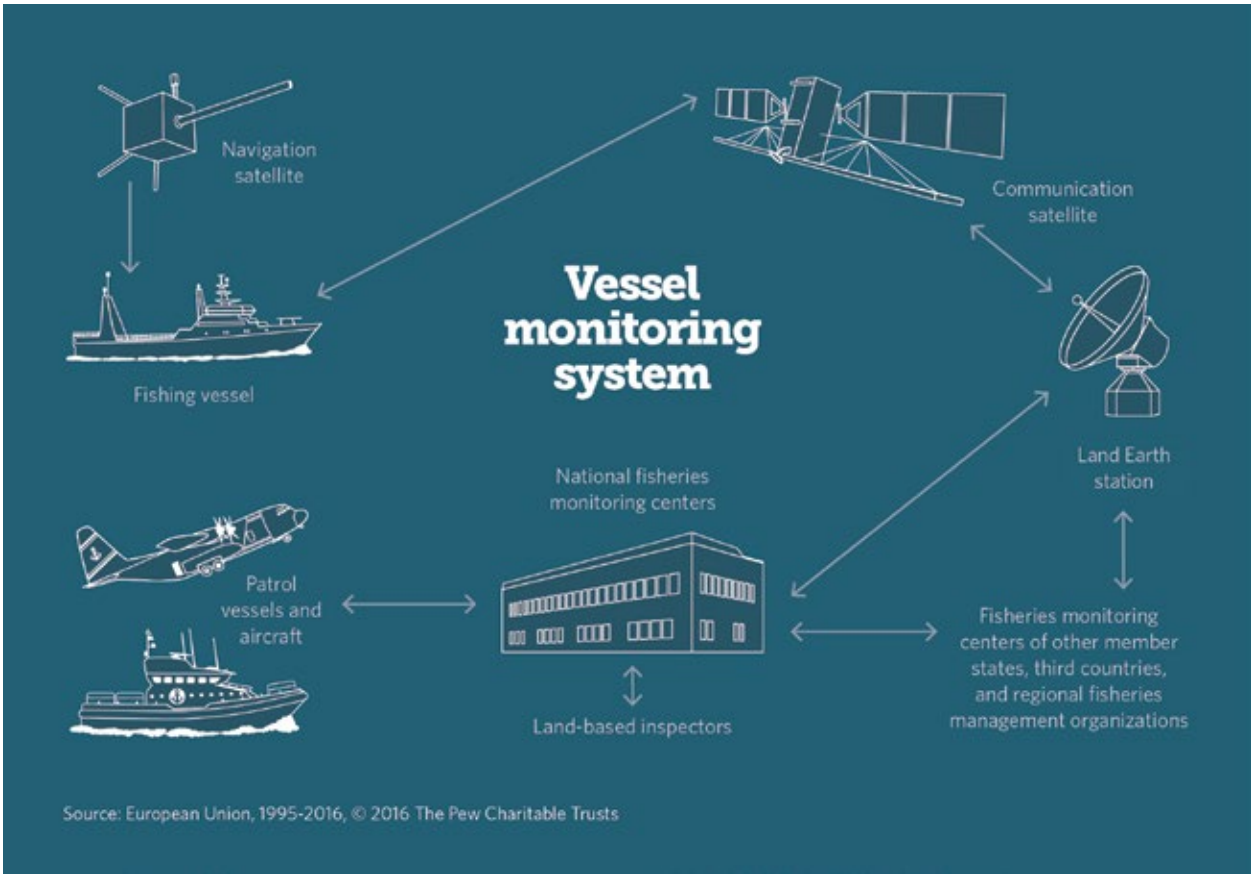
How vessel monitoring systems work

The building blocks

Each VMS relies on a piece of hardware installed on fishing vessels called an automatic location communicator (ALC) or a mobile transmitting unit (MTU), which sends information to communication satellites. As seen in Figure 1, data are relayed to land Earth stations (LES) managed by mobile communication service providers (MCSPs) and then transmitted by secure landline or internet connection to fisheries monitoring centers (FMCs) and the relevant RFMO secretariats. The monitoring centers can be managed by national, subregional, or regional entities, depending on national policies or international agreements.

