Global Fishing Watch

Vessel Tracking Best Practices Guide

A practical guide to vessel tracking systems

September 2026

Image Credit: Pok Rie

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Preface

The ocean is our planet's greatest shared resource, yet for decades, much of the activity upon it has remained largely hidden from view. As the ocean becomes ever more crowded and the industrial pressures mount against a backdrop of overfishing and illegal activity, the need for a common language in vessel tracking has never been more urgent.

Global Fishing Watch is an independent, international nonprofit organization dedicated to advancing ocean governance through increased transparency of human activity at sea. Since its founding in 2017, Global Fishing Watch has assisted many governments, drawing on its extensive experience with tracking vessels, especially fishing vessels, using satellite technology, cloud computing and machine learning.

Developed between 2024-2026, this guide responds to frequent requests from governments for a comprehensive, up-to-date vessel tracking reference — filling a critical gap left since the FAO's landmark 1998 publication. While vessel tracking technology has been in use for more than three decades, the pace of change in data processing, satellite communications and analytical tools has accelerated significantly in recent years — yet access to those advances remains uneven. This guide cannot change the financial and institutional realities each State works within. However, it offers a practical path to build or strengthen a system tailored to its needs, allowing every State — regardless of means — to manage its fleets, protect vital resources and detect illicit activity. The content reflects a synthesis of internal expertise with contributions from governments and academia.

The Vessel Tracking Best Practices Guide is commercially neutral and does not recommend any particular service provider or product. Its application is aimed primarily at large-scale vessels, including fishing and non-fishing vessels.

Decision-makers should assess the guide's recommendations within their specific national and institutional contexts to determine whether and when to adopt them. They should establish at the outset whether vessel tracking systems are necessary and identify the problems these systems can help address. This will help define the scope of their application and determine what data needs to be collected and how. If tracking systems have already been established, the guide can serve as a benchmark to assess their robustness and provide ideas for improvements. Because legal systems vary globally, this guide offers key considerations, examples and recommendations rather than explicit model language.

Technology, governance and the ocean are constantly changing. It is not possible to totally future-proof a document like this, and we recognize that many of the underlying conditions and scenarios will evolve, and many aspects of this work will change. The guide reflects current best practices, though we recognize these practices may be long-term aspirational goals for some. It is not prescriptive, but offers a flexible framework to guide progress and support phased implementation. Users are free to decide which suggestions to adopt, at a pace and level appropriate to their own situation. Adoption will vary across governments, depending on their capacity, readiness and circumstances.

Ultimately, it is our hope that this guide serves as a catalyst for a more transparent and sustainable ocean, empowering every nation to play an informed role in the stewardship of our global commons.

Sincerely,

Tony Long
CEO, Global Fishing Watch

Image Credit: Saïd photography

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Authors Charles Kilgour and Michele Kuruc

Communications Mariana Roudaut

Editing Barney Jeffries and Ben Shouse

Imagery Alain Margreve, Albert Ismagilov, Aneesh Thazhathethil, Arnaud Audoin, Charles Kilgour, David Clode, Deivis Sandoval, Doğan Alpaslan Demir, East Sea Fisheries Management Service, Global Fishing Watch, Ekaterina Bolovtsova, Fisheries and Oceans Canada, Hakan Kayahan, Jaanus Jagomägi, Joao Guerreiro, João Silveira, Jules Clark, Maël Balland, Mark Stebnicki, Md Sihabul Islam, Michael Held, Mikhail Nilov, Mikhail Preobrazhenskiy, Natalie Fobes, Nicolas Job, Nikolaos Dimou, Paul Einerhand, Photoneye, Pok Rie, Quang Minh Nguyễn, Quang Nguyen Vinh, Raimond Klavins, Red Zeppelin, Saïd Photography, Sergei Starostin, SweeMing Young, The Daphne Lens, Zheng Zhengyu and ZhiCheng Zhang, AJ Ahamad

Visualizations Charles Kilgour and Rodrigo Claudino Dos Santos

Design Nice and Serious

Translation Communications INC, Krizia Matthews, Luana Sêga and Mariana Roudaut

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Executive summary

Vessel tracking systems are critical tools for sustainable fisheries management and broader ocean governance. This guide provides a practical roadmap for acquiring and operating these systems effectively. When fully implemented, they provide the foundation for detecting illegal, unreported and unregulated (IUU) fishing, improving compliance, strengthening accountability at sea and making informed decisions about maritime security, marine spatial planning and environmental protection.

This guide reflects current global best practice, drawing on the experience of Global Fishing Watch and external experts. The recommendations in each section serve as a foundation for policymakers and practitioners around the world to strengthen national vessel tracking systems and policies.

It covers the technical, operational and legal processes for two primary systems:

- Automatic identification systems (AIS)
- Satellite-based vessel monitoring systems (VMS)

Structure of the guide

The guide fills a gap in this increasingly important field, and serves as a reference for governments, industry and civil society. It is organized into three thematic sections to assist policymakers and practitioners:

- Section I: Foundations of a vessel tracking system
- Section II: Technical standards and data processing
- Section III: Costs and legal considerations

Most chapters begin with summary recommendations to provide a preview of the more detailed material which follows. Consistent with Global Fishing Watch's mission and best practices, the recommendations encourage transparent and equitable data sharing. They aim to assist governments and industry in fulfilling their commitments to end IUU fishing, ensure fisheries are sustainable and protect vulnerable species and marine ecosystems. Achieving these goals depends on eliminating uncertainty surrounding who is doing what at sea. This requires making vessel tracking data open and accessible to all, while fostering collaboration and accountability among governments, industry and civil society.

Image Credit: Shutterstock

Integrated tracking as a foundational principle

A central recommendation of this guide is the adoption of integrated vessel tracking, combining VMS and AIS. These systems are complementary. Used together, they significantly improve data completeness, validation and enforcement effectiveness.
To enable this integration, States should ensure appropriate legal mandates exist, providing for the full range of data uses, and require institutional coordination with sustainable funding arrangements, including clear allocation of responsibilities across relevant agencies and justifications to users.

Transparency as an operational requirement

The guide emphasizes that transparency is not optional but foundational to effective vessel tracking systems. Many existing legal frameworks already allow or require relevant data sharing under international obligations, yet implementation remains inconsistent or non-existent. The guide therefore encourages States to adopt policies, legal provisions and technical solutions that make vessel tracking data as open and accessible as possible. In practice, this means routinely sharing vessel tracking data across domestic agencies as well as with regional and international bodies and with the public, with restrictions limited to clearly justified exceptions. The experience of States that have adopted transparent vessel tracking policies has consistently shown that the benefits to governance, compliance and public trust outweigh the concerns often raised during adoption. The guide also covers how data should be managed to ensure it can be relied upon in enforcement actions and legal proceedings.

Strengthening system integrity and interoperability

Effective systems also depend on strong technical foundations. The guide recommends secure, tamper-resistant and standardized onboard equipment linked to stable vessel identifiers, high-frequency data collection with flexible transmission systems and interoperability across vessel tracking, licensing, logbook, inspection and electronic monitoring systems. Standardized formats and secure automated data exchange are critical to ensuring that data can be reliably shared and used across jurisdictions and institutions.

Data processing, turning vessel tracks into actionable insights

Collecting vessel tracking data is only the first step. Its value depends on how effectively it is analyzed, accessed and acted upon. The guide provides a framework for automating the analysis of vessel tracking data, enabling authorities to move from reactive monitoring toward a risk-based approach that directs limited enforcement resources where they are most needed. It recommends a phased approach, starting with foundational steps such as integrating tracking data with licensing records and basic geofencing, and building towards more advanced event detection and artificial intelligence (AI)-driven analysis as capacity allows. Analytical tools in this field are evolving rapidly, and systems should be designed with enough flexibility to incorporate new methods as they mature.

Governance, legal frameworks and operational integration

Beyond technical design, the guide sets out best practices for legal, operational and institutional frameworks. This includes clear system objectives, certification and testing processes, cost components and approaches, long-term resourcing, alignment with international and regional obligations as well as robust legal provisions for compliance and enforcement. It also underscores the importance of integrating vessel tracking into operational decision making.

Taken together, these recommendations provide a coherent and practical pathway toward modern, transparent and effective vessel tracking systems.

Image Credit: Antonio Busiello

Introduction

Vessel tracking is a critical tool for responsible ocean management and sustainable fishing. Sitting alongside other maritime domain awareness tools, it equips policymakers and authorities with the information needed to ensure informed management, compliance and accountability across all maritime sectors.[1]

This guide assembles a comprehensive set of recommendations for operating vessel tracking systems and benefitting from the data they produce. The recommended practices can be applied to both domestic and foreign vessels that use a State's waters, marine resources or ports.

Two types of vessel tracking systems are discussed in depth, satellite-based vessel monitoring systems (VMS) and automatic identification systems (AIS). VMS is often presented first, as it is already in common use for monitoring fishing vessels and it is the system authorities are typically mandating. AIS began as a safety-of-navigation system, but its use for tracking is expanding as more States move to require and regulate it, bringing new responsibilities for authorities that oversee it. As awareness grows of AIS's value as a monitoring tool, this guide identifies those benefits and shows how the two systems can be integrated responsibly, with AIS complementing VMS rather than substituting for it.

Beyond hardware, this guide includes suggestions on working with the resulting data, provides technical specifications for system design and offers advice on operation, costs and legal frameworks. The ultimate intent is to catalogue how decision-makers can use these systems to help steward ocean resources responsibly.

The guide is intended to be useful for government authorities, industry, civil society and secondary support services like insurance and finance. It focuses on well-established monitoring practices for large-scale, ocean-going, industrial fishing and fisheries support vessels. Advice for other sectors, such as non-fishing, tourism, biodiversity conservation and marine spatial planning, is also included.

[1] The term "authorities," as used in this guide, may encompass different entities depending on the State. In general, it can refer to the government as a whole or units of government including departments, ministries, agencies or authorized officials with responsibility, in whole or in part, for the management, regulation or oversight of marine activities, including vessels. This may include, for example, naval forces, coastguards, maritime or marine agencies, transportation, fisheries, agriculture, environmental authorities, maritime police and legal or enforcement bodies.

Image Credit: Natalie Fobes

Small-scale fisheries, while very important in the fishing sector of many States, are not the main focus throughout the guide, as the tracking of small-scale vessels is still developing globally, with efforts concentrated on finding the right technological solutions to the challenges these vessels bring. Even so, the guide offers some insights that may be applicable to the emerging field of tracking these and other vessel types.

Centralized vessel tracking systems for shared and co-managed stocks, such as those used by regional fisheries management organizations (RFMOs), are not specifically the focus of this guide. The International Seafood Sustainability Foundation's publication, "RFMO Vessel Monitoring Systems: A Comparative Analysis to Identify Best Practices," is a useful resource that can be used in conjunction with this guide.[2] States that are party to or cooperate in an RFMO should ensure national systems for transboundary fisheries are compatible with RFMO tracking requirements.

The guide is intended for a global audience so it does not provide model legislative text or sample contract language, as those are highly dependent on context and domestic legal systems. Instead, it offers questions to be answered, issues to be considered and recommendations.

Finally, the guide addresses the limitations of current vessel tracking systems and problems in their operation, which can hamper their effectiveness. The best practices listed offer a roadmap for improvement and for harmonization, addressing the technical needs of practitioners and what is needed for policymakers and legislators.

[2] Holly Koehler, RFMO Vessel Monitoring Systems: A Comparative Analysis to Identify Best Practices (Version 3), ISSF Technical Report 2018-10 (Washington, DC: International Seafood Sustainability Foundation, 2018), 12, https://www.iss-foundation.org/wp-content/uploads/dlm_uploads/2018/04/ISSF-2018-10-RFMO-Vessel-Monitoring-Systems-A-Comparative-Analysis-to-Identify-Best-Practices.pdf.

Image Credit: Richard Whitcombe

Section I

Foundations of a vessel tracking system

Image Credit: Paul Einerhand

Today, vessel tracking systems are increasingly informing our collective understanding about what is happening at sea in ways that traditional tools could not. These systems allow authorities to track and monitor the activities of vessels, and act on that information.

The underlying technology for vessel tracking originated in the long-distance trucking sector and military positioning systems. Applications in fisheries began to evolve in the 1980s, in response to a growing need to monitor increasing numbers of industrial vessels, both within national waters and on unchecked high seas fishing grounds. This coincided with efforts to address increasing illegal, unreported and unregulated (IUU) fishing activity on a global scale.[3] This section sets out these foundations, covering the main tracking technologies and how they work together, how to define a system's purpose and scope and the role transparency and data ethics play in the design of modern systems.

Vessel tracking systems

There is currently no global requirement for all large-scale industrial fishing and support vessels to be publicly tracked. However, concerns over IUU fishing and other factors continue to drive demand for effective technologies and transparent data that can shed light on what happens out at sea in real time.

This guide concentrates on two major types of vessel tracking systems: VMS and AIS. Both are used to track vessels using a transponder and receiver, and are used across geographies and in a broad range of contexts.

VMS and AIS complement each other, and best practice is to use both simultaneously. Each system has distinct advantages and limitations; when used in conjunction, they provide information that strengthens monitoring, enforcement and management objectives.

VMS and AIS complement each other, and best practice is to use both simultaneously.

[3] From Jan. 1, 2020, all EU fishing vessels over 24 meters were required to report their location, via satellite, to monitoring centers in their flag states. European Commission, Council Regulation (EC) No 686/97 of Apr. 14, 1997 amending Regulation (EEC) No 2847/93 establishing a control system applicable to the common fisheries policy, 1997 O.J. (L 102) 1, https://faolex.fao.org/docs/pdf/eur49203.pdf.

[4] The FAO 2005 Ministerial Declaration on IUU Fishing, Rome, called on all States to "ensure that all large-scale fishing vessels operating on the high seas be required by their flag State to be fitted with VMS no later than December 2008 or earlier if so decided by their flag State or any relevant RFMO." Food and Agriculture Organization of the United Nations (FAO), 2005 Ministerial Declaration on Illegal, Unreported and Unregulated Fishing, adopted at the Ministerial Meeting on Fisheries, Rome, Mar. 12, 2005, https://www.fao.org/fishery/docs/DOCUMENT/ministerial/2005/iuu/declaration.pdf.

Satellite-based vessel monitoring systems

The introduction of satellite-based VMS marked a significant shift in how authorities collect and use data to manage marine resources. By providing accurate and consistent data on a vessel's position, VMS enables fisheries and government bodies to monitor compliance, enforce area-based quotas and closures, safeguard marine species, habitats and biodiversity, protect zones designated for small-scale fishers and respond to IUU fishing — particularly in vast or remote areas where conventional patrolling is costly, limited or nonexistent.

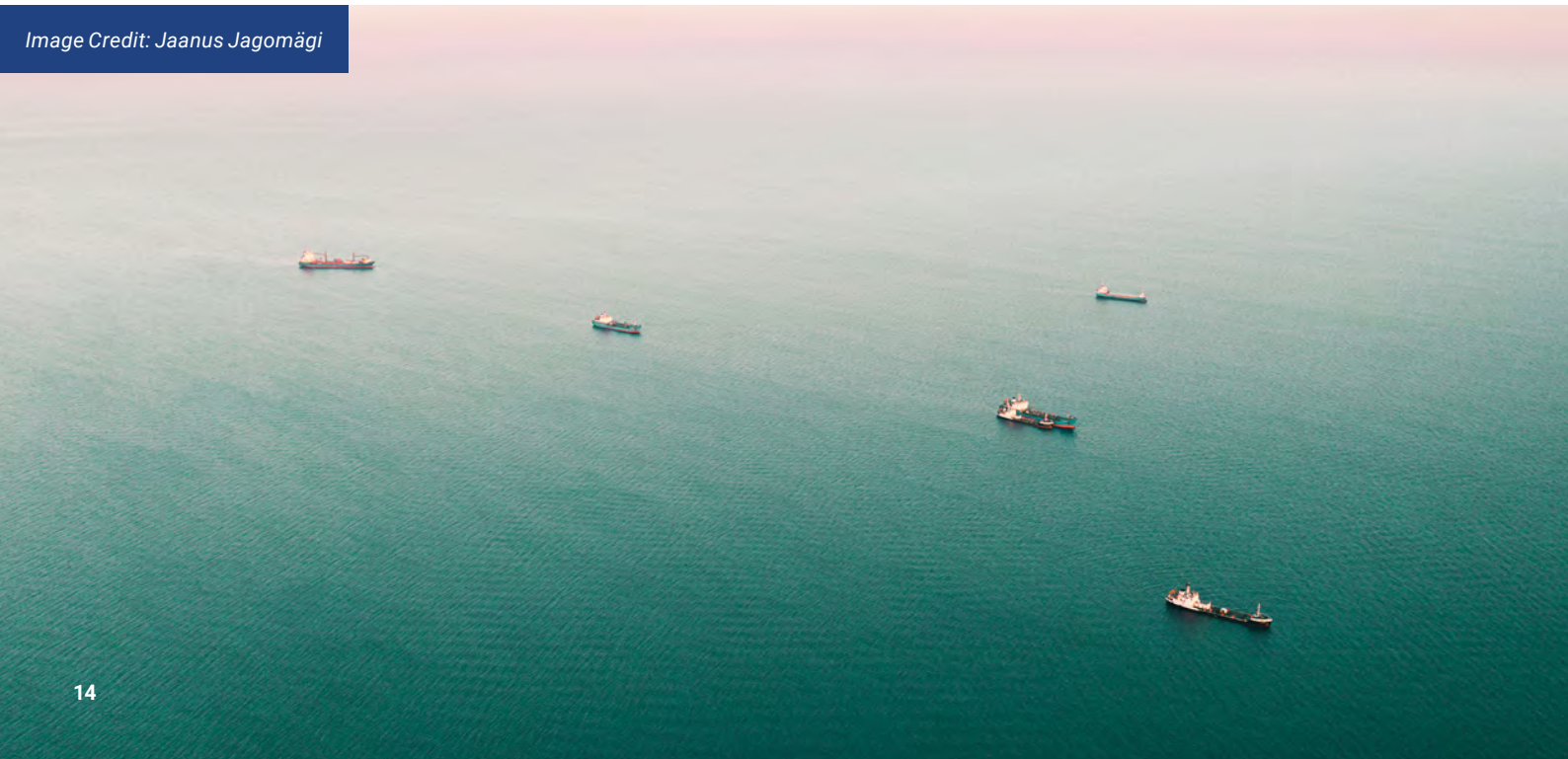
Originally applied to fisheries monitoring, VMS is now also widely used by a variety of non-fisheries regulatory authorities around the world, and it continues to expand into many ocean sectors. VMS data supports a broad range of uses, including marine research, fish stock assessments, marine spatial planning, protected area designation and management, and vessel safety during emergencies. VMS systems provide reliable data, but inconsistent data collection and sharing, which currently takes place in an *ad hoc* manner with no standards, compromises the value of the data. In addition, implementation can be plagued by underfunding, capacity limitations, and technical and political challenges.

Vessel monitoring systems can transmit a range of data, although the basics include unique vessel identification, geographical position, date and time of position, course and speed. Requirements are typically specific to a region, jurisdiction or fishery, and decided by governing bodies. VMS data is still generally treated as proprietary, but views on this are evolving. In particular, States are increasingly treating a portion of VMS data as public. Data-sharing agreements, such as those Global Fishing Watch has with some governments, are now more common, and used in organizations such as RFMOs and regional fisheries bodies, and bilaterally between States that share borders or manage transboundary and highly migratory fish stocks.

Vessel tracking data serves many uses beyond fisheries monitoring.

VMS enables both inshore and offshore fleets to be tracked at designated intervals. The devices, which generally include anti-tampering and safety features, allow a private flow of information between the vessel, the VMS service provider, its operators and owners, and management authorities and RFMOs.

Image Credit: Jaanus Jagomägi



However, VMS is not necessarily required for all fishing vessel classes or gears, nor accessible to all agencies with management and security responsibilities. In some jurisdictions, VMS is mandatory on most vessels over 12 or 15 meters as a license condition, but requirements can vary within a single jurisdiction. This makes it challenging to put together a complete picture of vessel activity at sea. A length threshold can also create incentives to stay below it. Some vessels are built to maximize catching power while sitting just under the limit. Length overall (LOA) is sometimes underreported or misreported to avoid the requirement. VMS is not immune to malfunctions, tampering or deactivation. In large systems these issues can be sufficiently widespread that they are difficult to identify systematically, and incidents are often not investigated or acted upon.

There is an increasing trend to expand VMS coverage to small-scale vessels, often referred to as inshore VMS or inshore vessel monitoring system (iVMS). While there have been a number of VMS trials and pilots in small-scale fisheries, authoritative best practices for this sector are still evolving and are not covered in this guide.

Automatic identification systems

AIS has a different history, beginning as a safety application. AIS was designed to provide key safety-related information, including a ship's identity, type, position, course, speed and navigational status. Vessels equipped with AIS transceivers broadcast short-range signals containing this data, which can be received by nearby ships, shore stations and satellites. The United Nations International Maritime Organization (IMO), which is responsible for ensuring safety and security of international shipping, adopted performance standards for AIS in 1998.[5] In 2000, the IMO adopted a revised Chapter V of the International Convention for the Safety of Life at Sea (SOLAS) that made AIS carriage mandatory for certain ships on international voyages, with implementation phased between 2002 and 2008.[6] The IMO requirement applies to all cargo ships over 500 gross tonnage (GT), any vessel over 300 GT on an international voyage and all passenger vessels.[7]

The growth in satellite AIS receivers over the past decade has fundamentally expanded the ability of governments, organizations and the public to see what is happening at sea.

The growth in satellite AIS receivers over the past decade has fundamentally expanded the ability of governments, organizations and the public to see what is happening at sea. AIS coverage is now effectively global, and platforms such as Global Fishing Watch track well over 120,000 vessels through their AIS transmissions.[8] Compared to VMS, AIS can be more affordable, simpler to install and does not require a government-managed communication infrastructure. Many fishing vessels that are not required to carry AIS have chosen to do so

[5] IMO Maritime Safety Committee, Resolution MSC.74(69), Annex 3, "Recommendation on Performance Standards for an Universal Shipborne Automatic Identification System (AIS)," adopted May 12, 1998, https://wwwcdn.imo.org/localresources/en/OurWork/Safety/Documents/AIS/Resolution%20MSC.74(69).pdf; IMO Assembly, Resolution A.1106(29), Revised Guidelines for the Onboard Operational Use of Shipborne Automatic Identification Systems (AIS), adopted Dec. 2, 2015.

[6] International Convention for the Safety of Life at Sea (SOLAS), Jul. 1, 1974, 1184 UNTS 2, reg. V/19, "Carriage Requirements for Shipborne Navigational Systems and Equipment," as amended. https://media.liscr.com/marketing/liscr/media/liscr/online%20library/maritime/solas%20v_reg19.pdf.

[7] International Maritime Organization (IMO), Revised Guidelines for the Onboard Operational Use of Shipborne Automatic Identification Systems (AIS), Resolution A.1106(29) (London: IMO, 2015), https://wwwcdn.imo.org/localresources/en/OurWork/Safety/Documents/AIS/Resolution%20A.1106(29).pdf.

[8] David Kroodsma et al., "Tenfold Increase in Public Vessel Tracking Supports Science, Management and Policy" (poster, 2025 One Ocean Science Congress, Nice, France, Jun. 4–6, 2025), https://globalfishingwatch.org/2025-one-ocean-science-congress-poster-rise-in-public-vessel-tracking/.

Image Credit: Global Fishing Watch / Diego del Rio

voluntarily, driven by safety benefits, commercial incentives from supply chain actors. When it is properly regulated, AIS provides position information nearly without interruption and its public and relatively accessible nature has enabled its application to transform how maritime security, marine research, fisheries monitoring and ocean management are implemented. AIS can provide essential data for States as well as industry when VMS is not in use or not readily accessible. Today, many fisheries agencies and maritime security agencies use AIS, either through established protocols or informal analysis, to support monitoring and surveillance of all types of vessels including fishing.[9] Many States have elected to require AIS for their fishing vessels or certain portions of their fleets.