Figure 1

Vessel Monitoring Systems: A Tool for Modern Fisheries Management



Setting up a typical "vessel-to-authority" VMS requires addressing three distinct elements:

- **Shipboard hardware.** The ALC/MTU—together the vessel's VMS unit—is installed and integrated with the shipboard GPS. Each VMS unit has a unique identifier for a specific vessel. Data reports are automatically sent to fisheries monitors at predetermined periodic times—the "VMS reporting rate"—and are of specific size. Management authorities determine how frequently data should be submitted, with a range of once a day to 24 times a day. The costs associated with the purchase, installation, and maintenance of shipboard VMS units may be borne by the fisheries management authority or vessel owners and operators, depending on management arrangements.
- **Satellite communications.** The fishing vessel data are sent securely through communication satellites and LES to the responsible FMC. The MCSPs are commercial entities that run and maintain the communication satellites and the LES, process the VMS data, and ensure that the information is sent to the FMC in a usable format. Airtime costs linked to the use of communication satellites and LES depend largely on the size of the data report, the overall VMS reporting rate, and the number of vessels being monitored.
- **VMS service provider.** Typically, a fisheries authority contracts with a commercial vendor to securely manage and store processed VMS data from MCSPs, and provide a user interface that displays the data so they can be analyzed appropriately. Fully managed services can include the costs of licensing, maintaining, and operating the software; maintaining a secure database and information technology (IT) hardware; managing, storing, and processing the data; and airtime. In some cases, VMS service providers also provide airtime and contract directly with MCSPs for bulk data to provide more seamless service. That can bring economies of scale and boost bargaining power with MCSPs on airtime pricing. In other cases, authorities prefer separate MCSP and VMS service provider contracts, allowing vessel owners to choose their preferred VMS unit from a list of approved devices. Table 1 lists some typical commercial providers for a range of VMS services.

Table 1

Sample Providers of Vessel Monitoring System Components

VMS element	Providers (not inclusive)
Shipboard hardware (ALC/MTU)	Applied Satellite Technology (AST), Thrane & Thrane, Faria Watchdog, Furuno, Thorium, SatLink
Mobile communication service providers	Vizada, Speedcast, Stratos, Iridium, Inmarsat, Argos
VMS service providers	PoleStar, Trackwell, Visma, CLS

The VMS unit transmits GPS data on vessel location and time to monitoring systems, commonly using conventional satellite systems, such as:

- **Inmarsat.** Originally founded by governments but now a commercial entity, Inmarsat maintains a constellation of geosynchronous communication satellites.
- **Iridium.** Uses a constellation of low Earth orbit (LEO) satellites to provide global coverage.
- **CLS Argos.** Uses LEO satellites from Europe and the United States in polar orbit.
- **AST.** Uses both mobile phone technology and Iridium communications through polar LEO satellites.
- **Qualcomm.** Provides access to Iridium satellite systems.

> Centralized systems eliminate redundant, separate, and costly satellite transmissions to multiple authorities by providing the same data automatically, securely, and in near-real time to relevant RFMO member countries and the RFMO secretariat.

Data reporting

Typically, FMCs use a data network identity (DNID) number to address specific groupings of VMS units. All units within a group must be configured to belong to a unique DNID. Vessels then can be identified by a VMS data report that uses both the DNID and the VMS unit identifier. The groupings may be associated with a fleet of vessels licensed by a national authority for a specific fishery, or they may be authorized vessels that must be monitored under specific RFMO arrangements. A single VMS unit may be configured to belong to and store more than one DNID group. That allows a vessel to be monitored simultaneously by more than one authority (for example, a national fisheries authority, an RFMO, or a vessel owner) through separately transmitted data reports. This can increase satellite airtime costs for the contracting party.