AIS is not without limitations. As a broadcast system, reception depends on line of sight, signal power and the density of receivers in range, which means that in areas with low reception or high vessel activity, signals may be dropped or not received at all. Examples of areas with poor coverage include the South China Sea, English Channel, Straits of Malacca and parts of the Mediterranean and U.S. East Coast. AIS is also designed to be open and unencrypted, which means vessel identity and position data can be incorrectly entered or deliberately falsified if not well regulated. Further, AIS transponders can also be switched off by design, though this is detectable through monitoring systems. These are known challenges, and when AIS data is used alongside VMS and other data sources, many of these issues can be identified and addressed. Where AIS is used voluntarily but not consistently regulated by authorities, problems can arise from units being shared among vessels or placed on gear rather than on the vessel itself. Aligning AIS requirements with IMO guidelines and applying them consistently to all vessels, including those not subject to SOLAS, promotes more responsible use and strengthens both the safety aspect of the system alongside monitoring, control and surveillance outcomes.

[9] Example of an AIS protocol: "Member States shall ensure that data from the AIS are made available to their competent authorities responsible for fisheries control for control purposes, including cross-checks of AIS data with other available data, in accordance with Article 109. Other countries like the United States, Canada, Panama and others also require AIS to be used." Council Regulation (EC) No 1224/2009 of Nov. 20 2009 establishing a Community control system for ensuring compliance with the rules of the common fisheries policy, art. 10, 2009 O.J. (L 343) 1, https://eur-lex.europa.eu/eli/reg/2009/1224/oj.

Integrated tracking using both VMS and AIS

VMS and AIS are at their most effective when used together. In isolation, each system leaves gaps in what authorities can see. Best practice is to use both simultaneously.

Integration in practice means that authorities receive, store and analyze VMS and AIS data together, linked through a common vessel identifier such as the IMO number. This allows analysts and automated systems to cross-validate vessel identity and position data between the two sources, an essential feature in order to conduct useful, reliable analysis. It also allows gaps and inconsistencies to be identified in either dataset. When used together, a more complete and reliable picture of vessel behavior likely operating within a certain area can be built. For example, if a vessel's VMS signal drops out, AIS data may reveal whether the vessel continued operating or returned to port. Conversely, if a vessel's AIS is switched off near a restricted area, VMS data can confirm whether it remained in the zone. These cross-checks strengthen both compliance monitoring and enforcement.

Using both systems does not require doubling costs or infrastructure. AIS hardware is generally less expensive than VMS units, and AIS data can often be accessed at lower cost than establishing a standalone VMS program. Where a government already operates VMS, adding an AIS data feed and linking it to existing monitoring tools is typically the most cost-effective way to improve the quality and coverage of vessel tracking. The key requirement is that systems are designed to ingest and display both data sources together, with vessel identifiers matched across them. Where this integration has been implemented, it has consistently improved the ability of authorities to detect noncompliance and respond effectively.

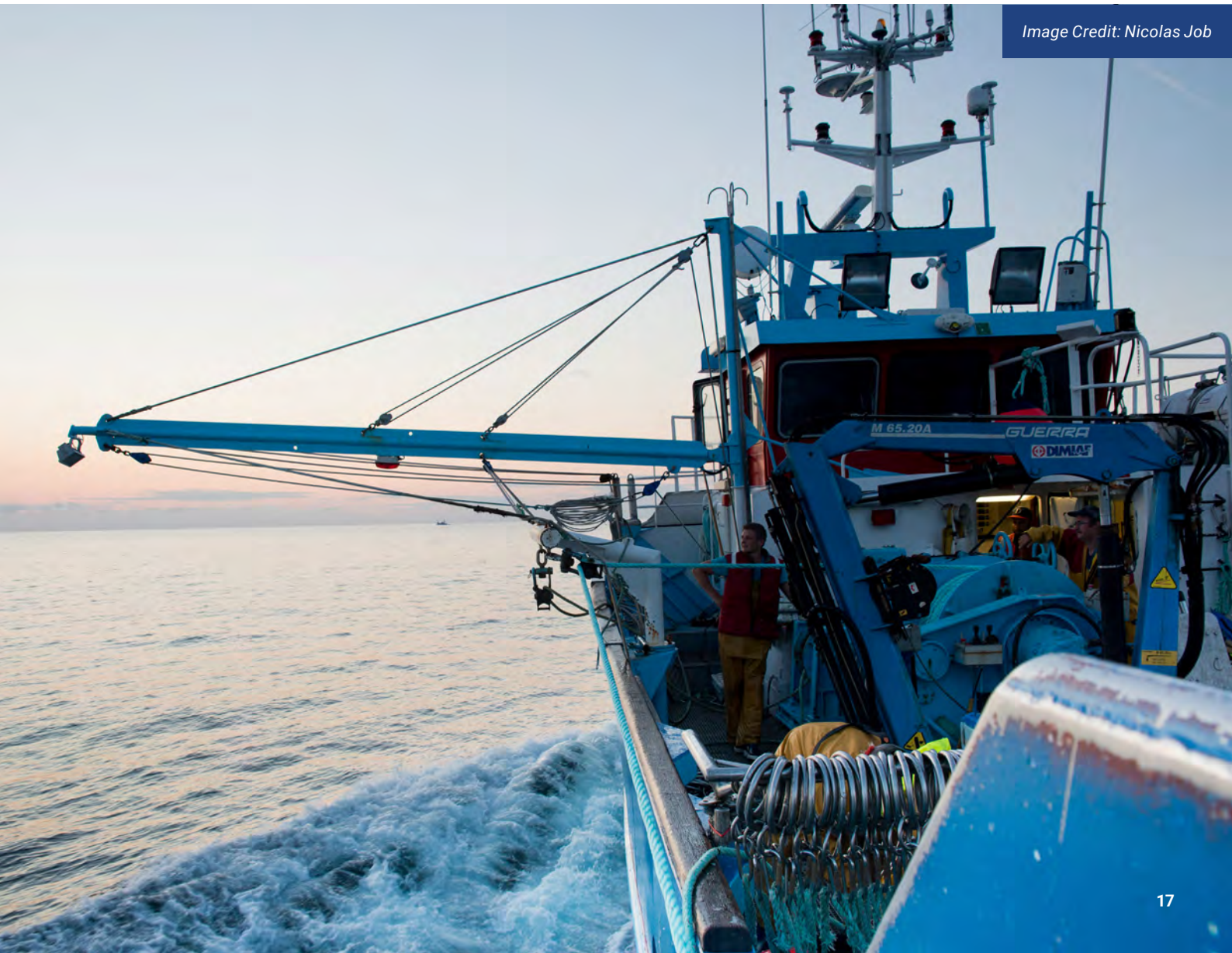


Image Credit: Nicolas Job

Table 1. Comparative Applications of VMS and AIS: Benefits of Integrated Use

Monitoring requirement	VMS application	AIS application	Integration benefits
Vessel identity verification	Device is registered to a specific vessel within the national system, providing a verified link to licence and registration data.	Reports vessel identity fields that can be matched against licence and registry records but are self-reported.	Cross-referencing identity data between two independent sources strengthens verification and helps detect inconsistencies such as false identities or unregistered vessels.
Tracking vessels and detecting unauthorized activities	Consistent, verifiable position reporting at regulated intervals within the national or regional system.	High-frequency position data with broad geographic coverage, including foreign and unregulated vessels.	Fewer gaps in track history and higher combined polling rates increase the likelihood of detecting unauthorized activities.
Monitoring vessels within a management area	A widely accepted tool for monitoring fleets required to carry VMS by the management authority.	Expands monitoring to foreign and unlicensed vessels equipped with AIS and non-fishing vessels.	Wider coverage of vessel activity within an area and improved maritime domain awareness.
Data integrity	Encrypted end-to-end transmission that can be monitored for system failure; tampering and transmission interruption possible. Good data integrity can be achieved with advanced systems.	Open, unencrypted broadcast transmissions; tampering is possible but can be identified through data processing.	Transmissions can be cross-checked between sources, strengthening the integrity of both systems.
Transparency and accountability	Traditionally restricted to authorities but evolving to be more readily shared and public.	Publicly accessible and easily sharable between agencies and countries to support collaboration.	Combined data supports both enforcement and public oversight.
Cost and accessibility	Requires government-managed infrastructure with ongoing communication and maintenance costs.	Lower hardware and operating costs with multiple data access routes including free or low-cost options.	AIS offers a cost-effective way to significantly enhance an existing VMS programme without doubling infrastructure or operating costs.

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Objectives, scope and application

Establishing a clear scope is essential when designing and implementing an effective vessel tracking system. Modern tracking technologies now extend far beyond traditional fisheries monitoring, control, and surveillance (MCS), supporting a growing array of maritime governance, supply chain transparency, and security applications.

Recommendations

1. **Define MCS objectives**
   Clearly define the objectives of the national MCS strategy that vessel tracking will contribute to and the challenges to be addressed.

2. **Establish certification processes**
   Develop a process for testing and certification of VMS equipment.

3. **Secure long-term resources**
   Ensure adequate resources – human, technical and financial – are available to support the systems into the future.

4. **Integrate systems**
   Integrate both VMS and AIS tracking to provide comprehensive data coverage and validation.

5. **Authorize multiple uses of data**
   Consider and authorize the diverse uses of tracking data, including fisheries management, MCS, marine protection, maritime safety and sustainability certifications.

6. **Enable data transparency and sharing**
   Adopt policies or laws that allow data to be transparent and publicly available to fully realize its benefits, including sharing data across government and with the public, while accommodating a reasonable delay for security and proprietary considerations if needed.

7. **Ensure system compliance**
   Ensure the systems comply with any applicable international and regional requirements.

8. **Strengthen external cooperation**
   Enter bilateral or multilateral agreements that enable cooperation, shared management of living marine resources, and sharing of data and information with international entities and foreign governments.

9. **Change domestic legal frameworks**
   Make conforming and corresponding changes to other applicable laws.

10. **Permit use in legal proceedings**
    Provide for use of vessel tracking data in legal proceedings.

Defining objectives for the systems

At the outset, when considering whether to adopt vessel tracking systems, the objectives should be clearly defined. This is best done as a three-part exercise:

1. Identify pertinent high-level objectives such as MCS or other system objectives.
2. Identify the specific challenges the system will be primarily directed toward.
3. Identify how vessel tracking data will help address those challenges.

It is important to understand where tracking data is useful. Examples could include detecting fishing before the season opens or is authorized, detecting fishing or transiting in marine protected areas (MPAs) and successfully prosecuting IUU fishing when onsite patrols are not present to observe violations. It can also support successful rescues in the event of accidents at sea, and fulfilling treaty obligations to supply data. Moreover, it is important to examine and justify how vessel tracking systems will help meet objectives and address challenges.

Defining scope

Another early decision point is determining which vessels will be covered. This will depend on national and regional definitions of vessel classes, but should as a minimum include all industrial or semi-industrial vessels. Parameters are often set by physical characteristics, such as LOA and GT. Regulations or laws need to clearly define such markers to clearly denote which vessels are obliged to follow the requirements. Establishing limits will often trigger vessels to report or reconfigure at just below the threshold: if the limit is set at 300GT, for example, some vessels will report their tonnage in the high 200s to avoid being subject to the requirement.

For VMS and AIS, the recommendations in this guide apply to several categories of vessels:

- Large-scale, industrial, domestic and high seas fishing vessels, as well as vessels that fish or operate in multiple exclusive economic zones (EEZs) or areas under national jurisdiction.[10]
- Vessels that engage in fishing-related activities, such as carriers, support vessels, reefers, bunkering vessels, transport vessels, transshipment vessels and processing vessels.
- Tugs, tourism vessels or recreational vessels that operate in or near MPAs should be regularly providing tracking data to authorities that regulate those areas or activities. In other words, those who are responsible for the management of MPAs should also be requiring tracking data.

Tracking can extend beyond a State's EEZ or areas under national jurisdiction and include the high seas for activities like transshipment monitoring. This broad application is consistent with the wide-ranging use of terms such as "fishing" and "fishing related activities" found in international instruments such as the Food and Agriculture Organization of the United Nations (FAO) Port State Measures Agreement (PSMA).[11]

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[10] While the majority of the world's fishing vessels are "small-scale" and need better monitoring, they are not the subject of this guide. While various trials for tracking small-scale vessels are under way, identifying best practices at this stage would be premature. There is no globally agreed definition of small-scale fishing vessels. The FAO applies the term to fishing vessels less than 12 meters in length and less than 10 gross tons, and estimates that over 80% of the world's 4.1 million motorized fishing vessels are under 12 meters. Annex 1 provides further details on how various countries with sizable small-scale fleets interpret the term.

[11] Food and Agriculture Organization of the United Nations (FAO), Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing, art. 1(c), (d), (j), approved Nov. 22, 2009, https://openknowledge.fao.org/server/api/core/bitstreams/515b81dc-ad65-41c9-ab02-6ff081103cc3/content.

Application

These recommendations can be applied to domestic-flagged vessels no matter the location, and to foreign-flagged vessels fishing in a coastal State's EEZ or areas under national jurisdiction, possibly as a condition of licensing, authorization or access agreements. They can apply to all gear types and all fisheries, whether or not human observers are required. At a minimum, vessels should be required to carry and use a tracking system, to keep it operational, to use alternatives when systems are not operational, and to send and make available the tracking system data. Increasingly, port States require fishing vessels entering their ports to have an operational AIS.[12]

Coastal, port and market States can all benefit from tracking domestic and foreign vessels. Vessel tracking systems can provide states with a better understanding of what is happening in their waters and with their vessels and marine resources, as well as who is bringing what to their ports or markets.

Various vessel tracking systems exist. Some States prefer to design, build and operate their own tracking systems. Some use a single provider, while others prefer to use multiple providers for equipment and services. All providers should meet agreed technical specifications and be subject to the same testing, approvals and certifications. Using multiple providers can meet pragmatic supply needs, improve competitive choices and enhance transparency, but also raises challenges around issues like data supply and consistency. This guide is commercially neutral and does not intend to favor any particular provider.

[12] Vessels can still visit the port under force majeure but for unloading fish they should have a functional and operating AIS device. See e.g., Norwegian Fisheries Law"; (1) Vessels of 15 metres in overall length (LOA) and over calling at ports in Norway or any other EEA country shall be fitted with an Automatic Identification System (AIS). (2) The system shall be maintained in operation at all times, except where international agreements, rules or standards provide for the protection of navigational information." Regulation of 13 June 2000 No. 660 on the Construction, Operation, Equipment and Surveys of Fishing Vessels, sec. 10-4a, "Automatic Identification System (AIS)," (Norwegian Maritime Authority), 119, https://www.sdir.no/siteassets/engelske-forskrifter-pdf/13-june-2000-no.-660-construction-operation-equipment-and-surveys-of-fishing-vessels.pdf.

Image Credit: Deivis Sandoval

Purposes and benefits of vessel tracking

Vessel tracking data supports a wide range of fisheries management, enforcement and ocean governance objectives. The benefits below apply to integrated tracking systems using both VMS and AIS, though individual benefits may draw more heavily on one data source than the other.

Key benefits of integrated use of VMS and AIS

1. **Strengthening MCS and compliance**
   Identifying vessel behavior and encounters at sea, validating data across multiple sources and reinforcing compliance with licensing, authorization and subsidy programs.

2. **Improving risk assessment and enforcement**
   Enabling risk-based monitoring, identifying high-risk areas and vessel patterns and supporting timely and targeted surveillance operations.

3. **Supporting fisheries science and management**
   Improving estimates of fishing effort, tracking spatial and temporal activity, as well as informing stock assessments and management decisions.

4. **Enhancing maritime safety and domain awareness**
   Supporting search and rescue, monitoring both fishing and non-fishing vessels and strengthening oversight across jurisdictions. Informal EEZ delineations can also benefit from the presence of a domestic fleet.

5. **Advancing transparency and traceability**
   Supporting certification schemes, due diligence processes and market access requirements, while improving public confidence through transparent operations.

6. **Strengthening enforcement and legal processes**
   Providing robust, multi-source evidence for investigations and legal proceedings, including both real-time monitoring and retrospective analysis to assist with patrol planning and flagging determinations.

7. **Monitoring crew conditions**
   Tracking data can also help surface vessel behaviors associated with poor crew conditions and forced labor, such as unusually long periods at sea, sustained high operational hours and patterns of avoiding ports or only calling at those with weak labor oversight.

8. **Supporting small-scale and Indigenous fisheries**
   Tracking data can help protect areas designated for small-scale and Indigenous fishers by providing evidence of encroachment by larger vessels. It can also help small-scale operators build a documented history of their fishing activity, which can support their claims of rights to fishing grounds, access to loans, financial assistance, quotas, insurance and other benefits that have traditionally been difficult to access without formal records.

9 **Designation of potential protected areas**
Providing information to help determine level and frequency of vessel activity and potential impacts in areas being considered for protection such as MPAs and other effective area-based conservation measures.

10 **Supporting broader ocean governance**
Informing marine spatial planning, maritime security, port monitoring, identifying activity hotspots and potential conflict areas and detection of risks such as forced labor and pollution events.

11 **Delivering industry benefits**
Improving operational decision-making, supporting compliance, enabling access to financing and insurance as well as strengthening social license.

12 **Improving safety of life at sea**
Sending emergency or distress calls to facilitate life-saving aid.

Transparency

In December 2024, the United Nations General Assembly adopted its Sustainable Fisheries Resolution, which "recognizes the importance of transparency and the use of technology in fisheries, as part of policies to combat illegal, unreported and unregulated fishing and also recognizes the importance of transparency for effective fisheries management."[13]

To fully realize the benefits of tracking systems, transparency is essential. Best practice is to share data with other government departments, the public more broadly, foreign governments, and regional or international intergovernmental institutions. Transparency is about making information – including ocean and vessel data, and related policies and decision making processes – available and accessible to everyone it affects. It supports better policies and planning, fosters accountability and equity, drives better compliance and enforcement and enables diverse stakeholders to participate in decision making, management and monitoring.

A transparent vessel tracking system improves ocean governance by allowing MCS officers to identify fleet behavior anomalies, conduct licensing due diligence, flag individual vessel violations, and strengthen port controls and at-sea patrols. When standardized, this data enables more accurate risk assessments across numerous maritime applications. It can give policymakers a clearer picture of activity in their waters and by their flagged vessels. And it can help supply chain actors conduct improved due diligence, ultimately safeguarding workers who put their lives at risk to make a living, among other benefits.

Ocean resources are public goods, so authorized fishing vessels should expect to be held accountable by transparently providing position data. Assertions of a vessel's position as proprietary or commercially protected can and should be re-evaluated in today's realities of routine monitoring of common activities by widespread technological means.

[13] United Nations, General Assembly, Sustainable fisheries, including through the 1995 Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of Dec. 10, 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, and related instruments, A/79/L.25 (November 2024), paras. 99–100, https://documents.un.org/doc/undoc/ltd/n24/377/87/pdf/n2437787.pdf.

Some of the benefits of transparency can be achieved through peer-to-peer data-sharing agreements such as interagency agreements. At a regional level, some RFMOs and regional fisheries bodies have adopted vessel tracking data-sharing arrangements. However, these arrangements are often inefficient, for example by requiring requests for information on a case-by-case basis, and can be implemented slowly, leaving key stakeholders without access.[14] Broader and more transparent VMS data-sharing policies are more efficient, allowing States to share a general overview of their fleets' activities with all stakeholders so resources can be focused more effectively.

National governments should embrace open data and incorporate transparency in their own systems and practices, as well as support broader national, regional and global transparency initiatives. The following eight steps support governments to put transparency into action by making vessel data public:

1. **Vessel identification:** Allocate each vessel with a unique, publicly available number that remains unchanged throughout the vessel's life, regardless of change of owner or flag. Use IMO numbers for eligible vessels, including all fishing vessels over 100 GT/12 meters and which fish beyond a State's national waters.[15] For vessels that are not eligible for an IMO number, national or alternative identifiers may be used, though these may not provide continuity across flags or jurisdictions.
2. **Authorization:** Make authorizations to fish and transship catch public, including validity dates of the authorization, license and associated permits.
3. **Ownership:** Record and make public a vessel's ultimate beneficial owner, registered owner, and operator or manager.
4. **Registration:** Maintain public vessel registers with up-to-date identification, authorization and ownership details and submit all data to the FAO Global Record of Fishing Vessels, Refrigerated Transport Vessels and Supply Vessels (Global Record) and to RFMOs, as required.[16]
5. **Tracking:** Make all vessel tracking data public, so vessels are publicly trackable.
6. **Transshipment:** Publish all transshipment activity.
7. **Compliance:** Publicly list vessels and organizations that have been convicted or found liable of IUU fishing activity.
8. **Policies:** Publish all policies and decision making processes that govern fishing and related activities at sea.

Transparency is about making information – including ocean and vessel data, and related policies and decision-making processes – available and accessible to everyone it affects.

[14] For example, the Western and Central Pacific Fisheries Commission has a regional VMS operated in conjunction with the Pacific Islands Forum Fisheries Agency. See also the Niue Treaty Subsidiary Agreement for institutionalized data sharing. Niue Treaty on Cooperation in Fisheries Surveillance and Law Enforcement in the South Pacific Region, opened for signature Jul. 9, 1992, https://www.ffa.int/download/niue-treaty/.

[15] "Help," IHS Markit, accessed Oct. 24, 2023, https://imonumbers.ihs.com/Home/Help.

[16] While States may define their own vessel registration process, as there is currently no binding international instrument mandating the information which should be collected, the registration information should be kept current, updated and public. This includes publishing de-registration information, including dates and making sure a de-registered vessel no longer uses the maritime mobile service identity (MMSI) number connected to the prior flag.

Data ethics

Global Fishing Watch has identified six basic data ethics principles which can support responsible collection, development and use of vessel data. These principles are designed to support reflection on ethical risks and trade-offs. While distinct, they are interrelated and should be applied as part of an integrated approach. The field is continuing to evolve and the suggested principles below are not meant to be static and absolute.

While each of the six principles represent an independent idea these ideas are connected and can work together as part of a process.

These principles include:

1. **Transparency:** Exercise transparency in how data is obtained, processed, analyzed and presented, including consulting with all stakeholders who will be affected by the decision. Core questions include what data will be collected and why, and what will be done with the data. Consulting early with all stakeholders builds understanding and yields better decisions by considering multiple perspectives, reducing the risk of challenges later.
2. **Impact assessment:** Examine the potential consequences, both positive and negative, for the government itself and its multiple actors and ministries, individuals, companies, a regulated or impacted community, various groups and the public more broadly.
3. **Long-term sustainability and quality:** Allocate sufficient resources, capacity and training to the use, development and maintenance of data products to achieve intended results.
4. **Responsible data management:** Responsibly manage, store and publish data.
5. **Accessibility:** Develop accessible and easy-to-understand products.
6. **Inclusivity:** Build collaboration that is equitable and inclusive through outreach and encouraging participation.

Context is central to the effective application of these principles. Governments and institutions operate under different legal, technical and political conditions and ethical considerations may vary across national, regional and international settings. Effective application therefore requires adapting these principles to specific circumstances while maintaining their core intent.