Data reports are typically provided to relevant authorities independently, which generates additional airtime costs. To help minimize these costs, management authorities can allow an MCSP or VMS service provider to establish a "gateway" within a centralized VMS database to provide simultaneous secure dissemination of reports to multiple authorized users under strict data confidentiality protocols. This allows a single vessel data report to be processed through a communication satellite to an LES and an MCSP.

Setup options

There are two approaches to housing the IT hardware, servers, and databases needed for a VMS:

- **In-house system.** A flag State or other authority establishes a secure physical space with limited access, buys the necessary IT hardware and software, maintains the equipment, and obtains VMS data directly from an MCSP. It sets up its own virtual private network so that VMS data can be sent directly to authorized users—such as a national FMC—to be viewed via software developed in-house or, more typically, owned and managed by a VMS service provider.

- **Hosted system.** The VMS service provider supplies the software for viewing the data and hosts the system in a secure space, with all IT hardware, software, and data storage provided. The flag State or RFMO secretariat uses secure internet access to view the data. This system has multiple advantages, including:
  - No capital outlay.
  - No ongoing IT costs (maintenance, upgrades, warranties, etc.).
  - Hardware solely dedicated to running VMS, which increases reliability.
  - Secure access from anywhere in the world.
  - Redundancies that minimize risk of system failures (power, internet, backup). An in-house system could have similar redundancies, but at a greater cost.
  - IT costs spread over multiple clients, which helps lower costs in the long term.

A hosted system can be tailored to individual client requirements, providing the basis for an RFMO centralized VMS. This allows for reporting of vessel position data, either directly to an RFMO secretariat or through the relevant flag State and then to the secretariat. In some cases, reporting is direct and simultaneous to both. For example, the VMS service provider can purchase IT services from an internet "cloud" provider (e.g., Amazon, Google, or Microsoft), contracting for needed hardware and data storage depending on the size of the fleet to be monitored and range of services. With a cloud system, capacity can be scaled up or down to meet clients' needs at a moment's notice, possibly increasing cost efficiencies.

In both in-house and hosted systems, data ownership protocols are retained and still belong to the client (flag State, RFMO, or other) in line with established data rules and procedures. Importantly, such centralized systems eliminate redundant, separate, and costly satellite transmissions to multiple authorities by providing the same data automatically, securely, and in near-real time to relevant RFMO member countries and the RFMO secretariat.

Size and cost implications for data reports

VMS data reports are typically transmitted in packets of different sizes and multiple parts, known as single- or two-packet reporting. Two-packet reporting contains information on the identity of a vessel and its current position in latitude and longitude in one packet, and the vessel's course and speed in the second. Older VMS software required two packets to display all three factors on a single graphical user interface. However, because two-packet reporting costs twice as much as single-packet reporting, most VMS service providers developed processing software to calculate the course and speed based on the last two VMS data reports received. This technological advancement has nearly eliminated two-packet reporting requirements and drastically reduced unnecessary and expensive airtime costs.

Two-way communication

Ideally, VMS units should allow for two-way communication between the vessel and relevant authorities. This enables a fisheries authority to change the reporting rate of a VMS unit or send the unit an order to immediately update a vessel's position—critical capabilities from enforcement and management perspectives. Known as duplex technology, these two-way communications allow authorities to alert a vessel if it is nearing or entering a closed area. A duplex VMS unit can provide direct communication, via text or email, allowing for near-real time transmission of electronic logbook and catch data. This can help with the flow of information for quota monitoring or product traceability. Newer duplex technologies are much better suited to smaller vessels than are older VMS units, a development that bolsters the case for using VMS on vessels of all sizes.

Fisheries management authorities use data from vessel monitoring systems to document the movements and activities of vessels within national maritime zones to make sure they are fishing legally.