Image Credit: João Silveira

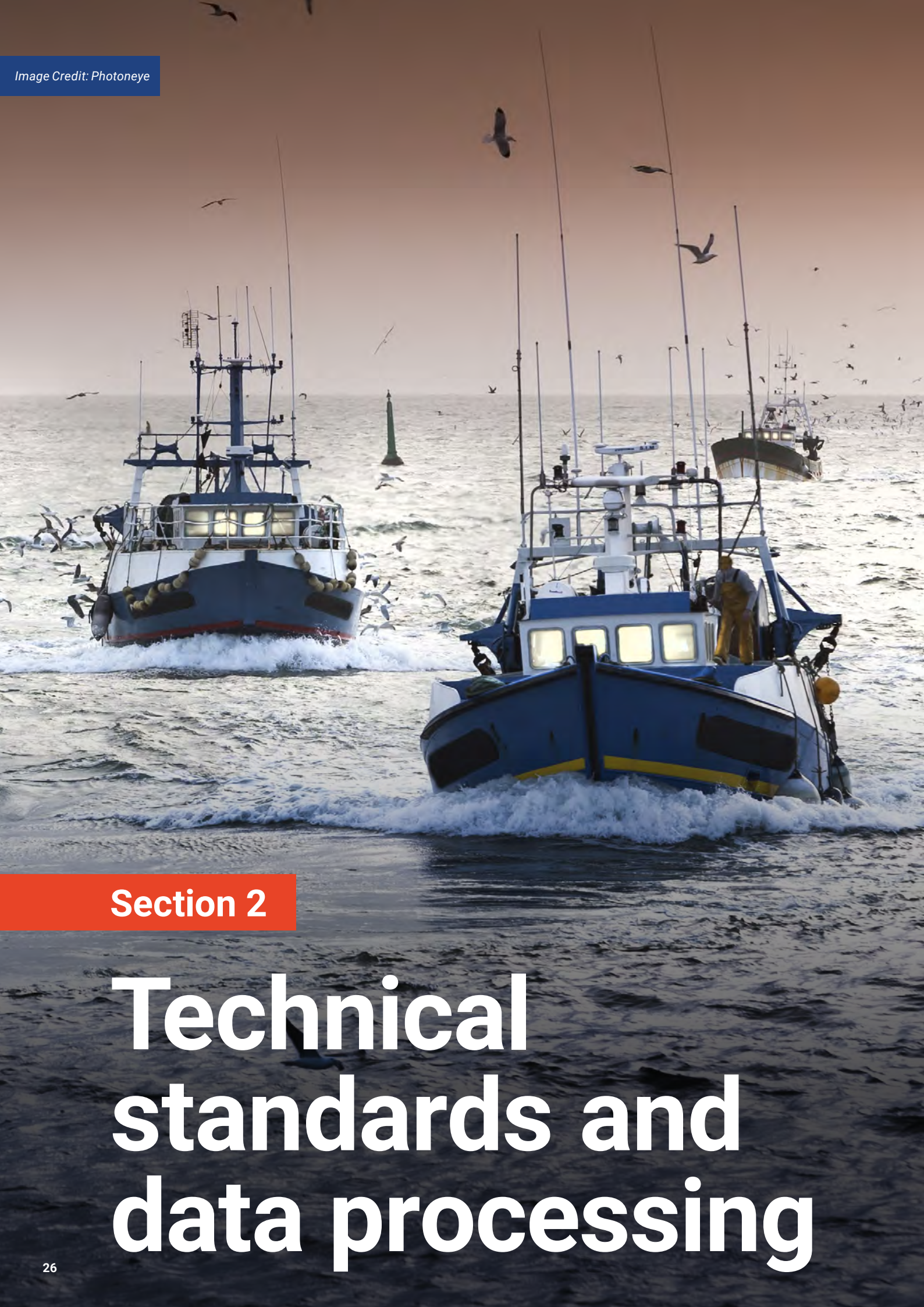


Image Credit: Photoneye

Section 2

Technical standards and data processing

This section covers the technical components of a vessel tracking system: onboard equipment, communication networks, data storage, system integration and interoperability, user interfaces, polling rates, and the analytics and automation tools used to turn tracking data into actionable information. There is no single technical design that fits all situations, and the right configuration will depend on a country's objectives, fleet profile, geography and budget. These components are also interdependent, and decisions in one area directly affect others. The section is structured to reflect this, moving from the vessel through to the monitoring center and the analysis of the data it receives. Where relevant, recommendations distinguish between foundational requirements and more advanced capabilities. Not every country will implement all elements at once, and a phased approach is a practical and legitimate path to building an effective system.

Once the purpose, scope and initial legal framework of a vessel tracking system have been established, its technical components and features must be defined. The following eight key factors need to be considered in the design of an effective vessel tracking system:

1. **Onboard equipment:** Physical devices installed on vessels, such as VMS or AIS units, collect and transmit data. VMS devices must meet the required technical standards set by the regulation (known as type approval), be tamper-resistant and function reliably under operational conditions. AIS devices should meet international standards set by the IMO and International Telecommunication Union (ITU).
2. **Data transmission:** Tracking data is sent from vessels to land-based systems using primarily satellite or cellular networks for VMS, and very high frequency (VHF) transmissions for AIS. VMS transmission must be secure, reliable and timely to support effective oversight.
3. **Data storage:** Tracking data should be stored securely in structured formats that ensure integrity and accessibility. Storage systems must comply with legal, operational and data protection requirements.
4. **Data access:** Who can view, use or share tracking data, and under what conditions, should be clearly defined. Access will be controlled by applicable legal requirements, and influenced by the needs of relevant authorities, desire for transparency and data privacy protections.
5. **System integration:** Linking a vessel tracking system with other data sources and platforms enhances coordination and improves the utility of collected data. Integrated tracking where VMS and AIS are used together is one example of effective integration.
6. **User interface:** The interface or application used to access and visualize vessel tracking data should be intuitive, operationally relevant and capable of supporting timely decision making.
7. **Polling and transmission rates:** The polling rate is the frequency at which positional data is recorded by a tracking device, while the transmission rate is the frequency at which the vessel transmits the data. Higher polling rates improve the ability to detect potential regulated activities such as fishing and transshipments, while lower rates risk missing key events. Polling should be tailored to the activity being monitored and balanced against cost and technical constraints.
8. **Analytics and automation:** Data analytics includes manual assessment of tracking data or using computer code to run algorithms, machine learning models or artificial intelligence models to identify risks, detect noncompliance and prioritize enforcement. Automating these functions to create risk indicators improves efficiency and enables more effective use of the data.

Image Credit: Maël Balland

Vessel tracking technology and equipment

Tracking data begins at the vessel. This section covers the onboard devices that collect and transmit data and the technical standards they must meet. These include the requirements common to all systems, and the specific standards for VMS and AIS. Reliable, tamper-resistant equipment is the foundation on which everything downstream depends.

Onboard equipment

The equipment installed onboard a vessel is the source of all the data that is transmitted, stored, analyzed and used to inform critical decision making. It is critical to ensure the correct information is collected in a usable format and that the equipment performs reliably and consistently in harsh marine environments.

Similarly, where national competent authorities such as maritime administrations or coast guards have adopted AIS requirements in line with IMO guidelines, these provisions should be taken into account when requiring AIS for fishing vessels.

Governments may have a contract with a single system provider, meaning all hardware is identical across the fleet of vessels being monitored. Alternatively, they can set technical standards and allow multiple providers to submit equipment for type approval; vessels can then select from the approved equipment list. The recommendations in this section apply to both procurement models.

Recommendations

1. **Durability and certification**
   Select devices that are rugged, waterproof and field-tested under real at-sea vessel conditions. Type-approve hardware by the competent authority or an independent third party and certify installations with periodic recertification every one to three years.

2. **Unique vessel identity**
   Link all tracking devices to a stable, unique vessel identifier, preferably the IMO number, to enable cross-referencing with licensing, catch reporting and other MCS data sources. Register AIS devices with a proper flag-State-issued maritime mobile service identity (MMSI) number.

3. **Compliance with applicable standards**
   Align VMS systems with relevant RFMO or regional fisheries body technical requirements. Ensure AIS systems comply with IMO Resolution A.1106(29) and SOLAS provisions where applicable.

4. **High-frequency polling with flexible transmission**
   Program VMS devices to record positional data at high frequency (1 to 15 minutes) and store it onboard, with the capability to transmit in batches or over low-cost networks. Enable polling and transmission rates to be adjusted remotely by authorities based on risk or operational need.

5. **Tamper resistance and data integrity**
   Install physical tamper-evident seals and use encrypted transmissions on VMS devices. Configure devices to detect and report disconnection of power, sensors or casing, and include backup power (minimum 72 hours) and onboard storage (minimum 30 days) to protect against gaps caused by power loss or signal failure.

6. **Safety and communication features**
   Where systems support two-way communication, utilize it to strengthen safety coordination and enable dynamic monitoring. Include emergency alert functionality, particularly where other distress communication systems are absent. Require AIS to remain active at all times unless deactivation is justified under IMO guidance or national requirements. Mandate real-time reporting for any deactivation with the supporting evidence, and investigate and sanction unauthorized disabling.

7. **AIS class selection**
   Match the AIS device class to the vessel size, operating range and regulatory context. Device classes differ in transmission power, reporting frequency and functionality, and selecting the appropriate class is important for ensuring reliable data and regulatory compliance.

8. **Integration with vessel navigation systems**
   Connect tracking devices to the vessel's navigation systems to access primary global navigation satellite system (GNSS) data. Integrate data with bridge radar and electronic navigation displays where possible for AIS-equipped vessels.

Image Credit: Aneesh Thazhathethil

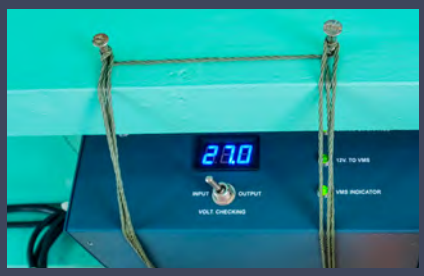
VMS

A national type-approved VMS installation

Type approval certifies the device, while certified installers and on-board audits confirm it has been fitted correctly. These three images show parts of the same VMS installation on one vessel.

The transmitter, mounted outside with a clear view of the sky. A wire tamper-evident seal runs through the housing.

Image Credit: Charles Kilgour



The unit inside the vessel, secured to a beam with loops of wire over two nails, with no tamper-evident seal fitted.

Image Credit: Charles Kilgour

The power supply, feeding the unit from an improvised power box through a domestic plug and socket.

Image Credit: Charles Kilgour

An internationally available VMS unit: Inmarsat-C terminal with built-in LRIT, dated from 2009. Older equipment like this can remain in service, provided it still meets type-approval requirements nationally or under any relevant RFMO measures.

Image Credit: Charles Kilgour

KEY POINT
A type-approved device can still transmit unreliably or be open to interference if it is poorly installed.

AIS

Examples of typical AIS components

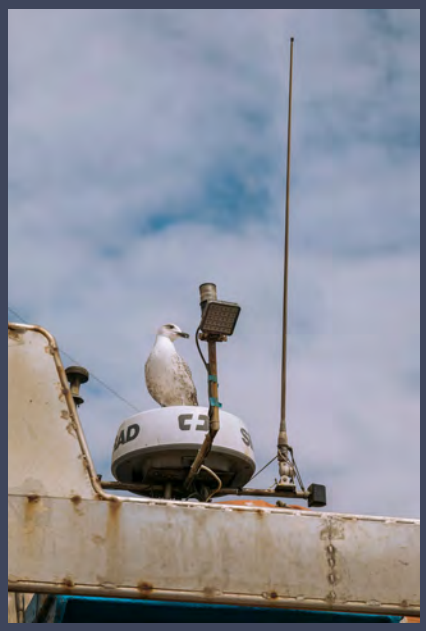
AIS units come in different forms. Some are “black boxes” wired into the vessel’s existing navigation system, with no display of their own. Others have a built-in screen and controls. Either way, AIS transmits over VHF and needs its own dedicated antenna.

A black box unit, which lacks a display screen, is often mounted out of sight, typically in a ship’s locker, engine room or helm console.

Image Credit: Charles Kilgour

Unit with built-in screen and keyboard.

Image Credit: Wikimedia commons



Dedicated VHF antenna. Mounting it high and clear of obstructions improves range.

Image Credit: Joao Guerreiro

Image Credit: Nikolaos Dimou

Universal system requirements

Durability

A seagoing vessel represents one of the harshest environments for technology, and any equipment will need to be resistant to saltwater, corrosion, vibration, shock and extreme temperatures. All equipment must be robustly tested onboard working vessels by a government or independent evaluator before being approved.

Positioning system

The primary data source for any vessel tracking system is GNSS. The vessel's location is derived from satellites from a number of systems including GPS (U.S.), GLONASS (Russia), Galileo (EU) and BeiDou (China). Where accuracy and reliability is a priority, devices that can use signals from multiple GNSS systems should be prioritized.

National and regional requirements for VMS typically state a minimum position accuracy of 100 meters; in some cases this is extended to 500 meters. However, with improvements in GNSS accuracy these figures are now outdated. A recent EU study recommended updating requirements to match modern GNSS systems, where 99 percent of positions are accurate to within 20 meters, and SOLAS requirements for AIS are within 10 meters.[17]

Power management

Devices should connect directly to a vessel's power system and consume minimal energy, ideally under 15 watts when transmitting. This helps conserve power, especially on smaller vessels.

Devices should be compatible with a vessel's 12-volt or 24-volt system.

When a vessel does not have onboard power or it is considered unreliable for the purposes of vessel tracking, a secondary power source like solar panels or an uninterruptible power supply is needed. This is most relevant for small-scale fishing vessels.

[17] Iñaki Quincoces, Research for PECH Committee – Workshop on Electronic Technologies for Fisheries – Part I: Transmitted Positional Data Systems, European Parliament, Policy Department for Structural and Cohesion Policies, Brussels, 2021, https://www.europarl.europa.eu/RegData/etudes/STUD/2021/652254/IPOL_STU(2021)652254_EN.pdf.

VMS specific requirements

International requirements

There are no universally agreed, internationally defined technical standards for VMS systems. States and regional bodies set different requirements, creating an increasingly complex regulatory landscape. When developing or updating national requirements, States should identify and meet the technical VMS standards set by any coastal State or regional body where their flagged vessels will likely operate.

Requirements set by regional bodies typically include reporting rates, malfunction protocols, data structure, transmission and data-sharing protocols, and system audits, for example the Western and Central Pacific Fisheries Commission VMS measure.[18]

Backup power

Devices should include an internal backup battery power source for continuous operation for at least 72 hours in standard operating mode in the event of loss of power from the vessel.

The device should always retain the recent settings when power is lost and should not convert to factory settings.

Data storage

Data storage capacity is most effective when it operates continually with an overwrite function, meaning when the memory is full it starts to overwrite the oldest data without the need for manual deletion. The amount that can be stored at once should exceed the typical time a vessel stays at sea to ensure the data can be interrogated later if required.

For vessels with extended voyage durations, devices should have sufficient onboard memory to store high-frequency position reports for at least 30 days.

Physical tamper detection

Physical tamper-evident seals should be installed on the casing, and where any equipment is fixed to the vessel, by certified installers and documented as part of the certification process. Opening or removing equipment should not be possible without breaking a tamper-evident seal.

Data tamper-resistant features

At a minimum, secure encryption is needed to prevent unauthorized interception or alteration of data during transmission. More advanced measures to prevent data tampering include:

- **Dual positioning with GPS and doppler effect:** This feature provides an additional layer of security by cross-verifying the vessel's location through GPS data and Doppler-based positioning. This approach is recommended as it can help to detect GPS interference and spoofing but is costly and requires a high degree of technical capacity to develop.
- **Automated system monitoring:** Advanced algorithms can be developed either by the system provider or the government agency to monitor for speed anomalies, unusual data patterns, gaps in transmission, frequent power interruptions or other anomalies that may indicate tampering. It is recommended that, at a minimum, alerts are created for two or more position reports where the speed would need to exceed 25 knots for the vessel to cover the distance.

[18] Western and Central Pacific Fisheries Commission (WCPFC), Conservation and Management Measure for the Commission Vessel Monitoring System, CMM 2014-02 (2014), https://cmm.wcpfc.int/measure/cmm-2014-02.

Image Credit: Diego del Rio

Data backup

Systems should include data backup functionality, storing data in both onboard and onshore physical and cloud servers, which reduces risk of data loss or tampering.

Unique vessel identifier

The VMS device should be linked to a unique vessel identifier (UVI) which is a key component of the FAO Global Record and critical for consistent vessel tracking across systems and jurisdictions.

Where possible, the UVI should be the vessel's IMO number. For vessels not eligible for IMO numbers, governments should assign a stable national identifier that is retained for the vessel's lifetime and never reused.

When UVIs are not used in a VMS system or are used inconsistently, it is difficult to cross-check a vessel's authorizations, port records, catch reports, AIS tracking data or compliance records. This means risky behavior is not properly investigated or followed up, trends and patterns cannot be identified, systems cannot be integrated or automated and data cannot be easily shared between agencies or jurisdictions.

Table 2. VMS Data Fields

Core data fields the device should record and transmit	• Vessel position
	• Speed and direction
	• Timestamp
	• IMO number or UVI
	• Device status
	  ○ On/off
	  ○ Power supply status
	  ○ Status of any connected sensors
	  ○ GNSS connection status
	  ○ Casing open

Optional data fields for enhanced systems covering specific system requirements	• Engine status: recommended when VMS is used to monitor fishing compliance • Gear deployment, hatch sensor, winch activation data or other electronic monitoring inputs: recommended when electronic monitoring sensors are required as a licensing condition • Environmental conditions • SOS alert: recommended when safety features are a high priority • Geofence alerts: recommended when area-based measures are being monitored

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Stored data and transmission rates

Modern VMS hardware should decouple the position-recording rate (base polling rate) from the rate at which data is transmitted to shore (transmission rate). This is the single most important hardware capability for keeping high-resolution tracking affordable.

Devices should:

- Record positions at 1 to 15 minute intervals and hold them in onboard memory.
- Enable flexible transmission rates through a risk-tiered framework. Under this system, low-risk fleets transmit infrequently, while vessels near MPAs, in dynamic fisheries or under real-time controls report at a much higher frequency.
- Support batch transmission, compressing multiple stored positions into a single message. For example, recording every five minutes and transmitting hourly sends 12 positions per message at roughly the cost of one.
- Permit direct extraction of stored data by authorised inspectors during port inspections or investigations, so the onboard record is usable for enforcement even if a transmission is missed.

There's no one global standard for VMS, so what gets built and adopted depends on what each State requires. Without a regulatory demand, higher-spec systems aren't supplied or adopted, so regulation must meet evidentiary standards for security, accuracy and reliability.

Optional enhanced feature:

- Offer dual connectivity — satellite plus global system for mobile communications (GSM) or equivalent — so stored data can be offloaded cheaply when the vessel is in coastal range.

Adjustable polling rates

There are situations where the management authority may want to increase polling rates. Two-way communication allows for this capability to be built into VMS systems. This flexibility supports risk-based monitoring approaches where fisheries officers can intensify tracking during sensitive operations, suspected violations or emergencies while reducing costs during routine activity.

Two-way communication

Two-way communication in VMS allows authorities to send messages to vessels and, in some systems, receive responses. This feature can provide additional ways for authorities to connect with vessels operating in remote areas, implement dynamic management measures, and follow up on compliance risks, weather reporting and emergency coordination.

Emergency messages

Where VMS units support two-way communication, it is possible to include an emergency alert function, allowing fishers to send distress messages to authorities. This is recommended in situations where VMS emergency messaging can provide a level of safety not covered by other systems. Where this functionality is adopted, it should be clearly documented, tested and integrated into national safety protocols as a best practice.

Certification

Provider certification: a provider's hardware is type approved and field tested under real-world operational conditions.

Device certification: a certified installer has documented and signed off on the installation of a specific device onto a vessel.

Device certification should be renewed periodically at an interval set by the competent authority, with a recommended timeframe of one to three years. During renewal, the device must be checked for tampering, proper functioning and overall condition.

AIS-specific requirements

International requirements

Unlike VMS, there are internationally agreed standards to follow for the onboard operational use of AIS. Where States require fishing vessels to use AIS, they should adopt relevant operational and technical standards established under SOLAS and associated IMO guidance. The most recent guidelines are found in IMO Resolution A.1106(29) adopted by IMO members in 2015.[19]

Key requirements include:

- **Uninterrupted operation:** AIS should be kept on at all times when ships are underway or at anchor. Deactivation is only permitted for safety or security reasons and must be logged and reported to authorities.
- **Accurate static data:** Ship identifiers — MMSI, IMO number, name, type, dimensions — must be correctly configured during installation and updated only when necessary, including following a change in ownership.
- **Navigation system integration:** AIS data should be continuously available on the bridge and integrated, where possible, into navigation displays such as radar or electronic navigation to enhance situational awareness and support safe navigation.
- **Position accuracy:** Position accuracy from the main GNSS sensor is indicated to be within approximately 10 meters.
- **Reporting intervals:**
    - Class A: Between two seconds and three minutes, depending on speed and maneuvering.
    - Class B: Between five seconds and three minutes, based on speed.
- **Emergency and safety messaging:** AIS supports broadcast of short safety-related messages and allows vessel traffic services to issue alerts.[20]

[19] Resolution A.1106(29) Adopted on Dec. 2, 2015 (Agenda item 10) REVISED GUIDELINES FOR THE ONBOARD OPERATIONAL USE OF SHIPBORNE AUTOMATIC IDENTIFICATION SYSTEMS (AIS) https://wwwcdn.imo.org/localresources/en/OurWork/Safety/Documents/AIS/Resolution%20A.1106(29).pdf.

[20] Vessel traffic services are shore-based systems operated by maritime authorities that monitor and manage vessel movement in designated sea areas and ports. Vessel traffic services use surveillance and communication technologies — including radar and AIS — to enhance navigational safety, coordinate traffic flow, and issue safety-related information and alerts to vessels.

Image Credit: Charles Kilgour

Class A

AIS systems are categorized into classes based on their technical features. Class A transponders are the most powerful and are required for larger vessels under SOLAS.

Specific requirements on how AIS Class A should operate include:

- Transmission power of 12.5 watts
- Connection to onboard sensors like a GNSS or GPS, heading sensor, rate-of-turn sensor and speed sensor
- Reporting rates
- Automatic fault reporting and built-in integrity test

To support integrated VMS and AIS tracking and promote responsible use of AIS by fishing vessels, regulations requiring the use of AIS Class A devices are recommended for large or industrial fishing vessels, especially those operating beyond national jurisdiction.[21] Any operational standards should be aligned with SOLAS and IMO Resolution A.1106(29).

Class B

AIS Class B units or sometimes called AIS Class CS, are a simplified version of Class A, designed primarily for smaller vessels not covered by SOLAS. They have lower reporting rates, a 2-watt reduced transmission power, and may not be connected to onboard sensors such as heading or rate-of-turn sensors.

While not subject to the same strict requirements as Class A, they must still comply with the International Telecommunication Union's ITU-R M.1371 technical specifications and relevant national or regional requirements.[22]

To support integrated VMS and AIS tracking and promote responsible use of AIS by fishing vessels, regulations requiring the use of AIS Class B devices are recommended for smaller vessels operating in waters under national jurisdiction. Any operational standards should be aligned with IMO Resolution A.1106(29).

Class B+

AIS Class B+ or sometimes called AIS Class SO, is a hybrid standard that provides enhanced functionality over standard Class B, including a higher 5-watt transmission power, higher transmission rates and greater priority for signal transmission. It uses the same transmission method as Class A units, improving visibility in high-traffic areas.

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[21] Each country defines "large" or "industrial" fishing vessels differently, depending on its legal, operational and fleet context. National definitions should guide implementation, but as a general rule of thumb, vessels over 24 meters in length or those operating in distant waters are commonly considered industrial.

[22] International Telecommunication Union (ITU), Technical Characteristics for an Automatic Identification System Using Time Division Multiple Access in the Maritime Mobile Band, Recommendation ITU-R M.1371-5, February 2014, https://www.itu.int/rec/R-REC-M.1371.

Image Credit: Aneesh Thazhathethil

AIS Class B+ is recommended instead of standard AIS Class B where improved tracking reliability is desired or in areas where AIS Class B reception is low due to high-traffic density (such as coastal waters of Europe, East Asia and the Atlantic coast of the U.S.). AIS Class B+ is also recommended in fisheries management contexts where data quality and frequency are important.

VHF Data Exchange System

An emerging development in AIS technology is the VHF Data Exchange System (VDES). VDES does not replace or fundamentally change AIS — AIS remains one of its components — but it adds the capacity to exchange a wider range of data, in greater volume and more securely, including via satellite. A SOLAS amendment adopted in 2026 and entering into force in 2028 permits the voluntary carriage of VDES as an alternative to AIS. It is, however, likely to be some time before VDES is seen on fishing vessels, the majority of which fall outside SOLAS requirements. The technology's potential is still being explored, but its likely benefits for vessel tracking are that it can carry more data types, potentially useful for electronic monitoring, and that its messages are authenticated, offering a means to verify the authenticity of AIS transmissions and reduce the risk of spoofing.[23]

MMSI

MMSI numbers are a unique nine-digit number used by AIS devices and other equipment to identify vessels. The first three digits of an MMSI are known as the maritime identification digits (MIDs). The MID indicates the flag State of the vessel, with the first digit denoting the geographic region.

Whenever a vessel is re-flagged, a new MMSI must be assigned to the vessel with the MID of the new flag State. MMSIs differ from the IMO numbers, which remain with the vessel for its entire lifetime, irrespective of changes in flag State, vessel name or ownership.

AIS devices should be registered with an MMSI number issued by the relevant competent authority. This should be public information included in a vessel registry. Using a false MMSI number should be prohibited and subject to sanction.

Static information

To maintain system integrity for safety, maritime security and monitoring, all vessels should input accurate static information into the AIS device during installation.

[23] In May 2026, the IMO Maritime Safety Committee (MSC 111) adopted performance standards for shipborne VDES and amendments to SOLAS Chapter V, meeting report pending. VDES is defined technically in International Telecommunication Union (ITU), Technical characteristics for VHF data exchange system in the maritime mobile service, Recommendation ITU-R M.2092-2, February 2026, https://www.itu.int/rec/R-REC-M.2092-2-202602-I/en.

This should not be updated unless there is a change in the vessel's name or MMSI number or a major modification that alters the vessel's type. Static information includes:

- Flag State-issued MMSI number
- IMO number where applicable
- Call sign
- Name that matches the name registered with the flag State and written on the hull
- Type of ship
- Length and beam
- For Class A devices, the position of the GNSS antenna

For accurate safety, security and vessel monitoring, it is critical that precise information is entered into the AIS device during installation.

Receiving data

AIS is primarily a safety-of-navigation system. For vessels equipped with electronic navigation, the AIS should receive AIS signals from other vessels, include a display on the bridge showing information on AIS targets and, where possible, integrate the information into electronic navigation and radar systems.

Emergency messages

AIS Class A devices have the capability to send emergency signals.

AIS Class B and B+ do not have this capability and will require alternative global maritime distress and safety system (GMDSS) devices like digital selective calling-capable VHF radios, emergency position-indicating radio beacons or VMS emergency signal compatible devices.

Disabling

IMO Resolution A.1106(29) states, "AIS should always be in operation when ships are underway or at anchor." However, an important safety feature is the ability to switch it off "if the master believes that the continual operation of AIS might compromise the safety or security of his/her ship or where security incidents are imminent."

AIS is sometimes intentionally disabled to try to hide illicit or unregulated actions. In line with IMO guidelines, AIS disabling must be prohibited, except where explicitly authorized for safety or security reasons. If the master does disable AIS, they should report the incident and reasons for it, duration and other relevant information to appropriate authorities as soon as possible and record it in the logbook. Flag, port and coastal States should investigate any AIS disabling events and appropriately sanction vessels that have not followed the required reporting protocols.

GNSS spoofing and position falsification

Position data can be compromised in two ways: externally, through GPS jamming or signal interference, or internally, through deliberate falsification of identity or location data by vessel operators. For fishing vessels, internal falsification is the more common and practical threat.

To reduce vulnerability, devices should support multi-constellation GNSS and be connected to the vessel's primary navigation system to allow cross-validation between data sources. Analytical systems should check for impossible travel speeds, positions outside receiver range and inconsistencies between VMS and AIS data. Authorities should factor position falsification into device specifications, type approval requirements and analyst training.

Image Credit: Red Zeppelin

Communications, access and security

Once a device records a position, that data has to reach shore, be stored, be accessed by authorized users and stay protected. This section follows the data from vessel to monitoring center, covering the communication networks that carry it and how it is stored, accessed and secured.

Vessel tracking communication networks

The communication network is a crucial component of a vessel tracking system, as it determines how vessel data is transmitted to fisheries monitoring centers or other regulatory authorities. It also directly influences decisions regarding onboard equipment, and these two components should be considered together.

Recommendations

1. **Platform selection**
   Choose communication platforms that match a vessel's operating environment, onboard power, data needs and cost constraints. Offshore operations generally require satellite links, while nearshore or inshore operations may rely on a GSM or encrypted VHF.

2. **Network optimization**
   Design systems to automatically switch between available networks. Prioritize lower-cost channels when within GSM range and default to satellite transmission when outside those areas.

3. **AIS integration**
   Use AIS to complement VMS rather than replace it. The two work best together, with AIS adding valuable coverage alongside VMS.

Vessel tracking systems rely on several communication platforms to transmit data to shore-based monitoring centers. The most common are satellite networks, particularly low Earth orbit systems like Iridium, Argos and ORBCOMM, which provide global coverage and are well-suited for offshore operations. Geostationary satellites, such as those used by Inmarsat and Thuraya, offer stable coverage in fixed regions but are less effective at high latitudes. For nearshore and small-scale fisheries, terrestrial networks GMS celluar and VHF radio offer cost-effective alternatives where infrastructure is available. The choice of communication platform should align with the vessel's operating range, data transmission needs, and cost and power considerations.

The term "near real time" is used frequently in vessel tracking but what it means in practice varies. A satellite-based VMS transmitting every 15 minutes delivers data that is near real time for most monitoring purposes, including detecting entry into restricted areas or identifying potential fishing activity. For some operational responses, such as dispatching a patrol vessel, even a one-hour delay may be acceptable given the time it takes to act on an alert. True real-time data, where positions update continuously with minimal delay, is more relevant for safety-critical applications like collision avoidance, which is the primary function of AIS. When designing or procuring a vessel tracking system, authorities should define what near real time means for their specific operational

needs rather than treating it as a fixed technical standard. In most fisheries monitoring contexts, the priority is receiving reliable, consistent position data at a frequency that supports the detection of the events being monitored.

Image Credit: Charles Kilgour

Image Credit: Charles Kilgour

Current technologies

The table below outlines the primary communication networks used or emerging in vessel tracking systems, including recommended applications and key limitations to guide selection based on specific operational contexts.

Table 3. Recommended Networks for Vessel Tracking for Offshore Operations: Satellite Communications

Description: The most widely used method for VMS due to global coverage, security and reliability. Provides secure, near-real-time data transmission with the ability to have two-way communication. Satellite constellations fit into two categories: geostationary, with high-orbit satellites fixed over one location, providing stable wide-area coverage; and low Earth orbit, with satellites that move across the sky enabling frequent data transmission and global reach.
Recommended use case: The best available technology for reliable, secure and adaptable VMS systems. For the majority of VMS programs, satellite communications will be the best choice, especially for industrial vessels that operate away from shore. Geostationary satellites are preferred for stable, continuous coverage in fixed regions, while low Earth orbit satellites are better for global coverage and frequent data updates, especially in remote or high-latitude areas.
Limitations: High data transmission costs compared to other systems, which may be unsuitable for some small-scale fisheries applications. Cost is related to the frequency of the transmissions, which has historically kept polling rates low, although this can reduce the value of the data needed for monitoring. Onboard equipment features like batch transmissions or hybrid systems that utilize satellite and GSM transmissions can help to reduce costs while improving position polling rates. Depending on the level of anti-tamper features and device certification, VMS systems can be tampered with. Tampering issues include systems being disabled, GNSS data being spoofed or devices swapped between vessels.

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Image Credit: Charles Kilgour

Table 4. Recommended Networks for Vessel Tracking for Offshore

Description: AIS broadcasts vessel location, identity, speed and course for collision avoidance. Transmissions are unencrypted and publicly readable, any receiver within range can collect them. Data is aggregated by governments and commercial providers via terrestrial and satellite receivers. Unlike VMS, there are no per-transmission costs to vessel operators.
Recommended use case: The primary use of AIS is as a navigation safety aid, and any vessel tracking system using AIS should aim to promote this function through regulations that ensure responsible use. AIS also provides an effective tool for vessel tracking and acts as a complementary data source to VMS systems. In this role, AIS provides detailed and real-time data on vessel positions and movements, which are invaluable for fisheries controls, particularly with transboundary fisheries, fisheries research, supply chain traceability and due diligence, and marine spatial planning and biodiversity protection.
Limitations: Coverage gaps exist in remote areas with limited satellite or terrestrial receiver density. Systems can be deliberately switched off or data spoofed. Regulating the use of AIS for vessels that are not covered by SOLAS — for example, fishing vessels — is different for each State, resulting in inconsistent policies and regulatory gaps. Where regulations do exist, enforcement is often sporadic or not followed up by authorities.

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Table 5. Recommended Networks for Tracking Small-Scale Vessels and Vessels That Only Operate Inshore: GSM

Description: Operates on the mobile phone network and is effective for vessels operating near shore where mobile phone coverage is available. Transmission costs can be relatively low, allowing high polling rates. Compatible with SOS features when in network coverage areas. Systems using this network can be as simple as a mobile phone app.
Recommended use case: Suitable for small-scale fisheries or iVMS. If the target vessels do not have reliable onboard power, the system can be paired with solar power to ensure constant operation. Systems should have the ability to store positional data when out of GSM coverage, which can be sent in one batch once the vessel is back in range.
Limitations: Limited to coastal areas with mobile network coverage, resulting in delays to sending data when out of range, which means the system is not always real time. GSM tracking systems typically have a range of 10 to 25 nautical miles, depending on factors like tower height, terrain and atmospheric conditions. Where coastal areas are mountainous, range can be significantly reduced. Remote regions with few GSM towers have limited coverage. Building a coverage map to identify potential gaps is recommended. Hybrid systems using low-cost GSM when in coverage and satellite communication when out of range can be an option if real-time data is a high priority.

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Table 6. Recommended Networks for Tracking Small-Scale Vessels and Vessels That Only Operate Inshore: Encrypted Proprietary VHF Transmissions

Description: Uses AIS technology to transmit encrypted messages on unused VHF frequencies. Data is prioritized by satellite and terrestrial receivers and purchased from providers. Low cost for the vessel and relatively low cost for the authorities.
Recommended use case: Effective low-cost tracking solution for small-scale fisheries or iVMS. Limited use case for large offshore vessels unless governments and RFMOs have tested and approved the tracking systems to meet regulatory requirements for reliability and polling rate.

Limitations: Position polling rates are not guaranteed, so the system may not meet government or RFMO VMS requirements without testing and approval.

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Table 7. Additional Networks with Very Specific Suitability: Bluetooth, Wi-Fi and Mesh Networks

Description: Devices use Bluetooth or similar wireless technology to create local networks within a port area to connect to centralized hubs for data upload.
Recommended use case: Low-cost system suitable for very near-shore small-scale fisheries where data is being collected to support science and management, particularly in areas where fishers return to port daily and data can be uploaded onshore.
Limitations: Limited to line-of-sight range — a few hundred meters — and requires regular docking or centralized hubs for data retrieval.

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Hybrid systems

Hybrid communication approaches are increasingly common in vessel monitoring systems. Satellite offers near-global coverage and secure transmissions but at higher costs. GSM is far more affordable and suitable for coastal operations, yet coverage is limited. Integrating these two networks ensures continuous transmission of tracking data outside GSM coverage, and cost-effective transmission when GSM is in range. Modern vessel tracking systems should be designed to automatically switch between available networks.

Emerging technologies

Low earth orbit (LEO) satellite broadband is reshaping maritime communications. These satellite constellations offer high-speed and real time connectivity that enables data-rich vessel communications and access to the internet that could transform how VMS operates.

For large vessels with sufficient power capacity, LEO broadband can already support continuous high-resolution data transfer. This has the ability to significantly enhance vessel monitoring, scientific data collection and environmental monitoring. Providing crew with access to the internet and reliable communication with family also improves welfare, reducing isolation at sea and the risk of mistreatment.

However, challenges remain. LEO terminals consume significant power — typically 50-150 watts — and equipment plus subscriptions are currently costly, making them impractical for all but the largest fishing vessels. Regulatory frameworks for LEO use are still evolving, and the increased connectivity also raises cybersecurity risks. The antenna also needs an unobstructed view of the sky, which can be challenging on fishing vessels. Finally, the promise of better connectivity and protections for crew are also hampered by a lack of

regulation – even if the vessel had the technology, there is no guarantee that crew members would be given access.

LEO broadband offers powerful new capabilities for VMS, but is only suited for large industrial vessels until it is better regulated and costs and technical barriers are reduced.

Data storage

Government authorities must ensure vessel tracking data is securely stored, accessible and protected from tampering or loss. While VMS data involves relatively small file sizes and is manageable compared to more data-intensive systems like electronic monitoring, ensuring secure and scalable storage remains a persistent challenge.

Recommendations

1. **Cloud storage**
   Adopt cloud-based storage to improve scalability, resilience and cost-efficiency as vessel tracking systems become more complex and data-heavy.

2. **Assess risk**
   Before selecting cloud storage, conduct a risk assessment in line with national or international guidance. Prioritize providers with in-country data centers or infrastructure based in trusted jurisdictions.

3. **Interagency ecosystems**
   Where national policy and data frameworks allow, pursue a gradual, phased transition towards interagency data storage ecosystems that facilitate secure data sharing, interoperability and coordination.

Most authorities rely on in-house servers housed within government facilities to retain full control and align with national data sovereignty priorities. However, these systems are often expensive to build and maintain and can be difficult to scale.

Cloud-based storage is where the data is stored offsite, within a government or private data center. It can replace or complement secure on-site systems. More governments are exploring this model to reduce infrastructure costs and improve data resilience. However, concerns around national security, data sovereignty and accessibility must be addressed when selecting cloud providers. Providers with in-country data centers or infrastructure based in trusted jurisdictions should be prioritized to address concerns around sovereignty, security and accessibility.

Before adopting cloud solutions, a tailored risk assessment that aligns with national data security policies should be conducted to evaluate vulnerabilities specific to vessel tracking data, such as unauthorized access and jurisdictional control. Clear governance frameworks must define data ownership, define open data policies, set access protocols for enforcement

[24] International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC), Information Security, Cybersecurity and Privacy Protection — Information Security Management Systems — Requirements, ISO/IEC 27001:2022, October 2022, https://www.iso.org/obp/ui/en/#iso:std:iso-iec:27001:ed-3:v1:en.

[25] United Nations Department of Economic and Social Affairs, United Nations E-Government Survey 2020: Digital Government in the Decade of Action for Sustainable Development, ch. 6, "Towards Data-Centric E-Government," (New York: United Nations, 2020), 161, https://digitallibrary.un.org/record/3884686?v=pdf.

bodies and establish accountability for misuse. Achieving standards like ISO/IEC 27001:2022 Information Security, Cybersecurity and Privacy Protection Requirements is recommended for agencies that require the systems to be certified for data security.[24] These practices align with the UN Department of Economic and Social Affairs' National Data Governance Framework, which promotes effective, inclusive and accountable national data policies and is a good source for further information.[25]

To build efficiencies within a country's maritime data storage, a shift towards interagency data ecosystems is recommended. This requires multiple agencies collaborating and sharing data storage resources under agreed data-sharing arrangements. For example, a fisheries authority could use the secure storage infrastructure of another agency, such as the coast guard or a maritime agency, and in return provide access to data that supports that agency's operational priorities. This approach supports cost-efficiency, improves interoperability and strengthens institutional coordination. It is, however, a significant step for many governments and requires considerable leadership from the top of government down to build trust, train personnel, formalize data-sharing agreements and standardize protocols. Without these elements in place, it will be challenging to overcome barriers to interagency cooperation on data management, meaning it may not suit all governments at once.

Image Credit: Sergei Starostin

Data access

Effective vessel tracking depends not only on secure data collection and storage but also on ensuring the right stakeholders can access the data when they need it.

Recommendations

1. **Role-based access**
   National systems should implement individual user credentials and role-based access controls to maintain accountability and audit trails.

2. **Data-sharing protocols**
   Establish clear, legally grounded data-sharing protocols through VMS regulations or formal agreements to ensure timely access to vessel tracking data by domestic agencies, RFMOs and any relevant coastal and port States for effective enforcement and oversight.

3. **Open-data policies**
   Where possible, adopt policies that make vessel tracking data accessible to government and public organisations involved in fisheries monitoring by default, reducing reliance on case-by-case agreements.

System access and user management

Within a national vessel tracking system, multiple teams and agencies will typically need access to the platform itself, whether for real-time monitoring, historical analysis, compliance review or system administration. Individual login credentials and role-based access controls are essential to ensure accountability, maintain audit trails and allow administrators to manage what each user can see or do. Without these controls, shared or generic logins make it difficult to attribute actions, investigate breaches or monitor the chain of custody that can be required for data being used in legal processes.

Data sharing beyond the national system

Vessel tracking data is often needed by agencies beyond those operating the national system, including maritime enforcement, port and customs authorities, coast guards, navies and environmental ministries, yet these agencies frequently do not share data or coordinate effectively. This is as much a political and institutional challenge as a technical one.

The complexity increases across borders. When a distant-water fishing vessel operates across multiple zones — such as RFMO-managed high seas and a coastal state's EEZ — and lands its catch in a third country, tracking data must be shared broadly. Effective compliance monitoring, risk assessment and enforcement require timely access for the RFMO secretariat and government agencies across at least three jurisdictions.

Formal data-sharing agreements between national agencies, other governments, RFMOs and regional fisheries bodies can provide a framework for access, though these require ongoing maintenance and can be undermined by incomplete data, poor interoperability or limited institutional capacity. The most practical solution is for VMS legislation or regulation to provide for data sharing and transparency by default, making tracking data accessible to government and public organizations involved in fisheries monitoring without the need for case-by-case agreements.

Image Credit: Charles Kilgour

Data security

As vessel tracking systems become more connected through cloud storage and application programming interface (API)-driven data exchange, they become more exposed to cybersecurity risks. A breach can compromise data integrity, disrupt enforcement and undermine trust between agencies that share data. This applies equally where data is being made publicly available. Transparency depends on the underlying data being trustworthy, and protecting the security of tracking infrastructure is a prerequisite for credible transparency, not something that becomes less important because of it.

Recommendations

1. **Core system security**
   Treat cybersecurity as a core system requirement by ensuring data is encrypted in transit and at rest, access is controlled through role-based permissions and audit logs are maintained. Include requirements around security standards, vulnerability assessments and breach notification in contracts when systems are procured from third-party providers.

2. **System design**
   Build cybersecurity into procurement specifications and system design from the outset. Implement fundamental measures first — such as encrypted communications, controlled platform access and clear incident response processes — before introducing advanced measures as capacity matures.

Cybersecurity should be treated as a core system requirement. At a minimum, authorities should ensure data is encrypted in transit and while being stored, access is controlled through role-based permissions with multi-factor authentication, and audit logs track who accessed or modified data and when. Systems should detect and alert on suspicious access patterns. Where data is shared between agencies or across borders, security requirements and responsibilities should be defined in formal agreements.

Transparency depends on data integrity. Making data public does not reduce the need to secure it. Open data is only useful if it can be trusted.

National cybersecurity policies and incident response plans should cover vessel tracking infrastructure. Fisheries monitoring staff should receive basic cybersecurity training. Where systems are procured from third-party providers, contracts should include requirements around security standards, patching, vulnerability assessments and breach notification.

Not all measures need to be implemented at once. The priority should be encrypted communications, controlled platform access and a clear incident response process. More advanced measures such as anomaly detection and routine vulnerability assessments can follow as wider data security capacity develops nationally. What matters is that cybersecurity is considered from the outset and built into procurement and system design rather than retrofitted later.

Image Credit: Charles Kilgour

Integration and presentation

Tracking data is most valuable when integrated with other data sources to provide actionable insights. This section covers how systems connect and share data, the interfaces used to view it and the polling rates that set how detailed the picture is.

System integration and interoperability

Vessel tracking data is a central component of any MCS system, but its value increases significantly when integrated with other data sources such as AIS, logbooks, electronic monitoring, licensing information and inspection records. Interoperability – the ability of different systems to exchange, interpret and use data consistently – is a critical enabler of modern fisheries management.

Recommendations

1. **Data integration**
   Integrate vessel tracking data with complementary sources (AIS, logbooks, electronic monitoring, licensing and inspection data). Prioritize VMS–AIS integration as a minimum requirement to ensure a complete and accurate picture of vessel activity at sea.

2. **System interoperability**
   Enable interoperability across systems and jurisdictions by ensuring data can be securely exchanged and used between agencies, States and RFMOs, supporting regional cooperation and international obligations.

3. **Progressive implementation**
   Implement interoperability progressively by focusing on three practical steps:
   1. Standardize core data elements, formats and units (e.g. ISO 8601 timestamps in UTC, speed in knots) to ensure consistency, comparability and reliability.
   2. Align data structures, naming conventions and metadata across systems through a shared data dictionary to reduce manual reconciliation and support seamless integration.
   3. Establish secure, automated data exchange, preferably via API to enable timely, reliable data sharing within and between systems.

Strong interoperability frameworks support integration and MCS systems in several key ways:

- **Enabling multi-source intelligence:** Integrating vessel tracking data with complementary datasets helps detect patterns, verify reported activity, and identify potential noncompliance. As a priority, VMS and AIS data should be integrated to provide the most complete, accurate and timely picture of vessel activity at sea.
- **Reducing manual reconciliation:** Standardized and interoperable data reduces the need for time-consuming manual data matching across systems. This is often where data-sharing agreements fail in practice, as the technical capacity required to integrate unstandardized data is too high.
- **Supporting compliance and enforcement:** Consistent, well-structured data improves the reliability, traceability and value of information as evidence in investigations and legal processes.
- **Enabling regional cooperation:** Interoperable systems facilitate timely and accurate data exchange between flag States, coastal States and RFMOs, supporting obligations under international frameworks such as U.N. conventions and RFMO conservation and management measures. This also improves the ability of authorities to engage with other MCS information-sharing systems such as the Global Information Exchange System under the PSMA.

Interoperability does not require a single system or standard. Rather, it can be implemented progressively by adopting common approaches to how data is defined, structured and exchanged. The following sections outline a practical framework for doing so.

Interoperability framework

Interoperability can be implemented progressively by addressing three core components of vessel tracking data systems:

1. **Data standardizaton, or what the data is:** Defining a consistent set of core data elements, such as vessel identity, position, timestamp, speed and course, then applying standardized formats and units to ensure comparability across systems.
2. **Data structure and nomenclature or how systems interpret the data:** Ensuring that data fields are consistently named, defined and organized so that different systems can correctly interpret and map the data. This includes the use of clear data dictionaries and metadata.
3. **Data exchange or how data moves between systems:** Establishing reliable and secure mechanisms for sharing data between systems, including the use of APIs or secure file transfer methods, supported by appropriate protocols and standards.

These three components provide a practical foundation for interoperability. Implementation can be phased incrementally, allowing authorities to improve system integration over time while aligning with international standards where appropriate.

Step 1: Standardize core data elements

Standardization of vessel tracking data begins with defining a consistent set of core data elements and applying agreed formats, units and reference systems. This ensures that data collected from different devices, fleets and jurisdictions can be compared, integrated and reliably used for monitoring and enforcement.

Vessel tracking core data elements should include, at a minimum:

- Vessel identifiers
- Position (latitude and longitude)
- Timestamp
- Speed and course

Where multiple vessel identifiers exist, all should be captured, with preference given to permanent identifiers that remain through flag changes or name changes, such as the IMO number.

Additional data fields, such as gear type, device status, electronic monitoring sensors, logbook-related fields or environmental data, can be included as enhanced or optional elements to support more advanced monitoring and analysis.

Use of international standards

Internationally recognized standards should be applied to ensure consistency across systems. These include:

- ISO standards for formatting date/time and geographic coordinates
- FAO International Standard Statistical Classification of Fishing Gear (ISSCFG) for gear classification
- IMO standards for vessel identification
- RFMO requirements for reporting and data exchange

These standards apply to different aspects of vessel tracking data and should be used in combination.

Interoperability doesn't have to be all-or-nothing. Taking it step by step lets any authority start now and gain benefits along the way, rather than waiting until the whole system is ready.

Image Credit: Global Fishing Watch

Image Credit: Charles Kilgour

The three most common interoperability challenges Global Fishing Watch has identified in vessel tracking systems are issues with unique vessel identifiers not matching between data sources, timestamp issues and how vessel speed is recorded.