Reporting rates

Fisheries authorities have the greatest confidence in VMS data that are provided routinely and with short time periods between reports. If vessels report data more frequently, authorities can determine with greater accuracy their location, direction, and speed. And that provides greater certainty when they examine movement patterns consistent with fishing activity. In addition, scientific assessments benefit from the increased detail that is available with more frequent reporting.

Gathering these data more often can be useful when vessels operate near known or disputed maritime boundary lines or in areas where vessels are not authorized to fish. Using two-way communications, authorities can automatically increase the VMS reporting rate for specific vessels when warranted. Importantly, authorities can send alerts to these vessels before they reach such boundaries or closed areas, providing proactive notification that may deter activities that violate fishery requirements. Increased reporting rates, however, bring greater airtime costs. As such, the management authority should work to balance effective monitoring and cost-effectiveness.

Type approval

To operate consistently and effectively and to provide certainty to fisheries authorities about the data transmitted, the VMS unit must have the correct capabilities for its purpose and be tamper-proof. Fisheries authorities generally require each make and model to undergo an established "type approval" process to ensure that the quality of data received from a specific VMS unit make and model meets specific operational and technical standards. Generally, an independent authority approved by either the national or regional fisheries management regime assesses the hardware via technical and environmental trials. Following testing, fisheries authorities prepare a list of approved VMS unit types. Hardware installers also must be approved to set up VMS units on board to ensure that authorities receive data from that vessel consistent with management requirements.

Data-sharing agreements

VMS data are commercially sensitive and not publicly available unless vessel identity and track history information—where the vessel has traveled—is removed. Still, the data can be shared among appropriate authorities under strict confidentiality arrangements. For example, the 17 members of the FFA have an established VMS data-sharing agreement to keep a close watch on their Pacific waters. Data for nearly 1,500 foreign vessels licensed to fish in the area are shared among fisheries authorities for each member state according to established, strict policies and procedures. Sometimes, VMS data are also shared among intergovernmental agencies, such as a state's coast guard, navy, or other maritime authority via a memorandum of understanding. This can help improve maritime domain awareness and allow authorities to remove legitimate fishing vessels from possible unwarranted surveillance or enforcement actions.

New technologies

The cost of operating and maintaining a VMS varies according to the requirements of the specific system. In general, the higher the functionality, the more expensive the equipment and required airtime costs. Some systems, such as those operated by the United States and the European Union, require more expensive onboard equipment and transmission of large amounts of data over the communication satellite link. Although these requirements result in increased airtime charges, they also provide a higher level of performance. The basic cost of VMS hardware, however, continues to decrease as technology advances. In most cases, a standard VMS unit for a vessel can be purchased for about US$1,000 or less, depending on its specific capabilities.

Fisheries managers can choose from various emerging VMS options. Although all available systems use GPS to monitor vessel movements, they differ in the methods and the ability to transmit VMS data to an MCSP.

Among lower-cost systems are:

- **General packet radio services (GPRS).** Using mobile phone technology, these systems use coverage from land-based mobile phone masts that can provide patchy coverage in some areas and have limited range. Marine-quality antennas can help optimize performance. The systems typically have the ability to continue logging vessel positions during periods of signal loss that can be transmitted when the signal returns. However, given the limits of mobile phone coverage, this system is more applicable to nearshore fisheries and smaller or artisanal vessels than those that go farther out to sea.
- **VHF time division multiple access.** These systems use a dedicated radio frequency to transmit data. Depending on the height of antennas installed on vessels and shore towers, transmissions are possible up to 40 nautical miles. There are no transmission costs once the system is set up, other than a VHF license cost.

However, much like GPRS technology, this type of VMS configuration is limited in range and more applicable to nearshore fisheries.

Choosing the right VMS

When flag States, coastal states, or RFMOs consider which type of VMS to use, they should take into account current management arrangements and the increased capabilities of today's systems. VMS are most useful in areas where fisheries authorities have imposed spatial or temporal restrictions on fishing within their waters. The systems also can track vessels on the high seas, enhancing general maritime domain awareness, and improving the effectiveness and efficiency of law enforcement activities. This helps managers target vessels and areas that demonstrate the highest risk for noncompliance.