Table 8. Standardizing Vessel Identity

Using a consistent and persistent vessel identifier enables reliable matching of data across systems. Where countries establish or maintain national vessel identification systems, these should follow the same principle as the IMO numbering system: a single identifier assigned to the vessel that remains constant throughout its lifetime, regardless of changes in name, ownership or flag State.

Vessel identity is one of the most common sources of interoperability challenges. Differences in identifiers across systems — name changes, MMSI reassignments or inconsistent national registration numbers — can make it difficult to link vessel tracking data with other datasets. A national identifier that changes when a vessel is sold or renamed undermines the ability to build a reliable history of a vessel's activity across data sources.

Key requirements:

1. Use a UVI wherever possible:
   - The IMO number is the preferred standard, as it remains constant over time.
   - Where an IMO number is not available, a stable national identifier should be used.
2. Capture and store all available identifiers, including:
   - IMO number
   - MMSI
   - Call sign
   - National registration number
   - Vessel name
   - Ownership
3. Design systems to link and reconcile multiple identifiers associated with the same vessel.
4. Avoid relying on vessel names alone, as names can change, be duplicated or spelt in different ways.

For MCS systems:

1. Use IMO number as the primary key for vessel identity wherever possible.
2. Maintain cross-references between all identifiers to support data matching across systems.
3. Ensure vessel identity data is aligned across tracking, licensing, logbook and inspection systems.

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Table 9. Standardizing Timestamps (ISO 8601)[26]

All timestamps should follow ISO 8601 format to ensure consistency across systems.

ISO 8601 is an international standard covering the exchange of date and time-related data. The format is **yyyy-mm-ddThh:mm:ssZ.**

Key requirements:

1. Year must always be expressed as four digits (YYYY).
2. The character "T" is used to separate the date and time in the code string.
3. Timestamps must represent a single point in time, expressed in one of the following formats:
   - Coordinated Universal Time (UTC), identified by Z at the end of the string:

     2018-05-12T20:45:19Z
   - Local time with timezone offset, identified by the appropriate timezone offset (±HH:MM, for example, Brasilia Standard Time is -03:00):

     2018-05-12T17:45:19-03:00
4. All timestamps should be anchored in UTC. UTC should be used for:
   - Data storage
   - System-to-system exchange
   - Audit and evidentiary records
5. When converting from UTC to local time:
   - The time value must be adjusted
   - The appropriate timezone offset (±HH:MM) must be applied
6. Timezone conversion should be handled with care, as:
   - Some time zones include non-hour offsets (e.g. ±30 or ±45 minutes).
   - Daylight saving time can change offsets seasonally.
   - Incorrect conversion can lead to misalignment of events in analysis or investigations.
   - To ensure accurate conversion, systems should use a reliable timezone reference such as the Internet Assigned Numbers Authority Time Zone Database, which accounts for regional time rules and daylight saving changes.[27]
7. When timestamps are included in reports or investigations:
   - They should follow ISO 8601 format
   - The applicable time zone must be clearly indicated, particularly where the information may be used in legal proceedings.

Example:

- **20:45:19Z** (UTC) is the same moment as **17:45:19-03:00** (local time in Brasília).

[26] International Organization for Standardization (ISO), Date and Time Format — ISO 8601, accessed May 7, 2026, https://www.iso.org/iso-8601-date-and-time-format.html.
[27] Internet Assigned Numbers Authority (IANA), "Time Zone Database," accessed May 7, 2026, https://www.iana.org/time-zones.

For MCS systems:

1. Store and transmit timestamps in UTC (Z).
2. Convert to local time only in user interfaces or reports.
3. When timestamps are included in reports or investigations, follow ISO 8601 format, and clearly indicate the applicable time zone, particularly where the information may be used in legal proceedings.

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Table 10. Recording Vessel Speed

Vessel speed data should be recorded and standardized to ensure consistency across systems and enable accurate analysis of vessel behavior.

Vessel speed may be recorded by different devices like AIS, VMS and onboard sensors using varying units and levels of precision.

Key requirements:

1. Vessel speed must be expressed using a consistent unit of measurement:
   - Knots or nautical miles per hour are the recommended standard for MCS systems.[28]
2. Where devices record speed in other units, for example kilometers per hour or meters per second, values should be:
   - Clearly identified with their original unit.
   - Converted into knots for storage, exchange or analysis within MCS systems.
3. Vessel speed data should be recorded with sufficient precision to support behavioral analysis:
   - At least one decimal place is recommended (Example, 3.4 knots).
   - Higher precision (two decimal places) may be beneficial for certain gear types or analyses.

For MCS systems:

1. Store and transmit vessel speed using a standard unit like knots.
2. Retain information on original units where relevant for traceability.
3. Ensure consistency of precision across datasets to support:
   - Fishing activity detection
   - Geofencing and speed-based alerts
   - Behavioral analytics and automated risk indicators

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[28] Knots are the standard maritime unit of speed used in IMO-regulated navigation systems.

Step 2: Standardize data structure and nomenclature

Once core data elements have been defined, the next step is to ensure that those data elements are consistently structured and clearly labeled so that they can be correctly interpreted across different systems. Even where the same data is collected, differences in field names, formats or definitions can create barriers to integration. Standardizing data structure and nomenclature reduces ambiguity, enables automated data exchange, and improves the reliability of system integration.

Data structure refers to how data is organized, including field names, formats, data types and units. Nomenclature refers to the naming conventions used to describe each data element.

In practice, this means that each data field should be consistently defined and documented across systems. For example, a timestamp should always be labeled using the same field name (timestamp), follow a consistent format, and be anchored in UTC, while position fields should be clearly defined (latitude, longitude) and use the same coordinate system and precision.

To support this, authorities should develop and maintain a data dictionary that defines each data element, including:

- Field name
- Definition
- Format and data type
- Unit of measurement, where applicable
- Whether the field is mandatory or optional

Supporting metadata and documentation should also be maintained to describe how data is generated, processed and transmitted. This helps ensure consistency across systems, supports integration with external partners, and enables continuity when systems or service providers change.

Where possible, consistent data structures and definitions should be applied across vessel tracking systems and other related data sources, such as logbooks, electronic monitoring, licensing systems and inspection records. Aligning these systems reduces the need for manual data reconciliation and supports more effective cross-referencing and analysis.

Image Credit: Md Sihabul Islam

Table 11. Common Data Fields Found in Vessel Tracking and Associated Standards

Data field	Description	Common practice	Standards/notes
Vessel identifier(s)	Unique vessel identity including IMO number (preferred), MMSI, call sign and national registration number	Core	IMO number preferred; include all available identifiers for cross-referencing
Position: latitude/ longitude	Vessel position with sufficient precision for monitoring and enforcement	Core	ISO 6709 (WGS84); recommended minimum 5 decimal places
Timestamp	Date and time of position record	Core	ISO 8601; must be UTC (Z) for storage and exchange
Speed	Vessel speed to support behavioral analysis	Core	Knots minimum 1 decimal place
Course	Vessel direction of travel	Core	Degrees (0–360); minimum 1 decimal place
Device status	Status of tracking device (power, GNSS signal, tamper alerts)	Core	Should include indicators for data reliability and system integrity
Engine status	Indicator of engine activity (on/off, idle/active)	Enhanced (optional)	Useful for activity detection and validation
Gear type/ deployment	Information on fishing gear used or deployed	Enhanced (optional)	FAO ISSCFG for gear classification
Environmental data	Contextual data such as sea surface temperature or weather	Enhanced (optional)	May support advanced analytics and fisheries research
Distress /alert (SOS)	Emergency or distress signal from vessel	Enhanced (optional)	Should be clearly flagged and prioritized in systems and follow GMDSS standard alongside national standards if different
Geofencing events	Entry/exit or activity within defined spatial areas like an EEZ or MPA	Enhanced (optional)	Derived from position data; requires defined spatial boundaries

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Step 3: Establish data exchange mechanisms

Once data elements and structures have been standardized, the next step is to ensure that data can be reliably and securely exchanged between systems. Effective data exchange enables vessel tracking data to be shared across agencies, integrated with other data sources and meet reporting requirements at national, regional and international levels.

In practice, this means adopting data exchange mechanisms that are automated, secure and compatible with existing systems. Wherever possible, data should be exchanged using APIs, which support real-time or near-real-time data transfer and reduce the need for manual handling. Where API-based exchange is not feasible, data can be shared using formats such as comma separate values or JavaScript Object Notation and transmitted via secure methods such as Secure File Transfer Protocol.

Data exchange systems should also incorporate measures to ensure reliability and performance, including:

- Secure authentication and access control
- Data encryption during transmission
- Message validation and error handling
- Logging and audit trails
- Data compression where appropriate to reduce transmission costs

Adopting these practices provides a flexible foundation for interoperability, allowing systems to exchange data efficiently even where more advanced standards are not yet in place.

Sharing data between systems and agencies is key to successful MCS. Once data is standardized, secure and automatic, exchange moves it between agencies and across borders, giving fisheries officers the full picture they need to check vessel activity.

Use of international data exchange standards

In addition to these general approaches, a number of internationally focused data exchange standards are being developed to support interoperability in fisheries and seafood traceability systems. The need for standardization is increasingly recognized as the current inconsistent data formatting and requirements limit effective data sharing, analysis and use.

Many States use the North Atlantic Format for data transmission, but this system is now nearly 30 years old and is no longer able to adequately address current data needs. However, an updated universal standard for electronic reporting of fisheries data, known as the Fisheries Language for Universal Exchange (FLUX), has been developed for government-to-government data exchange. FLUX has been endorsed by the United Nations and adopted by some RFMOs, such as the North East Atlantic Fisheries Commission, which has tested it and is in the process of transitioning to it.[29] Its adoption by some RFMOs, in particular where the EU is a member, may help build the needed capacity for others to adopt the new system.

FLUX provides a structured framework for automated, secure data exchange between authorities and covers exchange of data on vessels, vessel positions, authorizations, licenses, sales data, fishing activity, aggregated catch data and inspection reports, although all modules are not yet deployed.

[29] "Introduction to the UN Fisheries Language for Universal eXchange (UN/FLUX)" (presentation, Coordinating Working Party on Fishery Statistics, 26th Session, Rome, May 15–18, 2019), https://www.fao.org/fi/static-media/MeetingDocuments/cwp/cwp_26/PR9.pdf.

Image Credit: Hakan Kayahan

As a standard rather than a standalone software solution, it typically requires custom system development and integration with national data systems. Implementation can therefore be complex and resource-intensive, particularly where existing systems are not already aligned with its data structures and processes. While reference tools and a few components currently exist, they do not yet constitute a complete, ready-to-deploy solution.

The FAO has recently announced that it will communicate with FLUX for fisheries instruments like the PSMA/Global Information Exchange System and the FAO Global Record.[30] Implementation costs should be weighed against the benefits, which are most evident where regular, structured data exchange is required between authorities, particularly in regional or RFMO contexts where partner systems have adopted the standard. However, FLUX remains difficult for most users outside the EU and the current level of technical support available impedes wider adoption.

The Global Dialogue on Seafood Traceability (GDST) standard is a voluntary, industry-led initiative that enables interoperable digital traceability across seafood supply chains. It defines common key data elements recorded at critical tracking events and is built on widely used frameworks such as GS1 electronic product code information services, allowing different systems to exchange data seamlessly.[31]

While primarily designed for business-to-business traceability, GDST can complement vessel tracking systems by linking vessel activity with downstream events such as landing, transshipment and processing. This supports verification of catch origin and cross-checking between vessel activity and reported supply chain data. GDST does not provide vessel movement or monitoring data, but can enhance interoperability where integration between government systems and industry traceability data is required.

These standards are not mutually exclusive and may be complementary in some contexts. Authorities should assess their specific operational needs, technical capacity and regional context when considering adoption. For most countries, interoperability does not require immediate adoption of complex international standards. National authorities or regional bodies should start with the three core steps outlined above: standardizing data elements, applying consistent data structures and nomenclature, and establishing secure, automated data exchange using lightweight approaches such as APIs. These steps can be implemented through system design, procurement requirements and data management policies.

As systems mature and the need for more formalized exchange increases, particularly in regional contexts, authorities can progressively align their systems and data exchange arrangements with international standards where this provides clear operational benefits.

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[30] "FAO Adopts UN/FLUX as the Global Standard for Fisheries Data Exchange," Food and Agriculture Organization of the United Nations (FAO), Mar. 22, 2024, accessed May 5, 2026, https://www.fao.org/iuu-fishing/news-events/detail/en/c/1737866/.

[31] Global Dialogue on Seafood Traceability (GDST), GDST Standard 1.2: Materials and Resources, accessed May 7, 2026, https://thegdst.org/resources/standard/.

User interface

A vessel tracking system is only as useful as the interface that allows the user to interact with the data. If the people using the system cannot navigate the interface or find the information they need, then the value of the data behind it is lost.

Interfaces should be designed with the end user in mind, not just data engineers or developers. This means prioritizing clear layouts, plain language, visual cues and logical workflows that help users quickly interpret vessel movements, identify potential issues and take action when needed. Systems should be tested with actual users to ensure they work in practice. The proper processes for user-driven software development are beyond the scope of this guide, but there are many resources available to support this process.[32]

Recommendations

1. **Interface design**
   Prioritize designing or selecting off-the-shelf interfaces around your operators' needs. Ensure layouts are clear, intuitive and include features that support quick interpretation and navigation, even for non-technical users, often achieve the best results.

2. **Operational context**
   Choose vessel tracking interfaces that support the operational context. Cross-reference vessel data with license and registry data, and visualize critical information in a way that reflects real-world boundaries, authorizations, rules and monitoring priorities. These may include MPA boundaries, port calls and duration at sea.

3. **Action-oriented tools**
   Build or select tools that enable action, not just observation. Configure automated alerts linked to vessel tracks and ensure the interface can manage data feed disruption, maintaining sequence and clearly flagging vessels where transmissions have stopped or are overdue.

4. **Workflow support**
   Optimize the interface to directly support operator workflows and allow for frictionless initiation of investigations, tracking and sharing of cases between operators, quick data export and automated report generation.

5. **System accessibility**
   Implement role-based access and, where operationally relevant, ensure the interface supports mobile or remote access for field officers and patrol vessels.

The user interface needs to reflect the operational context of the fisheries it supports. This means showing relevant geographic zones, fishing areas and management lines, such as EEZ or areas under national jurisdiction or MPAs, and allowing filters by gear type, flag State or risk indicators. For example, an enforcement officer monitoring purse seine activity in a

[32] International Organization for Standardization, Ergonomics of Human-System Interaction—Part 210: Human-Centred Design for Interactive Systems, ISO Standard No. 9241-210:2019, https://www.iso.org/standard/77520.html.

closed area should be able to see, at a glance, whether a vessel's movement pattern looks like a fishing set. Interfaces should also support timelines or activity summaries that allow staff to reconstruct vessel behavior over hours or days without scrolling through raw data logs. Where the interface can be configured to cross-reference vessel data against licensing and registry information, this significantly increases its operational value, allowing officers to quickly identify whether a vessel is licensed for the gear type or area in which it is operating.

Real-time or near-real-time data only works if the interface keeps up. Authorities need live updates when vessel data is received, with alerts triggered by automated risk indicators. These alerts should be easy to configure and presented clearly in the interface. Where possible, alerts should be linked directly to vessel tracks, allowing quick review of the incident. Interfaces must also be resilient to the realities of data transmission. In many operational contexts, connectivity is intermittent and data may arrive delayed, out of sequence or with gaps. A well-designed interface should handle these realities without losing data or losing the sequence, flagging vessels where data has stopped arriving is a fundamental feature.

A good user interface does not stop at visualizing data. It should also support the operator's workflow from initial suspicion through to action, enabling flagged vessels to be shared between colleagues and agencies in line with standard operating procedures, with data and automated reports easy to download or transfer to other monitoring center systems.

This means tools for tagging events, assigning them to users or teams, leaving notes and exporting relevant data segments. Basic reporting functions that let users generate a summary of a vessel's movements over a given period are essential for building cases and maintaining continuity across shifts, teams and agencies.

Not all operators need the same level of access. Role-based permissions ensure that analysts, enforcement officers and managers each see and can action only what is appropriate to their role, which supports both security and operational clarity. Where the system needs to be accessed beyond the MCS center, for example by patrol vessels, port inspectors or field officers, interfaces should support mobile or remote access even in a limited or read-only form. Systems that support this workflow help ensure that nothing is missed and that data leads to real outcomes.

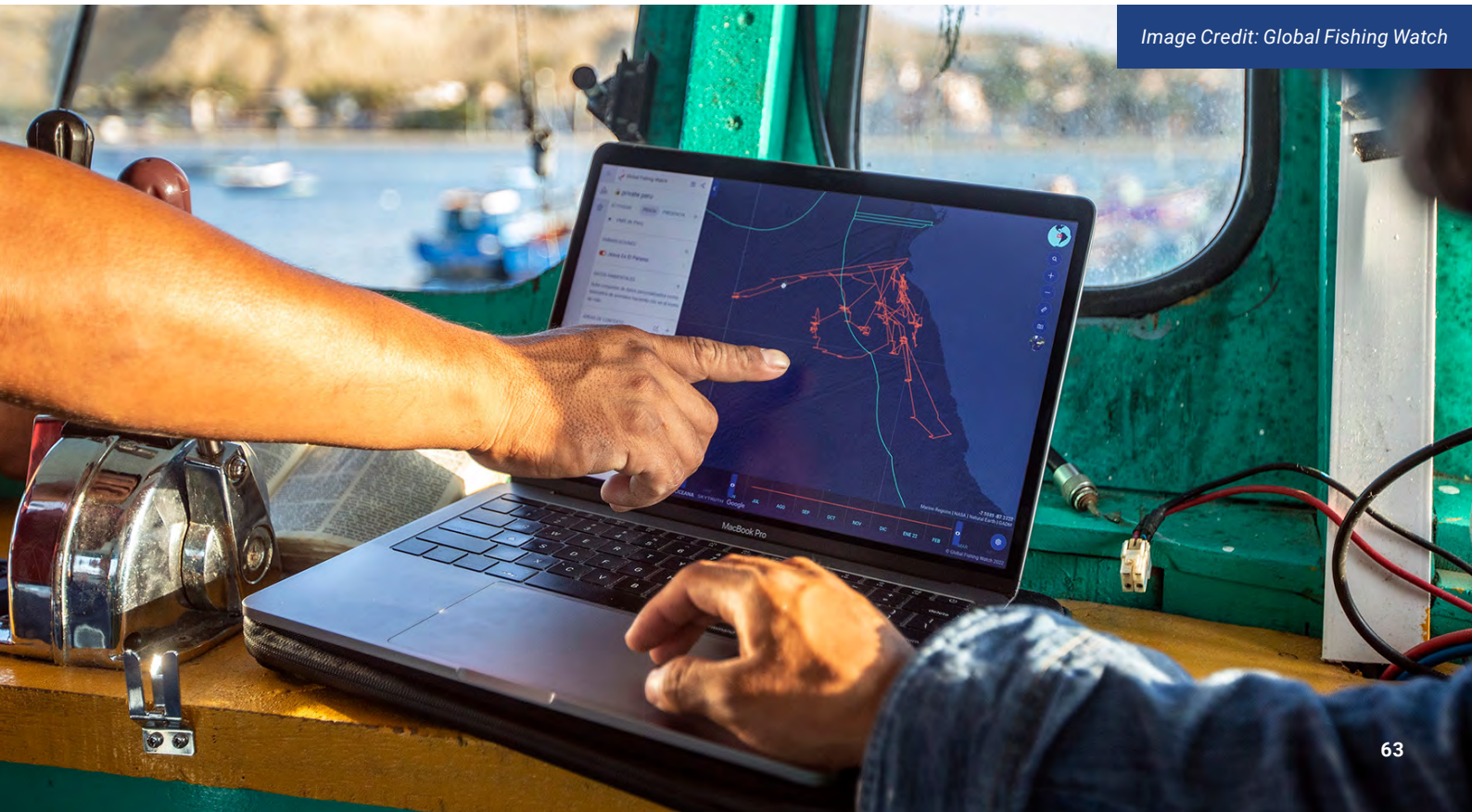


Image Credit: Global Fishing Watch

Polling rates

As vessel tracking technology evolves, updating regulatory standards around polling frequencies and data transmission is vital for effective maritime enforcement.

Recommendations

1. **Frequency regulation**
   Update regulations governing VMS and system implementation to shift to high-frequency polling of 1 to 15 minutes.

2. **Risk-based polling**
   Base polling rates on the duration of the events being monitored, with intervals not exceeding one-quarter of the event duration. Utilize higher polling rate to increase the likelihood of detection.

3. **Transmission decoupling**
   Design systems to decouple the polling rate from the transmission rate. In addition to transmitting regular position reports, ensure devices record high-frequency positional data – for example polling rates of 1 to 15 minutes – and store it on board, with the capability to transmit data in batches or over low-cost networks when available.

The base polling rate refers to how often a vessel tracking system records and transmits positional data. It is a critical design consideration that directly affects the system's ability to monitor vessel activity, detect compliance risks and support enforcement efforts.
The transmission rate refers to how often those recorded positions are sent to shore.

Traditionally the base polling rate and transmission rates were synchronized, a position was recorded and transmitted to shore as one process. It is now possible to treat these two parameters as separate both in the system design and regulatory framework. When they are treated independently, systems can increase the base polling rate to improve the resolution of the data, without necessarily increasing the transmission rate.

High-frequency polling — for example polling rates of 1 to 15 minutes — creates the granular track data needed to reliably detect short-duration activities such as fishing operations, transshipments or entry into restricted areas. Conversely, low-frequency polling, like one to four hours, may miss these events entirely or produce data that lacks the detail necessary for enforcement.

Image Credit: Mark Stebnicki

Image Credit: The Daphne Lens

Setting base polling rates

Optimal polling rates should be set based on:

- Specific activities being monitored
- Typical duration of those activities
- Operational context and risks associated with the fleet

As a guiding principle, polling intervals longer than one-quarter of the duration of the activity being monitored can lead to difficulties detecting those events. For example, if a fishing operation typically lasts one hour, polling should occur at least every 15 minutes to ensure the potential activity can be detected by an analyst or automated process. The likelihood of detection increases with higher polling rates, making vessel tracking data more reliable for use in enforcement actions as well as scientific research.

Low-frequency polling may be sufficient for basic monitoring — for example, whether a vessel is at sea or in port — but it is generally inadequate for detecting compliance-related events like fishing or transshipment. Regulatory frameworks or licensing conditions commonly set default polling rates at one to two hours, and this has been the standard for over two decades. With technological developments, these polling rates are now outdated, and authorities should be setting new rates consistent with the advice above.

Setting transmission rates

Transmission rates should be set according to the risk, not tied to the base polling rate. Low-risk fleets may need only infrequent data transmissions to confirm position and status. Higher-risk fleets, including those operating near MPAs, in dynamic fisheries or under real-time controls, warrant frequent or near real-time updates.

Cost has historically been the driver of low-frequency polling, particularly where satellite charges are passed on to operators. New satellite communication technologies and growing market competition are bringing those costs down, and three hardware techniques further mitigate them while preserving data granularity:

1. **Decoupled recording and transmission.** Devices record at 1 to 15 minute intervals and store positions on board, then transmit on a separate, configurable schedule. This onboard high-resolution record can be required under VMS regulation and used as an additional source of evidence during inspections or enforcement proceedings.
2. **Batch transmission.** Multiple stored positions are compressed into a single message. A device recording every five minutes and transmitting hourly sends 12 positions per message at roughly the cost of one.
3. **Dual connectivity.** Satellite plus GSM or equivalent cellular allows stored data to be offloaded cheaply whenever the vessel is in coastal range.

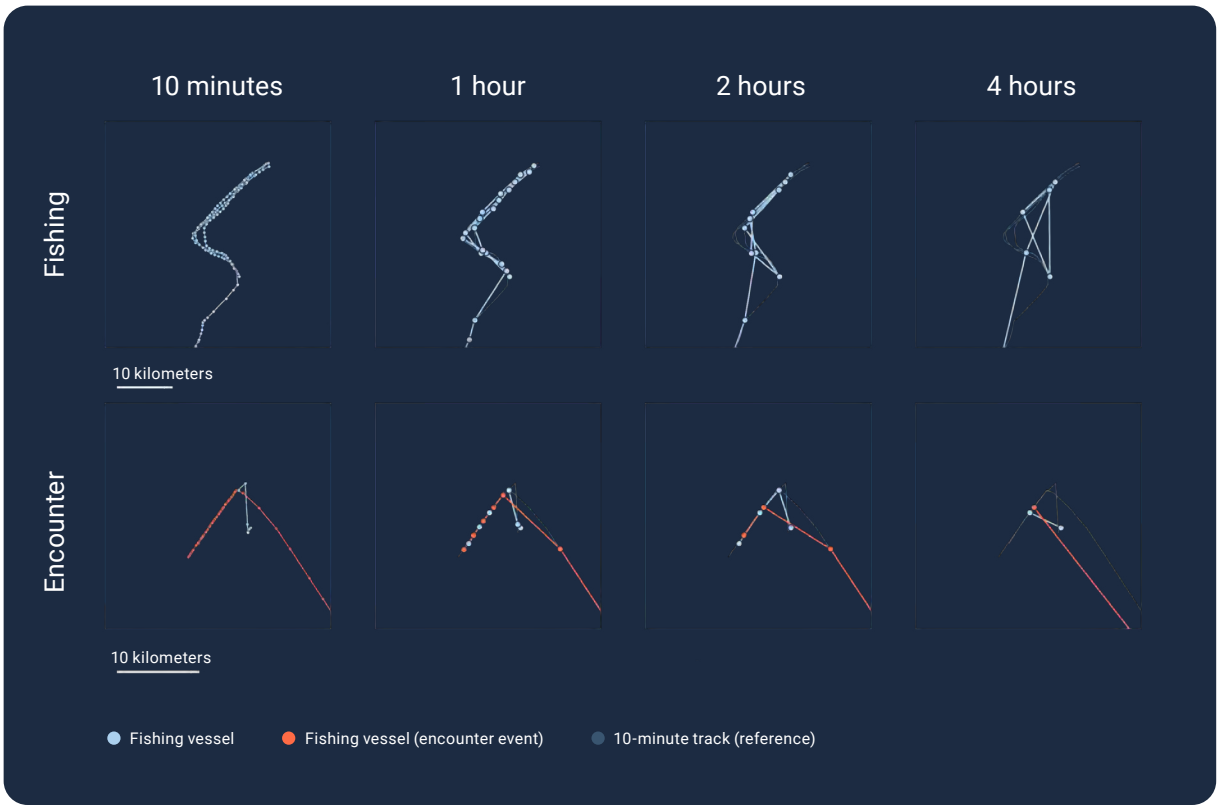
Together these allow regulators to require high-resolution recording without imposing high satellite costs on fishers.

Polling and automation

Accurate automation of event detection, such as identifying fishing or transshipments, depends on sufficiently high polling rates. If the polling rate is too low, automated systems may fail to detect key events or misinterpret vessel behavior. High-frequency polling provides the dense data points needed for effective automated analysis, particularly for short-duration or dynamic activities.

Regularly validating polling rate effectiveness using logbooks, electronic monitoring data or observer reports helps ensure alignment with real-world vessel behavior.

Figure 1. How Polling Rate Determines What Is Detected



The same fishing event and vessel encounter, sampled at 10-minute, one-hour, two-hour and four-hour polling intervals. At 10 minutes both are clearly resolved. Beyond a one-hour interval the activities become significantly harder to detect: fishing turns are reduced to straight lines, making the footprint of the activity inaccurate, and the encounter shrinks to a few scattered points that are easily missed. Higher polling rates markedly improve detection of activities such as fishing and transshipment, while coarser rates risk missing key events.

Source: AIS vessel tracks
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Analytics and automation

With the infrastructure for generating, transmitting and storing vessel tracking data in place, the question becomes what is done with it. In most fisheries monitoring centers (FMCs), the starting point is a live map showing where vessels are. This is useful, but in practice it means analysts watching screens, waiting to spot something that looks wrong. For small fleets, that can work. For large fleets with hundreds or thousands of vessels, it quickly becomes unmanageable. Analysts spend their time chasing transmission gaps and system errors rather than identifying genuine compliance risks.

Automation addresses this, but it needs to be approached carefully. Systems configured with broad, uncalibrated alert rules can generate far more notifications than staff can realistically assess. When analysts are overwhelmed with low-priority alerts, genuine risks get missed. Effective automation is risk-based: alerts should be calibrated to the events that matter, refined through ground-truthing against real outcomes, and matched to the capacity of the team responding to them. The goal is not to automate everything but to ensure that the right information reaches the right people at the right time.

This is also a field where the technology is developing rapidly. Systems and procurement frameworks should be designed with enough flexibility to incorporate new analytical methods as they mature. Countries that build their data infrastructure and interoperability now will be best positioned to benefit from these tools as they become available.

For large fleets, watching a live map doesn't scale. Automation is essential, but it only helps if it flags the things that really matter, rather than creating more alerts than staff can realistically handle.

Image Credit: Jules Clark

Recommendations

1. **Start with basic automation**
   Simple and cost-effective foundational elements include geofencing, so the system alerts when vessels enter restricted areas and speed-based rules.

2. **Scale up with complex algorithms**
   For larger fleets or areas with significant IUU fishing risks, invest in developing complex rules-based algorithms to detect specific events, like potential transshipments or encounters at sea.

3. **Integrate multiple data sources**
   Combine VMS data with licensing, AIS, electronic monitoring and catch reporting systems to improve the reliability and completeness of automated detections. Cross-referencing multiple datasets reduces false positives and enhances credibility.

4. **Incorporate ground-truthing for validation**
   Validate automated alerts against real-world observations from inspections, observer reports or electronic monitoring. Regular validation quantifies detection uncertainty and lets authorities implement risk-based monitoring with less risk of unintended biases in the data.

5. **Establish clear protocols for responding to automated alerts**
   Alerts from automated event-based risk indicators are not definitive evidence, action needs to be proportionate and targeted at gathering more evidence. Develop clear operational protocols for responding to different types of automated alerts. For example, certain geofencing breaches may require immediate action, while low-speed events in restricted zones might warrant inspection at port. Protocols ensure consistent enforcement.

6. **Leverage AI for high-resolution analysis**
   Where resources and data availability allow, deploy AI-driven tools to refine detections and handle complex datasets.

7. **Prioritize customization**
   Tailor automation thresholds and algorithms to reflect the specific behavior of vessels in the fleet, ensuring high accuracy and relevance to regulatory objectives.

8. **Plan for scalability**
   Ensure systems can handle increasing vessel numbers and integrate seamlessly with multiple data sources, such as VMS, AIS and electronic monitoring.

Automated alerts indicate a risk that a specific activity has taken place. They are not definitive evidence and should always be investigated further by an experienced vessel tracking analyst, with additional evidence collected whenever possible.

For large fleets, automation is essential to manage monitoring workloads across complex regulatory frameworks. These solutions must be developed in-house or procured externally, as there are currently no established standards for automating vessel tracking data analysis. This section provides a framework for integrating automation methods into existing systems or incorporating them into procurement requirements.

Automation methods

Automation methods in vessel tracking exist along a spectrum. At the simpler end, tools like geofencing and speed-based alerts are quick to implement and effective for basic monitoring, though they can generate false positives that require manual review. More advanced systems combine multiple data points such as vessel speed, location and proximity to detect specific activities like transshipments, reducing false positives by applying more precise thresholds. At the most sophisticated level, AI and machine learning can analyse vast datasets to detect complex patterns such as gear-specific fishing behavior or anomalies in a vessel's typical movement patterns. These models require more resources and high-quality training data but offer analytical capability that scales across large fleets.

It is recommended to begin with a user and context analysis to identify which tools and methods will be practical to implement and maintain. Starting with simpler approaches allows agencies to build experience and refine their processes before adopting more complex methods as data systems and institutional capacity mature. Ground-truthing and regular review of detection logic, including any algorithms, is essential for improving accuracy, reducing false alerts and ensuring the system remains calibrated to real-world vessel behavior.

Basic automation

Essential automation features form the foundational tools of an effective vessel monitoring system, enabling fisheries authorities to monitor vessel activity efficiently. Features such as geofencing and speed-based alerts provide the critical functionality needed to detect and respond to potential compliance issues in real time.

Table 12. Geofencing

Sets virtual boundaries around specific areas and generates alerts when vessels enter or exit those areas.
Applications: Essential for monitoring restricted zones such as MPAs, inshore exclusion zones or foreign coastal State waters.
Limitations: Geofencing alone may result in numerous false positives, particularly in cases where vessels transit through restricted areas without conducting prohibited activities. For instance, vessels crossing an exclusion zone to reach permitted fishing grounds may still trigger alerts.

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Table 13. Speed-based Automation

Uses vessel speed as an indicator of activity, such as fishing. Alerts can be refined by combining speed thresholds with geofencing.
Applications: Helps identify suspicious or prohibited activities in restricted zones by monitoring speed variations, such as slower speeds that can indicate fishing operations.
Limitations: Reduces false positives compared to geofencing alone, but some activities other than fishing – for example, engine maintenance – may result in similar speed profiles, requiring additional validation.

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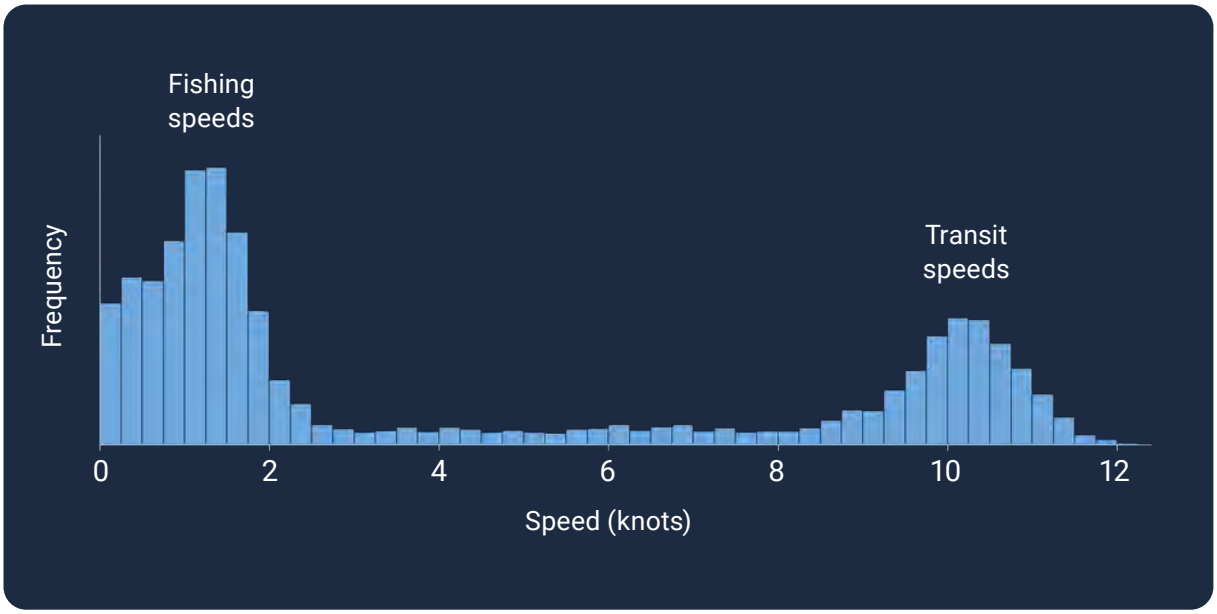
Figure 2. Vessel Speed Analysis



Plotting a year of speed values for a single fishing vessel produces two peaks, a lower one at fishing speeds and a higher one at transit speeds. This separation is what lets a simple speed filter distinguish likely fishing from passage, although on its own it can also flag slow non-fishing movements as false fishing alerts.

Source: AIS vessel tracks
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Table 14. Complex Algorithms

Advanced algorithms that incorporate multiple data fields — such as speed, location or direction — to detect specific events, like encounters between vessels at sea.
Applications: Can detect specific activities. For example, thresholds could be set to identify two vessels being within 500 meters for at least one hour at speeds below two knots as potential transshipment.
Limitations: Can be resource-intensive and require customization to align with the behavior of vessels in the monitored fleet. Significant computing power may also be required for large datasets.

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Advanced automation

Advanced automation features use sophisticated algorithms and machine learning to analyze complex datasets, detect nuanced vessel behaviors and adapt to evolving compliance challenges. These capabilities enhance the precision and scalability of fisheries monitoring systems.

Table 15. AI And Machine Learning

AI models analyze vast amounts of tracking data to automatically detect patterns or events that indicate apparent gear deployment, hauling or fishing within restricted areas. Development requires large volumes of labeled training data, where subject experts have identified specific events from tracks. Algorithms are refined using verified events to improve accuracy.
Applications: AI can increase confidence and detect subtle patterns in track data, such as gear-specific fishing behaviors.
Limitations: Requires significant resources to develop and train algorithms. Models must also be continuously updated with new data to adapt to evolving fishing practices or compliance requirements and need to be interpreted with caution, as all models have a degree of error and indicators of possible activities that need to be confirmed by other means.

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Image Credit: Charles Kilgour

Event-based risk indicators

Applying a risk-based approach to monitoring, control and surveillance enables authorities to focus limited resources on the vessels, areas and activities that present the greatest likelihood of noncompliance. Risk indicators highlight identity, historical and behavioral factors that suggest where compliance risks are most likely to occur. They can be derived from various sources, including vessel licensing and ownership data, catch and effort records, inspection results, compliance history and movement patterns detected through tracking systems. This section focuses on the automated detection of event-based risk indicators from tracking data.

Any interpretation of tracking data carries some degree of uncertainty, but many movement patterns can be associated with specific activities, often with a high degree of confidence. When a vessel's behavior matches a known pattern – for example, slow speeds and distinct movement patterns – the system can flag this as a noteworthy event for further investigation.

Automated alerts based on vessel behaviors and anomalies can help prioritize enforcement activities such as patrols, port inspections, licensing decisions and vessel investigations. Common regulated events that can be detected automatically include vessel departures from or arrivals to port, entry into or exit from restricted zones, gaps in tracking transmissions and potential transshipment activities at sea.

Automation of these indicators can be introduced in phases, starting with what trained analysts already detect reliably in manual workflows and building from there.

Vessel tracking compliance indicators

Transmission gaps

Gaps in transmission occur when a vessel's tracking signal — VMS or AIS — unexpectedly stops for a significant duration. A prolonged silence in transmissions could indicate a number of outcomes, including that a vessel has turned off its tracking device, gone out of coverage or faced a technical issue.

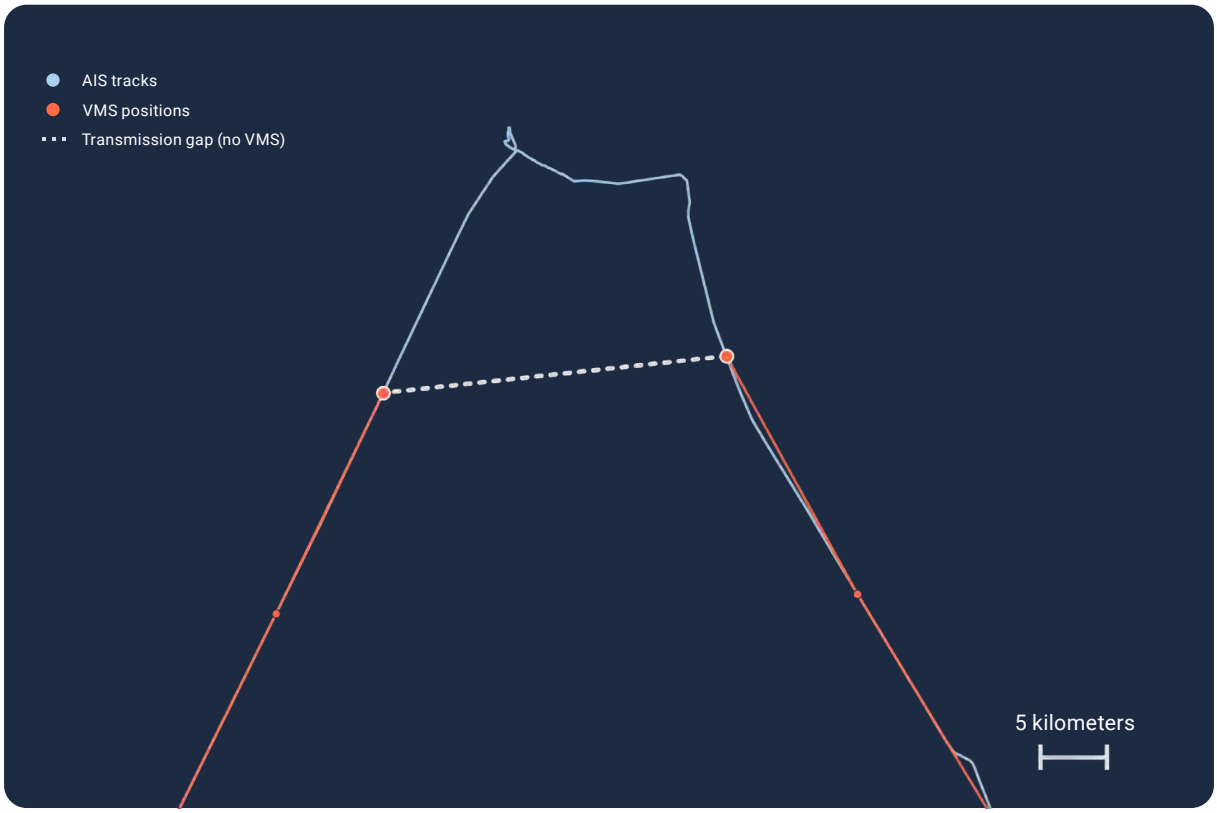
Basic systems can trigger an alert if a vessel fails to report beyond a set time threshold.

More advanced systems assess the context of the gap, for example by noting the last known location in reference to restricted areas, along with the duration of the gap and the distance between the start and end locations.

Frequent or unexplained transmission gaps, especially near sensitive areas, are treated as high-risk indicators since they may suggest intentional disabling of tracking to hide unauthorized activities.

Gaps in VMS or AIS transmissions can result from either deliberate disabling or limited satellite or coastal coverage. Understanding these coverage patterns helps determine the likely cause of missing data. Comparing VMS and AIS data allows authorities to identify vessels that deactivate one or both of the systems near restricted zones, highlighting potential noncompliance or high-risk activity.

Figure 3. VMS Transmission Gap



The vessel's VMS positions (orange) stopped for around six hours (grey dotted line), yet its AIS continued to track it throughout (blue) and behavior consistent with purse seine fishing can be seen. Cross-checking the two independent tracking systems reveals the gap.

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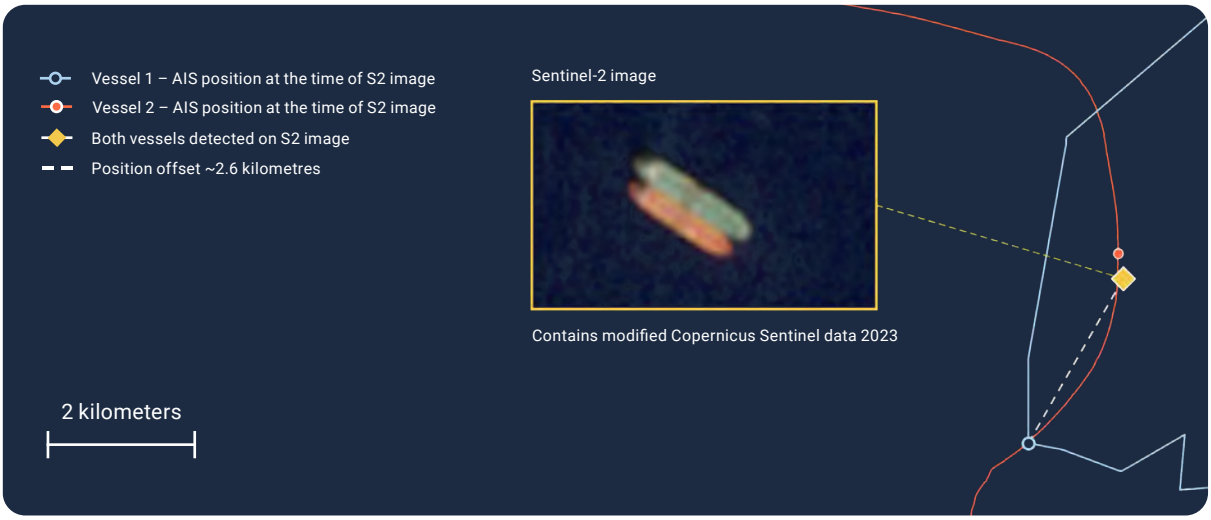
Position tampering
Positional falsification techniques used outside fishing are ahead of what is currently seen on fishing vessels. They are worth understanding now because the same techniques are likely to reach the sector, and detection systems built today should be designed with that in mind.

A global tanker fleet, largely driven by sanctions evasion pressure, now broadcasts realistic computer-generated tracks that no longer show obvious technical errors. Matching reported AIS data against the footprint of the satellite receiving the signal to ensure they match or reviewing satellite imagery has proven highly effective at identifying vessels broadcasting more subtle false locations.

An indicator is a reason to look closer, not a finding of guilt. It flags risk so authorities can target scarce resources, but it still needs to be checked against other evidence before any action is taken.

Third-party GNSS interference is a parallel and growing problem, affecting tens of thousands of vessels, particularly in areas of military conflict. Devices that cause interference with GNSS receivers generate distinctive spatial patterns such as perfect high-speed counterclockwise circles centred on suspected coastal interference devices, with vessel positions jumping abruptly to inland airports or to coastal infrastructure like oil terminals in the Black Sea and Persian Gulf.

Figure 4. Detecting False Track Positions



A Sentinel-2 image detected both vessels together at a single location (yellow diamond), yet Vessel 1's AIS reported a position around 2.6 km away (blue). This falsified position was exposed by cross-checking the vessel's broadcast position on AIS against the satellite imagery.

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Positional falsification should not be seen simply as a problem with vessel tracking. When a vessel is found to be falsifying its position, it raises an immediate red flag for authorities. Investment in detection pays off in both cleaner data and sharper enforcement targeting.

Basic detection checks for impossible travel speeds between points, for example a vessel "teleporting" hundreds of miles in a short time. More sophisticated methods identify position spoofing, where the reported position falls outside the footprint of the receiving satellite.

Multiple vessels with AIS transponders using the same MMSI can also cause systems to confuse a vessel's true location, this is also detectable and solvable by enforcing rules on use of unauthorized MMSI.

Imagery from optical or synthetic aperture radar satellites can detect vessels at sea even when they are not broadcasting a position or are broadcasting a false one, providing a way to validate reported locations and identify tampering.

Port activity indicators

Port arrival and departure
Automated geofencing around ports detects vessel entries and exits. When a vessel crosses a defined boundary, the system records an arrival or departure event. This supports port State controls by providing near-real-time information on vessel movements.

Basic systems trigger alerts upon crossing geofences, but a geofence needs to be created for each relevant port.

Advanced systems validate entries and exits against declared port-in or port-out requests or for foreign vessels submitting port entry requests.

Figure 5. Understanding Different Types of Port Stops

However port stops are detected, it is necessary to know where vessels actually stop. A port call can mean berthing alongside the quay (square) or stopping within an anchorage (anchor), and both need to be captured. Here a single geofence (green) encompasses all port areas, so that either type of stop is detected.