Among the questions that policymakers should ask when selecting and implementing a VMS are:

- Why is the system being implemented?
- Which vessels will be required to report?
- How will the information be used and for what purposes?
- Who will be able to view and use VMS information?
- Are additional functionalities—such as electronic logs, observer reporting, or catch documentation—desired or needed?

> The systems also can track vessels on the high seas, enhancing general maritime domain awareness, and improving the effectiveness and efficiency of law enforcement activities.

Once these overarching questions have been answered, managers can look at other variables, such as which VMS units should be considered for type approval, whether a two-way communication system should be adopted, and, for RFMOs, what is the best way to share VMS information among flag States, the secretariat, and coastal state members. Policymakers also need to set standards, specifications and procedures, operating requirements, and data confidentiality rules, as well as consider how to handle manual reporting if a vessel's VMS unit fails.

Recommendations for RFMOs

While it is difficult to generalize, a review of current VMS requirements in many RFMOs points to some best practices. Specific approaches will depend on the circumstances and needs of each region, as well as how fisheries managers answer questions about how they want to use VMS.

VMS should be required for authorized vessels of any size and type. The requirement should apply to all vessels authorized to fish in areas beyond national waters—such as the high seas or in another state's EEZ—and apply to all vessels defined as fishing or fishing support vessels. That includes fish carriers and bunkering vessels, because these vessels are typically authorized to engage in fishing-related operations, such as transshipment. At first, VMS were used to monitor only larger industrial fishing vessels because of the costs and technical requirements. Now, though, these systems can be used for even the smallest vessels because of newer, compact hardware and cost reductions, as well as the availability of battery-powered units and cellular technology.

Regional surveillance efforts, such as the Pacific Islands Forum Fisheries Agency's Tui Moana operation in the Pacific Ocean, involve multiple nations and are strengthened when vessel monitoring system data is shared.

VMS should be type-approved and tamper-proof. VMS units should be sealed and fully automatic, and have adequate backup and recovery procedures.

Type approval establishes and maintains uniformly high system integrity. The approval process ensures that VMS units are reliable, robust, and secure. Systems should be able to demonstrate that they can:

- Transmit mandatory, automatically generated position reports that contain the unique identification of the VMS unit.
- Include visible and/or audible alarms to indicate a unit malfunction.
- Provide comprehensive and transparent communications, which function uniformly within the entire geographic coverage area.
- Provide two-way communications between an MCSP and a VMS unit.
- Send and receive email or text messages.
- Report positions accurately within 100 meters, unless otherwise indicated by an existing regulation or VMS requirement.
- Store a predetermined number (100 or more) of specific geopositions so that data can be recorded and saved when the VMS unit is unable to transmit or is configured to a "store and retrieve mode."
- Allow for variable reporting intervals between five minutes and 24 hours.
- Have reporting intervals changed remotely by an authorized user.

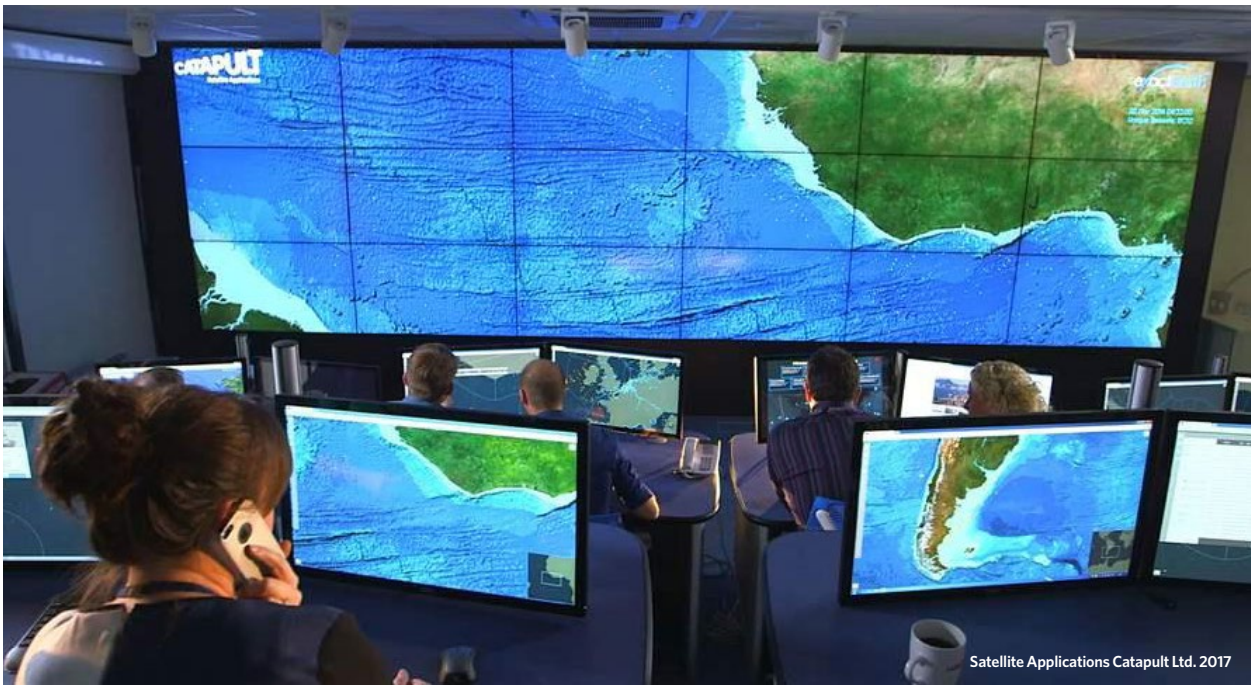
Fisheries management authorities can track fishing fleets more effectively if vessel monitoring systems have been mandated.

In addition, communications must be secure and not allow unauthorized access to passwords and data. The units should have mechanisms to prevent, to the extent possible, interception of data during transmission to the MCSP, spoofing—one MTU fraudulently identifying itself as another VMS unit, any modification of unit identification, and introduction of viruses that could corrupt messages, transmissions, or the entire system.

To ensure security, the RFMO should require that specially identified position reports be generated in the event of:

- An antenna disconnection.
- A loss of the positioning reference signals.
- A loss of the mobile communications signals.
- Shipboard emergencies, power-up, power-down, and other status data.
- A vessel crossing predefined geographic boundaries.

VMS should operate continually, but have backup systems in place. VMS units should remain in continuous operation at all times at sea and in all areas, providing "port-to-port" tracking from the moment a vessel leaves port until it returns. Management arrangements should be implemented to avoid potential gaps or loopholes in monitoring by the most appropriate authority (flag State, coastal state, or relevant RFMO). In cases of VMS failure, the rules should ensure that vessels operate without a functioning system for the shortest possible time and continue to report manually at sufficiently frequent intervals, ideally no longer than four hours. If a VMS unit remains nonfunctional for a set period of time, a vessel should be required to return to port, arrange for immediate repair or replacement, and remain in port until the unit is operational. Fortunately, the improved reliability of modern VMS units has greatly reduced the number of failures and the need for manual reporting.



Using state-of-the art systems that integrate multiple sources of information, analysts at fisheries monitoring centers can scan vessel monitoring system data to track the movements and activities of fishing vessels.

VMS transmissions should be provided to authorities in near-real time. Vessels should transmit VMS data at the highest possible frequency, ideally at hourly intervals. Higher reporting rates permit more accurate monitoring of fishing or transshipment operations and, when correlated with catch data, helps improve scientific stock assessments. Authorities must recognize that there will be a degree of delay or latency between the time a VMS data report is transmitted from a vessel to the point it is displayed on a user interface within an FMC. In most cases, when a VMS is performing correctly, data latency should be less than one hour for at least 90 percent of position data.