Land source: ©OpenStreetMap contributors
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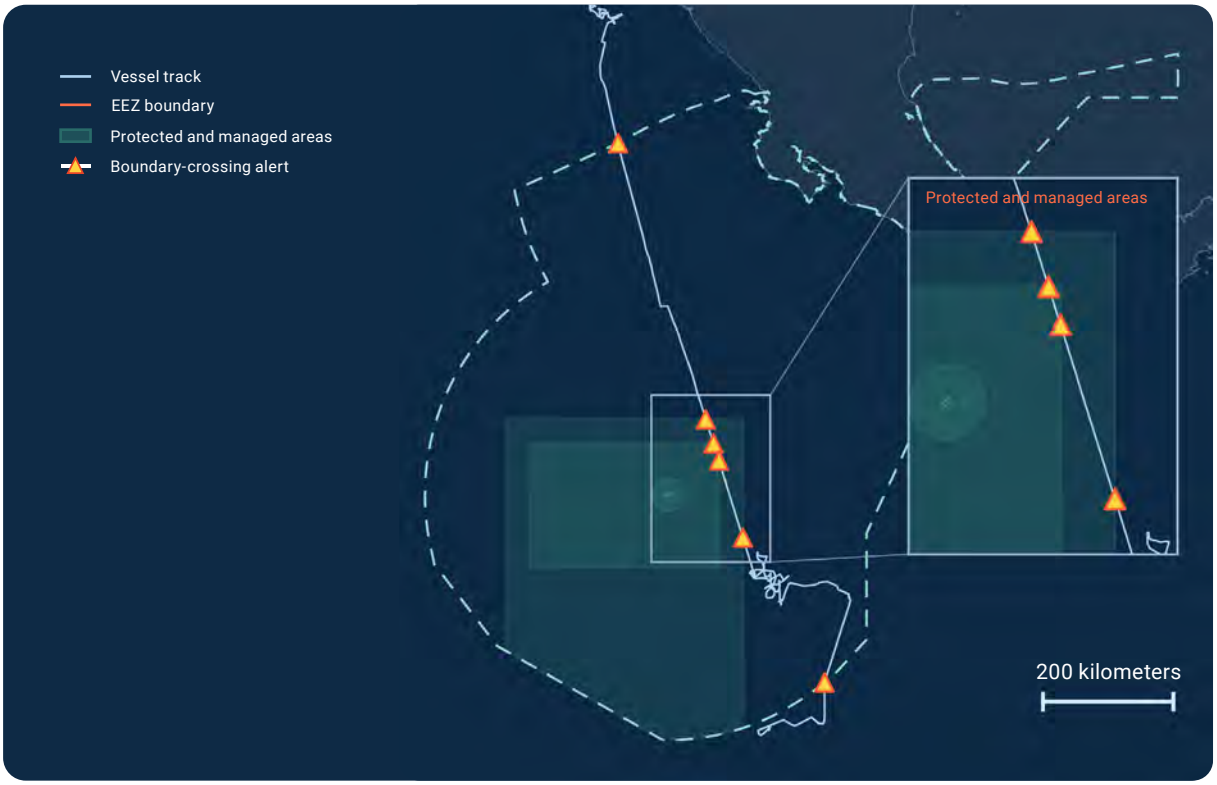
Restricted area indicators

Zone boundary crossings
Automated systems track when vessels cross into or out of regulated maritime zones, such as EEZs or areas under national jurisdiction, MPAs, inshore exclusion zones or RFMO areas. Alerts are triggered when a vessel enters or exits a mapped boundary.

Simple geofencing detects crossings and can create real-time alerts within the system. Advanced systems also cross-check each boundary crossing with the vessel's permits or authorizations. For instance, if a vessel enters a protected area, the system immediately verifies if it has the required permit. If not, the incursion is flagged for investigation.

To reduce false alarms from innocent passage, such as vessels transiting through an EEZ or areas under national jurisdiction, speed filters or fishing activity detection models can ignore fast transit and focus on vessels that slow down to operate within the zone.

Figure 6. Geofenced Alerts for Protected Areas



Geofencing systems automatically generate real-time alerts when vessels cross maritime boundaries. These notifications prompt analysts to verify a vessel's activity and licensing. With protected areas, EEZs, and RFMO management zones now covering most of the ocean, these geofenced alerts serve as a primary trigger for maritime compliance.

Land source: ©OpenStreetMap contributors
Other sources: EEZ: Flanders Marine Institute (2023), marineregions.org;
MPAs: UNEP-WCMC and IUCN (2026), Protected Planet (WDPA/WD-OECM);
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Fishing activity indicators

Fishing activity detection
These indicators infer when a vessel is actively fishing based on its movement patterns. Detecting potential fishing events is crucial for monitoring compliance with closed seasons and area restrictions.

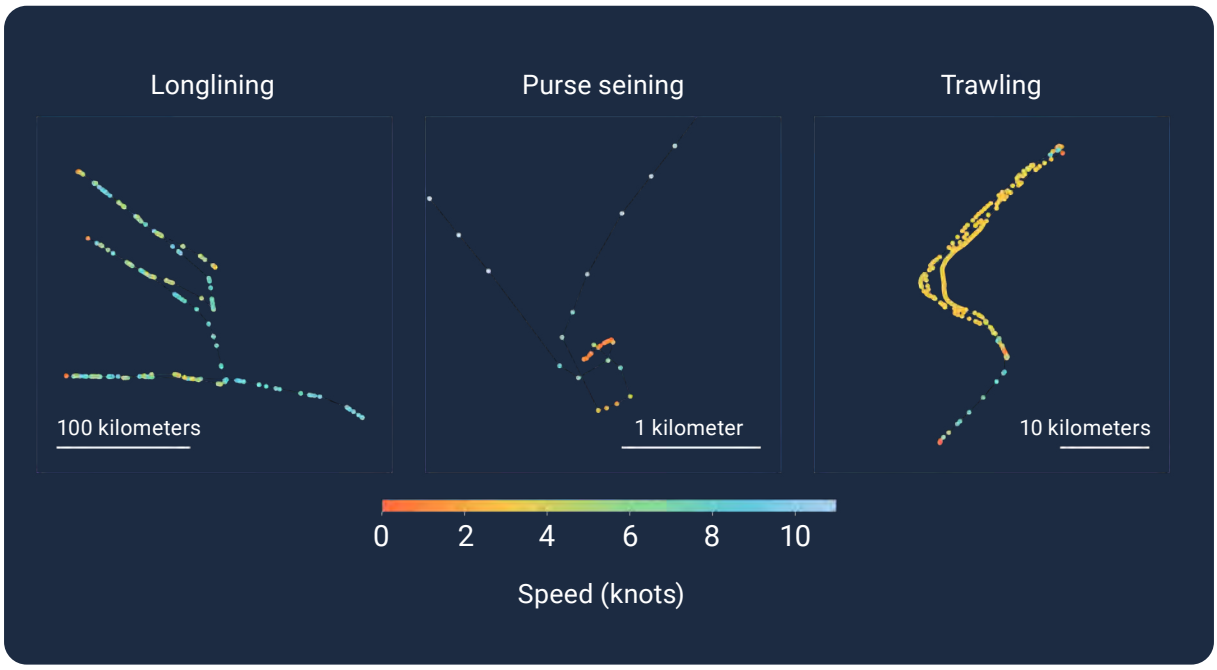
A basic approach is to set a speed filter. In addition, a common proxy for fishing is a vessel moving at typical fishing speeds, often 1 to 5 knots, but this needs to be specific to gear type. While this simple method helps identify likely fishing behavior, it has a tendency to misclassify other slow movements as fishing.

More advanced analytics use machine learning models or sophisticated rules that take into account not just speed, but also factors like course changes and vessel type, to better distinguish true fishing activity. Such models can even be trained to recognize patterns specific to different fishing gear, for instance, trawling compared to longlining, for improved accuracy.

High-frequency position data from AIS or high-frequency VMS can improve the reliability of fishing detection, since it provides finer detail on the vessel's movements.

Identifying which type of fishing a vessel is engaged in, not simply whether it is fishing, generally requires complex algorithms and machine learning models, and is made more difficult by the way gear and methods vary across global fleets. Each gear type nonetheless leaves a characteristic movement pattern, shown here with color indicating speed.

Figure 7. Detecting Different Fishing Methods



The longliner (left) shoots its line, which can extend to 100 kilometers on the largest vessels, at higher speed and then follows a slower pattern as it hauls back along it. The purse seiner (center) can run in at high speed, a possible sign of targeting fish aggregation devices, before slowing into the looped set and haul of the net. The trawler (right) tows at a steady low speed, with faster runs between successive tows.

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Transshipment indicators

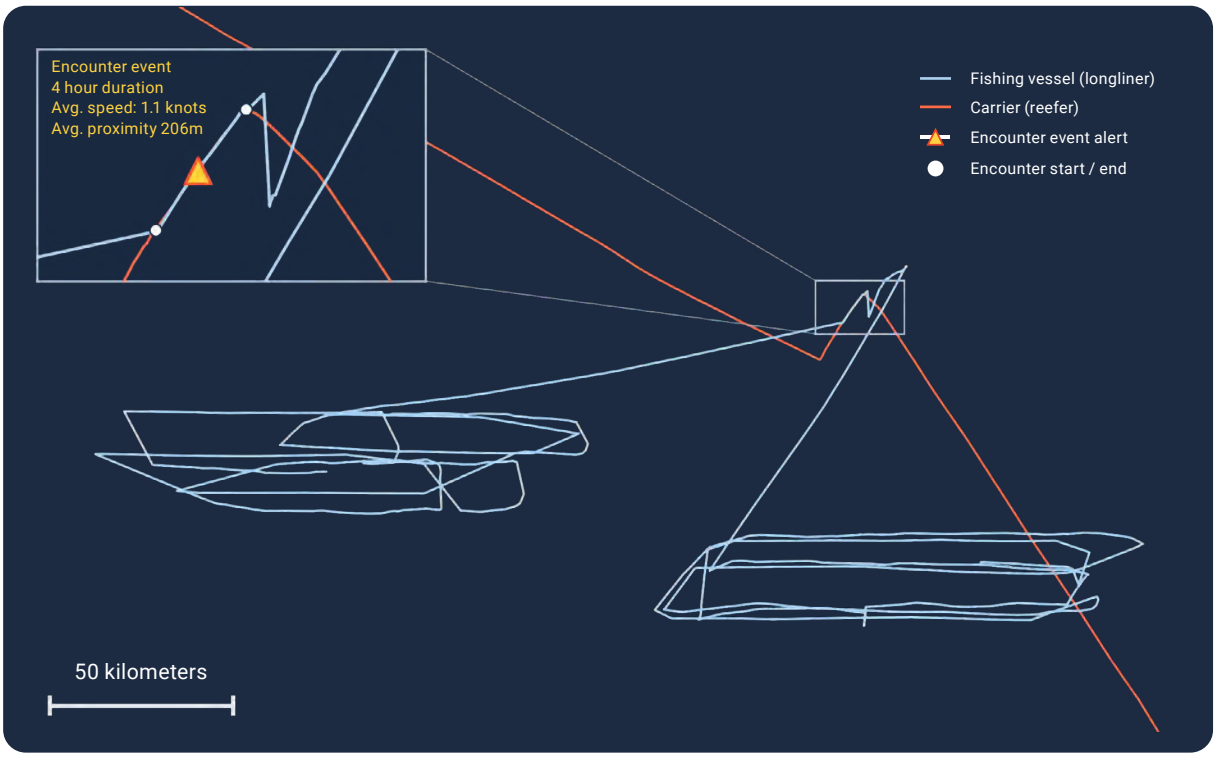
Transshipment involves a fishing vessel transferring its catch to a refrigerated cargo ship, often referred to as a reefer, or another vessel at sea. Transshipment can facilitate IUU fishing and other illicit activities, so it should be treated as a high-risk event. Automated indicators target two main patterns associated with transshipment: encounters and loitering.

Encounter events

An encounter occurs when two vessels come together at sea or in port for a period of time, typically involving a fishing vessel and a carrier — a transport vessel used to collect and refrigerate catch at sea. The system can detect encounters by identifying two vessel signals in close proximity for an extended duration. A simple proximity alert might be set off whenever any vessels are very near each other, but this can yield many false positives because fishing vessels often operate near one another legitimately.

To improve reliability, advanced detection algorithms apply specific thresholds. For example, vessels may need to be within a defined range of a few hundred meters for several hours, and maintain compatible speeds and courses before an encounter is flagged.

Figure 8. Detecting Vessels Meeting at Sea



When two vessels stay within 500 meters for over two hours at low speed and away from port, Global Fishing Watch flags an encounter event — as in this example (~200 meters apart, for a duration of four hours, traveling at ~1 knot). Cross-checking these against declared transshipments is an effective way to validate reporting and identify potentially unauthorized transshipments.

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Loitering events

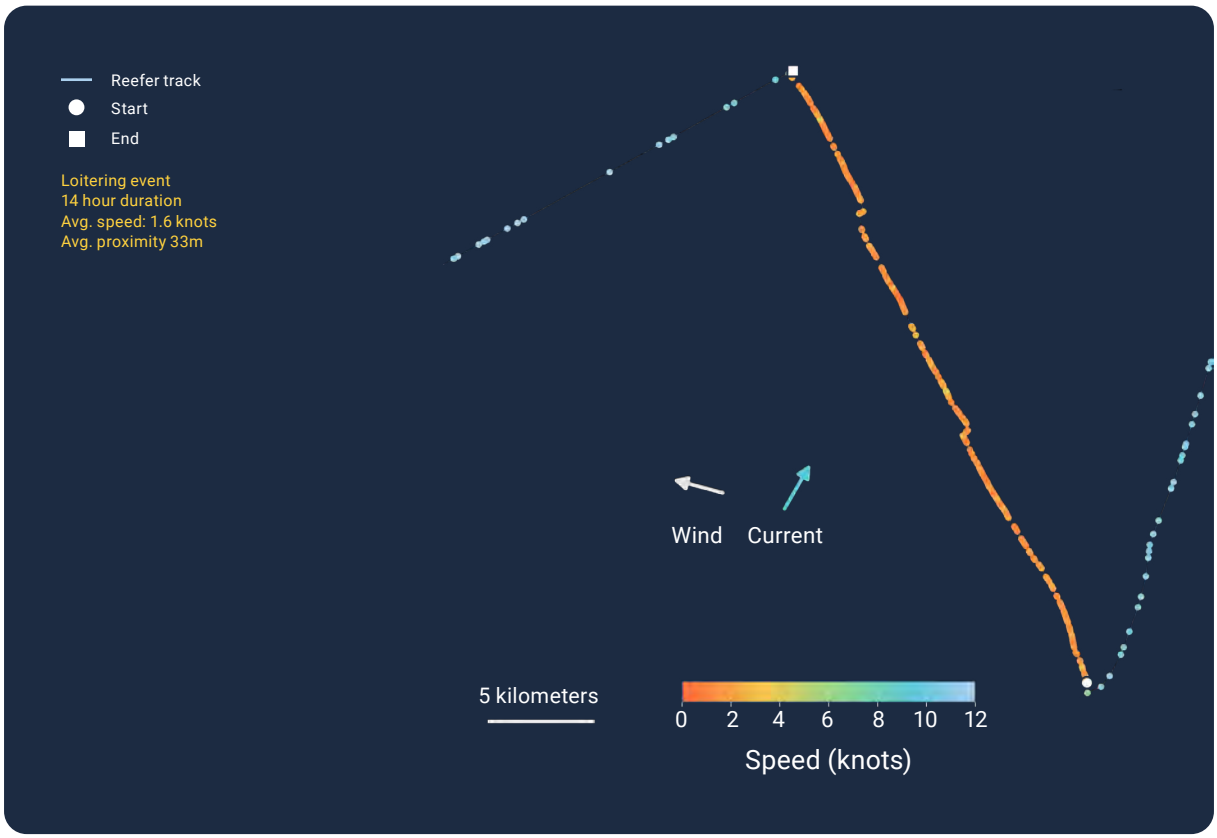
Loitering refers to events in which a single vessel, typically a fish carrier, drifts or waits at sea in a manner consistent with an encounter, but no other vessel is detected. This could indicate transshipment involving another vessel that lacks a tracker or has disabled it.

In this case, the carrier's behavior alone is the indicator. The system detects loitering by identifying when a vessel remains in one area, moving slowly or not at all, for longer than normal operational patterns.

A basic rule might flag any carrier vessel that suddenly slows down or circles in the open ocean outside of port. More refined detection looks at the vessel's speed profile, course

consistency and duration of the stop to differentiate purposeful loitering from, say, a vessel simply waiting to enter a port.

Figure 9. Detecting Vessels Loitering at Sea



Loitering events flag when a vessel operates away from shore at low speed, behaving as it would during a transshipment – stationary or drifting slowly – but with no other vessel visible on tracking systems. These are not evidence of a transshipment, but rather an opportunity where an encounter could have occurred.

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Each of these event indicator types, whether simple (rules-based) or advanced (algorithmic or AI-driven) contributes to a comprehensive automated monitoring system. By combining multiple indicators, authorities can build a robust picture of vessel behavior and focus their limited resources on the most suspicious or noncompliant activities.

Image Credit: Charles Kilgour

Case study: Risk indicators in PSMA AREP assessment

The Port State Measure Agreement requires every foreign-flagged fishing or carrier vessel requesting entry to a designated port to submit an Advance Request for Entry to Port (AREP). Authorities must verify identity, check whether the catch was lawfully taken and decide whether to authorize entry, deny entry or allow entry but inspect on arrival. With limited inspection capacity, AREPs need to be triaged quickly and consistently. Automated risk indicators built from satellite tracking and vessel identity data make that possible.
A risk-based AREP assessment typically draws on a small set of automated risk indicators that can be reviewed before arrival:

1. Identity and authorization mismatches against vessel registries, RFMO authorized vessel lists and IUU lists.
2. Flag and ownership behavior, including frequent reflagging or flags of convenience.
3. Validation of reported fishing activity, port stops and transshipments from tracking data can surface potential unreported activity.
4. Vessel tracking performance, particularly long gaps near MPAs, EEZ boundaries or transshipment hotspots.
5. Pre-port activity, including apparent fishing in unauthorized waters, encounters at sea and loitering patterns.

Each indicator is scored against a national risk matrix to produce a single classification the inspector can act on. Where indicators show the vessel is IUU-listed or has falsified its identity, the port State can deny entry. Where indicators flag specific suspicions, the AREP is approved but the vessel is targeted for inspection with inspectors briefed on exactly what to verify. Where indicators are clean, the vessel is cleared with routine checks, freeing capacity for higher-risk visits.

Vessel tracking analysis, cross-checked against documentation and shared through regional cooperation, can convert risk indicators into enforcement action.

Since 2021, TMT and Global Fishing Watch have been piloting this approach with fisheries and port authorities in Côte d'Ivoire, Ghana, Kenya and Senegal, using the jointly developed Vessel Viewer tool, which combines vessel identity data with AIS-derived activity. In one case, manual analysis of AREPs by Ghana and Côte d'Ivoire surfaced indicators of unauthorized transshipment in the Angolan EEZ between a Bahamian-flagged reefer and several Cameroonian-flagged pelagic trawlers. Information shared between members of the Fisheries Committee for the West Central Gulf of Guinea's, West Africa Task Force, and with Angola through the Southern African Development Community MCS Coordination Center, confirmed the illegal activity. Angola sanctioned all vessels involved as the coastal State, and Cameroon followed up by sanctioning the donor trawlers as flag State.

This case study illustrates how vessel tracking analysis, cross-checked against cargo and transshipment documentation and shared through regional cooperation mechanisms, can convert risk indicators into enforcement action across multiple jurisdictions. From building manual processes the work has progressed to automating common indicators, like possible transshipments, to help turn the AREP from a paperwork exercise into a screening process that can flag high-risk vessels for inspection or denial of entry. In this case, port authorities focused their scarce inspection capacity — which requires cross-checking multiple data sources — on vessels most likely to be carrying illegal catch.

Image Credit: Doğan Alpaslan Demir

Section 3

Costs and legal considerations

This final section covers operationalizing vessel tracking, from the costs of building and sustaining a system to the legal framework that underpins it. Even the most technically advanced system will underdeliver if it is not appropriately resourced and backed by a sound legal grounding that enables the data to inform decision making and enforcement.

Costs of vessel tracking systems

Deciding who pays for a vessel tracking system and how can be challenging. Decisions need to be made early in the process, and costs carefully calculated so adequate funding is secured and negotiated contracts can be appropriately financed. These are practical and political considerations driven by many localized issues, with no single best approach. As with other decisions, governments should determine what is appropriate in their particular situation. This section will outline what elements need to be factored into the cost equation.

Recommendations

1. **Provider contracts**
   Negotiate comprehensive contracts with providers that include all current and future anticipated services, to avoid unexpected costs or service gaps.

2. **Funding identification**
   Ensure adequate and sustainable funding to develop and operate vessel tracking systems in the long term.

3. **Cost model**
   Determine financial responsibilities and cost allocations. This choice is context-specific but involves a number of common issues.

4. **Cost calculations**
   List costs in a realistic and comprehensive way, which include more than the initial purchase and installation of individual units. Additional and ongoing costs include repair and replacement of units, VMS and AIS communications, staffing and capacity development, operations and analytical tools, operation of a monitoring center, and future growth and changes.

5. **Cost sensitivity**
   Be sensitive to costs passed to fishers and incorporate incentive models to encourage compliance whenever possible.

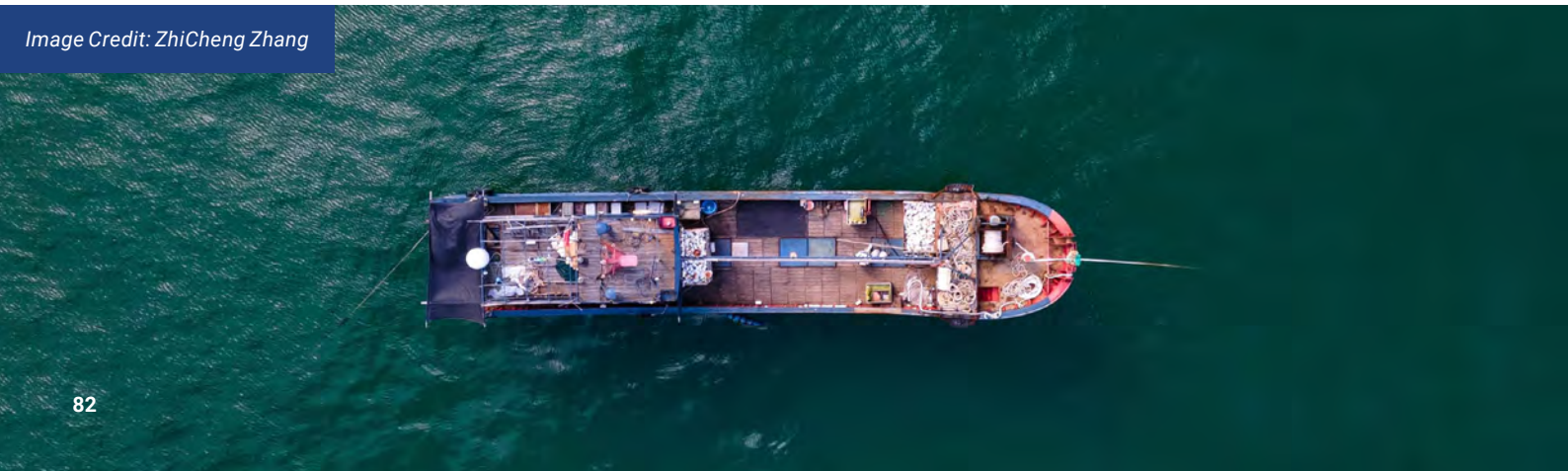

Image Credit: ZhiCheng Zhang

For governments, it is essential to identify stable funding to pay for the costs of setting up and operating a vessel tracking system. This is not a one-time expense but a series of ongoing costs, outlined below, that will be subject to many variables. Deciding who pays for the system, units and communication costs, is influenced by local conditions such as the fishery involved, its problems, its health and stock status and that of the community involved. Therefore, there is no universal best practice that will work for everyone.