VMS data should be sent to all relevant coastal states and the relevant RFMO. VMS data should be provided simultaneously and in near-real time to the vessel's flag State and to all other relevant authorities. Simultaneous and direct reporting to authorities can be accomplished directly from the vessel via multiple transmissions (through appropriately assigned DNIDs) or after the data are received within a centralized hosted or "cloud-based" VMS. The centralized method is more cost-efficient and limits opportunities for tampering, deliberate manipulation, or altering of VMS data because secure landlines and HTTPS protocols (similar to internet banking) can provide data directly to relevant authorities in near-real time. If the VMS data are first transmitted to the flag State authority, measures should be put in place to securely transfer these data to the relevant coastal state and RFMO as close to near-real time as possible in an agreed upon and standardized data exchange format. Relevant VMS data also should be available to RFMO scientific committees to cross-check the accuracy of fisheries management data to improve overall stock assessments (this does not need to be in near-real time). The data will also be used to bolster inspections and at-sea enforcement actions.

VMS should provide for two-way reporting. VMS units should allow for communication—known as duplexing—between a management authority and the VMS unit. This enables the authority to increase the reporting rate when a vessel nears an environmentally sensitive or closed area and to ask the VMS unit for an updated vessel position. Alerts can be sent when needed for an inquiry or for real-time communication with the vessel operator.

The extra costs associated with two-way communications include sending data to and from VMS units with text or without text, as well as status requests. Strict protocols and procedures to identify situations that warrant increased reporting intervals can help mitigate these costs.

Viable penalties should be in place if vessels fail to comply with reporting requirements. Flag States, relevant coastal states, and RFMOs should have mechanisms in place to ensure effective implementation of VMS regulations and to apply appropriate penalties when those regulations are not followed—including possible revocation of the authorization to fish. These penalties should include possible prosecution and fines. Enforcement authorities also should be able to order a vessel to port for nonreporting or failure to report manually in case of a malfunctioning VMS unit.

> Flag States, relevant coastal states, and RFMOs should have mechanisms in place to ensure effective implementation of VMS regulations and to apply appropriate penalties when those regulations are not followed—including possible revocation of the authorization to fish.

Officials on a Micronesian patrol boat prepare to board a purse seine fishing vessel in national waters.

Conclusion

VMS are an essential tool for fisheries monitoring, control, and surveillance that is being used increasingly by maritime authorities to combat illegal fishing. The systems also play an important role in effective fisheries management.

With the adoption and implementation of effective rules and data-sharing among appropriate authorities, these systems can help to detect, deter, and eliminate IUU fishing in the world's oceans. At the same time, they can provide fishery managers with the information needed to design and implement effective management measures that ensure the long-term sustainability of critical fisheries.

Endnotes

1 United Nations General Assembly, "Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks" (1995), http://www.un.org/depts/los/convention_agreements/texts/fish_stocks_agreement/CONF164_37.htm. Article 18.3(e) requires "recording and timely reporting of vessel position, catch of target and non-target species, fishing effort and other relevant fisheries data in accordance with sub-regional, regional and global standards for collection of such data. Article 18.3(g)(iii) mandates flag States to conduct monitoring, control, and surveillance of their vessels by, inter alia, "the development and implementation of vessel monitoring systems [VMS], including, as appropriate, satellite transmitter systems, in accordance with any national programs and those which have been sub-regionally, regionally or globally agreed among the States concerned." Annex I provides standard requirements for the collection and provision of data, including on vessel positioning and fishing activity.

For further information, please visit:

pewtrusts.org/en/projects/ending-illegal-fishing-project

Contact: Kimberly Vosburgh, senior associate, communications
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Project website: pewtrusts.org/en/projects/ending-illegal-fishing-project