Costs associated with vessel tracking systems include:

- **Choosing the system:** determining what system or systems to use, what they need to do, technical specifications and testing.
- **Type approval:** setting technical standards, independent testing of the equipment, certification and periodic audits of providers and systems, public and legal processes.
- **Onboard units:** initial procurement, which includes installing, replacing and repairing the units and associated travel costs; engineers or other technical professionals certification and documentation; securely storing the units before installation.
- **Data transmission:** sending VMS data (costs will vary depending on how much data is sent and how frequently); purchasing AIS equipment and receiving AIS data may involve fees. Running both VMS and AIS should not result in a doubling of costs.
- **Operational infrastructures:** AIS is broadcast by vessels and received via antennas, often operated by governments. This covers approx 30 kilometers from shore and some areas are not well covered. There are also commercial satellite operators, if required, that receive AIS signals. These operators sell the data.The operators also aggregate the AIS data from terrestrial receivers as part of what they offer for sale. States and others can buy this.
- **Training and capacity development:** initial training, periodic troubleshooting and updated training from the provider. Staff will be needed to operate the FMC, conduct analysis, carry out their duties and receive and provide training. These staff will also need to be skilled in processing large quantities of data and be trained to analyze it. Automation and the level anticipated will also influence costs. Contract provisions with the service provider should address the need to train government personnel, not only at the start of the contract. Consider training for private sector users.
- **System evolution and long-term planning:** while current usage provides a solid baseline, systems require ongoing maintenance, updates and continuous evolution. These should be planned for both in contracts and in budgets, along with staff and training needs.
- **Setting up and running a fisheries monitoring center/data analysis unit:** physical space, equipment, software, staffing and associated costs. These responsibilities may fall across multiple agencies – fisheries, transport, coast guard or navy – so those responsible for managing the data and operating the monitoring center should be clearly defined.
- **Service provider(s) contracts.**
- **Developing and maintaining the user interface:** making it compatible with new browser versions, fixing bugs, in-house software developers or outsourced, platform hosting.
- **Costs associated with the automation:** computing and infrastructure costs – data storage, ingestion, processing, archiving – *ad hoc* data analysis, automated reports and alerts; specialist data and machine-learning personnel (staff or consultants).
- **Provider and system compliance:** certification of providers and their systems, periodic audits of providers and the systems and any other recurring or one-time costs.
- **Drafting costs:** costs associated with drafting needed by legal authorities, such as creating an AIS requirement.
- **Legal enforcement:** pursuing legal cases based on vessel tracking data.

The government must determine its level of cost subsidy — whether funding all, none or a portion of these expenses — and establish long-term budgetary plans accordingly. For example, a government may decide to pay for the onboard vessel tracking units and related equipment. Before making any announcement, it should be clear about how much it is prepared to pay, which vessels will qualify and how they will apply. Careful planning is needed to avoid a scenario where the provider increases its unit price before payments have been made, imposing an unanticipated cost on the vessel owner or fisher.

While a high polling rate is important, transmission can be less frequent to reduce costs.

No average cost per unit is included here, as it varies by provider, features and class. Governments need to think carefully about what information they require, their own capacity to handle and utilize data, and how things may change as the technology continues to evolve.

In addition to their own costs, governments should be sensitive to the costs paid by fishers or system users, and consider how to mitigate these costs. For example, fishers are likely to bear the cost of transmitting VMS polling data. While a high polling rate is important, transmission can be less frequent to reduce costs; where more frequent transmission of polling data is needed – if a vessel enters a closed area – the system can trigger this automatically.

Governments can also provide incentives in the form of subsidies or cost offsets for fishers who comply with VMS requirements. This option is similar to an indirect cancellation or reimbursement of the fisher's purchase cost.

Costs associated with AIS data

While AIS does not carry per-transmission costs like VMS, it is not free to operate. Hardware must be purchased and installed, with costs varying by device class, periodic certification, and replacement costs apply as with VMS units.

The more significant cost relates to data access. Investing in inshore-based AIS receivers supports wider maritime domain awareness, but these typically cover only 20 to 25 nautical miles and coverage can be uneven. For monitoring vessels further offshore or accessing comprehensive historical data, countries need additional sources. Commercial AIS providers sell data from satellite constellations that receive AIS globally and sell this data either as raw feeds or through monitoring platforms, and ongoing subscription costs can be substantial. Some governments access AIS data through arrangements like the U.S. SeaVision program or Skylight, a tech-for-good platform that combines real-time AIS with satellite imagery and has limited free access for government agencies. Limited or delayed data is available at no cost through platforms like MarineTraffic and Global Fishing Watch, though at the time of writing these can provide strong historical analysis, but they do not replace the real-time feeds needed for operational enforcement. Countries with their own receiver networks may also negotiate data-sharing arrangements with commercial providers, exchanging coastal data for access to broader satellite-derived datasets.

Raw AIS data requires significant processing before it is useful. The data contains gaps, duplicates and identity mismatches that need cleaning, which requires technical capacity that should be factored into costs if this is not managed by the provider. Fisheries agencies should coordinate with navies or coast guards that may already have access to AIS feeds or receiver infrastructure, avoiding duplicated procurement. When budgeting for AIS, authorities should also account for the costs of integrating AIS into existing VMS or MCS platforms.

Legal processes, legislation and regulations

This section outlines the legal considerations that underpin effective vessel tracking systems. It addresses legal steps that may be required in setting up a system, ongoing legal considerations and existing legal provisions pertinent to vessel tracking. It discusses the sorts of legal requirements that need to be codified to spell out obligations, prohibitions and possible consequences. It also explores the realities of using vessel tracking evidence in prosecutions.

Recommendations

1. **Technical specifications**
   Establish technical specifications that providers of units and services need to satisfy, including security standards and ensuring units are tamper-resistant. Include these in legal or regulatory provisions to ensure tracking units meet these requirements to be certified as an approved provider.

2. **Legal frameworks**
   Use specific legal or regulatory provisions to clearly set out vessel tracking requirements. These should specify who is required to comply and when, what information must be collected, how and to whom it must be provided, required formats and procedures to follow in the event of system malfunction. Where possible, use participatory processes to allow input from fishers and other stakeholders.

3. **Certification processes**
   Develop a testing, piloting and certification process, being conscious of time limits and effective dates for each portion and how they work together as part of a larger process.

4. **System compatibility**
   Address compatibility issues between systems when working with multiple providers; require uniform data formats and consistency with other data elements.

Image Credit: Quang Nguyen Vinh

5 **Legal clarity**

Ensure legal provisions comprehensively define all obligations and prohibited acts related to vessel tracking. These provisions must clearly articulate the responsibilities of regulated entities and the consequences or sanctions for failing to meet them. Provide guidance to help regulated sectors understand and meet their obligations.

6 **Legal alignment**

Consult relevant existing laws or provisions — such as those governing data collection and handling, evidence rules, due process and constitutional provisions — and take these into account when developing specific vessel tracking legal provisions. Re-examine any existing confidentiality provisions, given the growth of monitoring technology and the government's responsibilities to manage marine resources in the public interest.

7 **Data transparency**

Share data generally and make it publicly available whenever possible. Incorporate into national legislation any obligations and requirements on vessel tracking derived from RFMOs and international instruments, if applicable. This includes AIS operational standards, as adopted by the IMO, where applicable.

8 **Legal presumption**

Where permitted within the national legal system, establish a legal presumption of accuracy and reliability for VMS data — a statutory mechanism that allows a judge to accept the data as evidence without requiring foundational proof in every instance.

Image Credit: Alain Margreve

Establishing the framework

Legal requirements need to be considered in the early stages of system development and as the system progresses, along with considerations for ethical handling of data.

Step 1: Technical standards and certification
The first step is to identify and publish technical requirement standards as legal requirements. This includes establishing a testing and certification process for VMS and AIS units.

Step 2: At-sea testing and installation
Service providers should have their units tested under real-life, at-sea conditions by the government or an independent third party. Authorities must ensure providers can meet fleet demands by the required deadlines. Engineers should document proper installation to prevent unauthorized removal or relocation. This applies to reinstallation after repairs as well. Where AIS is required, these principles should be applied to VMS and AIS.

Step 3: Provider management and audits
Maintain a public list of certified providers and approved devices. Service providers should be subject to regular audits, with clear provisions for the suspension or withdrawal of accreditation in cases of noncompliance. While not a legal step, negotiation of a service provider contract is a critical step in the process. Contracts should address the full life cycle of tracking units — including shipment, storage, installation, maintenance, repair and replacement — and specify provisions related to data access and system maintenance, as well as training and support for government staff.

The form of legal provisions

States will structure legal requirements for vessel tracking differently depending on their legal systems, institutional arrangements and governance frameworks. Rather than specify a particular mechanism — like a statute, regulation, directive or decree — this chapter outlines key issues to consider. Regardless of the format, enshrining requirements in formal legal documents provides appropriate public notice to all concerned at each stage of the process and should clearly delineate the requirements, prohibited actions and their consequences. Governments should also provide guidance to help them understand and meet their obligations, which supports greater compliance.

In legislation, VMS and AIS should be dealt with in separate provisions, though using both systems is recommended.

All stakeholders, including those who will be subject to regulation, should be consulted, preferably early in the process. As part of any listening exercise, government officials should explain their plans and how any existing legal requirements come into play, such as general domestic transparency requirements or treaty or international obligations. Some of the issues are complex, may be controversial and may justify a reexamination of certain issues, such as confidentiality and data privacy.

These considerations apply equally to VMS and AIS unless noted. From a legislative standpoint, VMS and AIS should be addressed in separate provisions. Operationally, however, the concurrent use of both systems is highly recommended.

In many cases, this guide makes suggestions for policies. These are less formal and easier and quicker to change than statutes, offering greater flexibility to adapt to changing conditions, experience and needs.

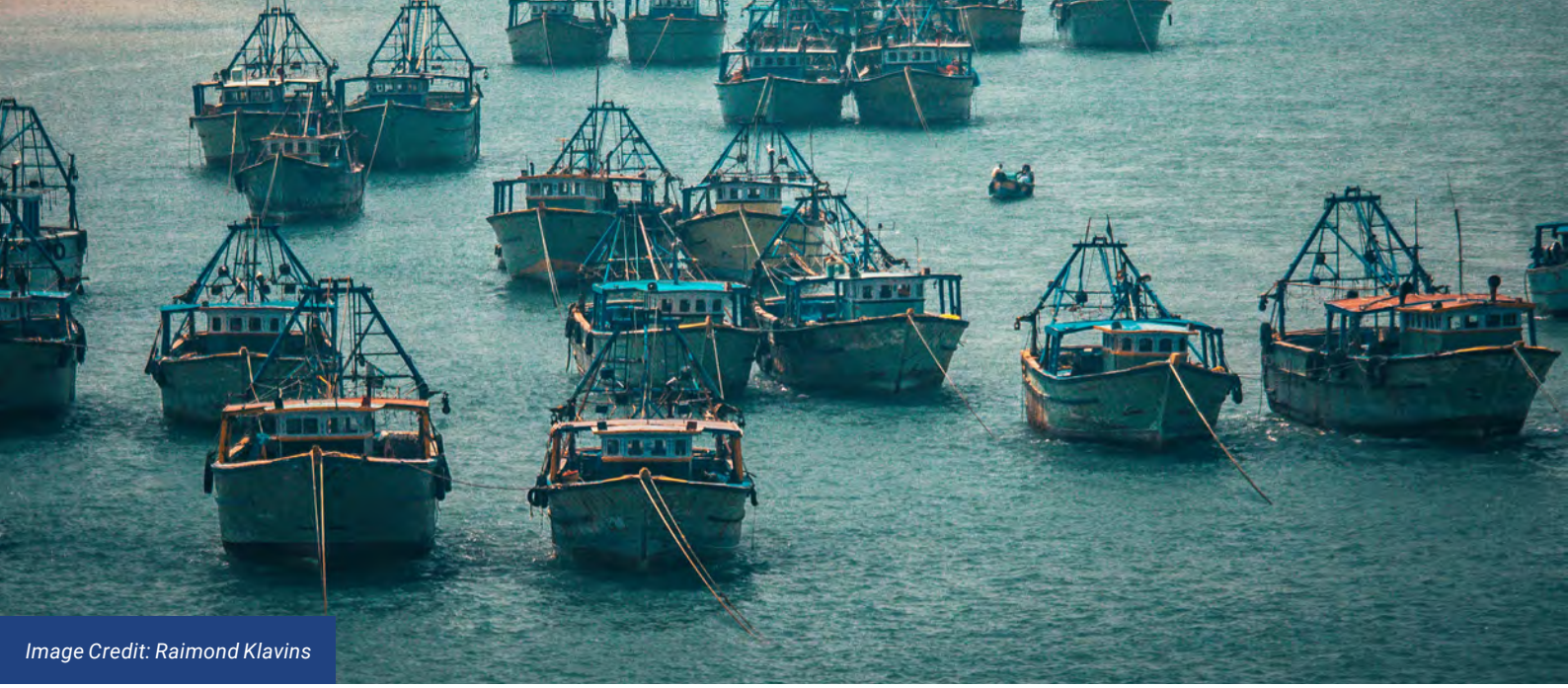

Image Credit: Raimond Klavins

Applicability of general laws

Before drafting new regulations, States should assess how their existing national legal frameworks apply to vessel tracking technologies and the data they generate.

Recommendations

1. **Data governance**
   Various requirements may already exist relating to data that is currently collected, including its scope, collection, handling, use, housing, storage and accessibility.

2. **Application of transparency laws or principles**
   These laws about the public's access to information and transparency, may be incorporated into a constitution or a general principle, and be known by various names, including sunshine laws, right to know laws, freedom of information or other types of accessibility and transparency laws, and may cover vessel tracking data required or collected by the government.

3. **Data confidentiality**
   Provisions on commercially sensitive or proprietary data, as well as personal data protections and privacy restrictions, need to be taken into account. However, these may benefit from reevaluation – many States' laws include legacy provisions that are no longer appropriate or applicable. Best practice is for data to be shared and made public whenever reasonably possible and to provide for this in the law expressly.

4. **Existing powers of authorized government officers**
   Existing provisions in other laws that define the scope of authority of an officer who will come into contact with aspects of vessel tracking to enter, inspect, question, search, seize and detain, and otherwise discharge their responsibilities, although there may be some additional powers needed, like the ability to order a vessel into port. These powers may be conferred on fisheries officers, coast guard, marine police, navy, law enforcement agents, investigators and other designated authorities.

5 **Rules of evidence**

Generalized rules of evidence applicable in court proceedings around data and technology, including admissibility requirements and determining probative value, likely are already in force and should apply to proceedings with vessel tracking evidence. The legal system may include provisions for data or technologies which are new and not previously offered in court.

6 **Due process**

Due process is a basic tenet of many legal systems and typically provides for fair treatment under the law, reasonable notice of charges, an opportunity to be heard and a neutral decision maker.

7 **Implications of sale, lease or transfer of relevant assets and transfer of sanctions**

Understanding how sale, lease or transfer of assets will be treated, such as a sale of a vessel with a VMS unit installed or unmet sanctions on the vessel. Existing legal provisions which apply to all commercial transfers or preexisting sanctions on assets may address these situations, if not additional or modified provisions addressing how these situations will be treated may be needed.

Technical specifications, procurement and certifications

Legal provisions should set technical specifications for the vessel tracking system and onboard units. These may include, among other elements, the capacity for two-way communication, accurate position recording, alert transmission, standardized message formats and defined polling and transmission rates. Technical specifications should contain sufficient detail on system performance and include any specific conditions, such as full performance at sea, durability in the maritime environment and compatibility with various types of vessels.

For procurements, providers and units need to be certified by the government or an approved independent tester. Sufficient testing must be completed and results verified before any units are purchased or contracts signed with providers.

For AIS, IMO operational standards should be applied, as outlined in SOLAS.[33] AIS must provide real-time information about a vessel's position, course and speed to improve safety and collision avoidance between vessels and automatically provide this information to coastal authorities. The performance standards and technical requirements for AIS equipment are detailed in the IMO's Resolution MSC.74(69), which specifies technical requirements for the system's design, installation and operation.[34]

[33] International Maritime Organization (IMO), Revised Guidelines for the Onboard Operational Use of Shipborne Automatic Identification Systems (AIS), Assembly Resolution A.1106(29), adopted Dec. 2, 2015, https://wwwcdn.imo.org/localresources/en/OurWork/Safety/Documents/AIS/Resolution%20A.1106(29).pdf.

[34] International Maritime Organization (IMO) Maritime Safety Committee, Adoption of New and Amended Performance Standards, Resolution MSC.74(69) (adopted May 12, 1998), annex 3, "Recommendation on Performance Standards for a Universal Shipborne Automatic Identification System (AIS)," https://wwwcdn.imo.org/localresources/en/OurWork/Safety/Documents/AIS/Resolution%20MSC.74(69).pdf. International Maritime Organization (IMO), Guidelines for the Installation of a Shipborne Automatic Identification System (AIS), SN.1/Circ.227 (Jan. 6, 2003), 2–5, https://wwwcdn.imo.org/localresources/en/OurWork/Safety/Documents/AIS/SN.1-Circ.227.pdf.

Prohibitions and affirmative obligations

Standards and obligations should be set out in clear, precise legal provisions. Legislation should explicitly identify who bears responsibility for compliance – registered owner, beneficial owner, vessel master, operator or another designated party. The legislation should include definitions and try to eliminate any ambiguities, keeping in mind local rules around legal construction and interpretation of legal language which may not always be judged as clear.

If needed, national legislation can use language from international instruments like the PSMA to define fishing, fishing-related activities, vessels or other key terms. Consistency with widely accepted international agreements is recommended, as many States have already adopted these texts. Adoption of AIS is another example of preexisting, agreed standards and terms that can be used in national legislation.[35] It is recommended that the authorities should also provide guidance in appropriate forms to regulated sectors to inform them about legal requirements and enhance understanding and compliance.

Legal frameworks should clearly distinguish between prohibited acts and affirmative obligations related specifically to vessel tracking. There may be both prohibited actions and affirmative actions that could result in fishers or owners being prosecuted if they do not adhere to them, depending on the country's legal system and how it formulates violations. Prohibited actions are those that regulated parties are not permitted to undertake, such as operating a fishing vessel without a functioning VMS. Affirmative obligations are actions that regulated parties are required to take, such as transmitting vessel tracking data to the country's FMC in accordance with the content, time, frequency and format requirements. This guide does not include possible violations related to fisheries and fishing, of which there are many. It is specifically related to vessel tracking.

The standards and behaviors for vessel tracking should include:

- **Initial implementation:** Specify the date and time by which the approved units must be on board and transmitting data. Define what is an approved unit and who is responsible for installation and operation. Require installation, repairs and reinstallation to be carried out and documented by a certified engineer – this is important if there are allegations of tampering. The standards should specify either that transmission of data must occur at all times, even if the vessel is in port, or that it is only required as a vessel leaves port.
- **Data to be provided:** Specify what data should be collected and transmitted, to whom, when (e.g., 24/7 even when in port, or only when the vessel is out of port), how often, and how, including the format of the message in detail. This applies to both VMS and AIS.[36]

[35] International Maritime Organization (IMO), Recommendation on Performance Standards for an Universal Shipborne Automatic Identification System (AIS), Maritime Safety Committee Resolution MSC.74(69), Annex 3, adopted May 12, 1998, 3, https://wwwcdn.imo.org/localresources/en/OurWork/Safety/Documents/AIS/Resolution%20MSC.74(69).pdf. International Maritime Organization (IMO), Revised Guidelines for the Onboard Operational Use of Shipborne Automatic Identification Systems (AIS), Assembly Resolution A.1106(29), adopted Dec. 2, 2015, 7, https://wwwcdn.imo.org/localresources/en/OurWork/Safety/Documents/AIS/Resolution%20A.1106(29).pdf.

[36] Recommended minimum information to be supplied via AIS includes the following seven fields regarding vessel identity: 1) Official Maritime Mobile Service Identity (MMSI) number from the relevant Flag State authority* 2) IMO Number for applicable vessels, 3) Call sign, 4) Name of vessel, 5) Ship type, 6) Dimensions-length (LOA) and width and 7) Navigational status.
*Note that the MMSI number is linked to the relevant Flag State authority, making keeping this information current and correct very important. Vessel registration and de-registration information need to be up-to-date.
States can elect to require more information than the seven fields listed above, as Indonesia has done in the following example: Indonesia, Ministry of Transportation, Installation and Activation of Automatic Identification System for Ships Sailing in Indonesian Waters, Regulation No. PM 7, 2019, art. 3, https://leap.unep.org/en/countries/id/national-legislation/regulation-minister-transportation-ri-no-pm-7-2019-installation. This regulation requires the broadcast of extensive data fields that exceed standard international recommendations. Under Article 3, skippers must provide "correct information" on AIS Class A, including static data (name and ship type, call sign, nationality, MMSI, IMO number, weight, draft, and dimensions) and dynamic data (navigation status, coordinates, sailing destination with estimated arrival time, speed, and ship's bow).

- **Obligations if the system is not working:** Specify what alternative methods to use if the unit is not functioning, including if it has been disabled. Alternative methods should be activated after a set period of time when there has been no transmission, which should be included in the legal provisions. Consider the applicable polling rate and how many missed polls will trigger the alternative practice. Less formal policies – for example, contacting the vessel or owner to notify them that required polling information has not been received – can be considered but may be impracticable.

  Alternative methods for delivering tracking information could be strict, like a requirement to immediately return to port, or more flexible, such as allowing information to be manually recorded and submitted within a set timeframe. If the unit needs replacement or repair this alternative could also apply, as the unit will not be operating.

- **Disabling systems:** Treat intentionally disabling any system as a serious violation, as it is often done to hide suspicious or illegal activity. Where VMS is disabled or faulty, the incident should be reported to the relevant fisheries authority immediately, and the vessel may be required to return to port, hold position until the system is restored, or manually report its position periodically. VMS blackouts in active fishing grounds should trigger prompt action from authorities. Similarly, disabling AIS can put vessels and crew at severe risk in areas of high shipping traffic.

  For AIS, a temporary suspension of AIS transmission is permitted where the master believes that continual operation might compromise the safety or security of the vessel , its crew or its cargo. Authorities should be guided by IMO Resolution A.1106(29). Under that resolution, the AIS disabling action must be recorded in the ship's logbook and where the vessel is operating within a mandatory ship reporting system, the master should also report the decision and reason to the competent authority. The AIS must be restarted as soon as the source of danger has passed. These provisions represent a minimum standard. To achieve more effective enforcement and strengthen AIS implementation, a growing number of flag and coastal States are legislating more stringent requirements, including an obligation to contact authorities in real time rather than merely recording events in a logbook. This practice is recommended because it provides authorities with the discretion to take decisive action in near-real time if they suspect illegal activity.

- **Updated and accurate vessel registration:** Registration and de-registration of vessels are important processes that require information to be obtained and verified, often quickly. Basic information to collect includes vessel name, IMO number, dimensions, registered and beneficial owners, prior flag, operator, date of registration and date registration ended. Compliance-related information should also be required, examined and verified.[37]

  Registration violations, such as falsifying or failing to update registration documents, or failure to update registration-related documents such as a failure to change MMSI, having multiple vessels using the same MMSI simultaneously or using a false MMSI, can result in misleading AIS information. Standards should include these omissions or actions as violations that can be prosecuted even if the vessel is no longer in the jurisdiction. Rapid changes of flag, even during provisional registrations, should be seen as risky behavior and be further investigated. Given that States need quick access to information to confirm vessel registration, vessel information should be kept up to date in national, regional and global systems, on the IMO's system, and publicly available when possible.

[37] See Food and Agriculture Organization (FAO), Voluntary Guidelines for Flag State Performance (Rome: FAO, 2015), paras. 7–13, which provide guidance on the registration, de-registration, and suspension of vessels, alongside inter-governmental and public data sharing. See also FAO, International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (IPOA-IUU), 2001, art. 42. While the United Nations Convention on the Law of the Sea (UNCLOS), Dec. 10, 1982, 1833 U.N.T.S. 3, arts. 91 and 94, allows States to fix conditions for registration, the flag State must exercise effective jurisdiction and control. These instruments draw on the Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas (Compliance Agreement), 1993, art. VI(1)–(2), regarding physical vessel characteristics. For further analysis, see FAO, Implementation of the International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing, FAO Technical Guidelines for Responsible Fisheries 9 (Rome: FAO, 2002).

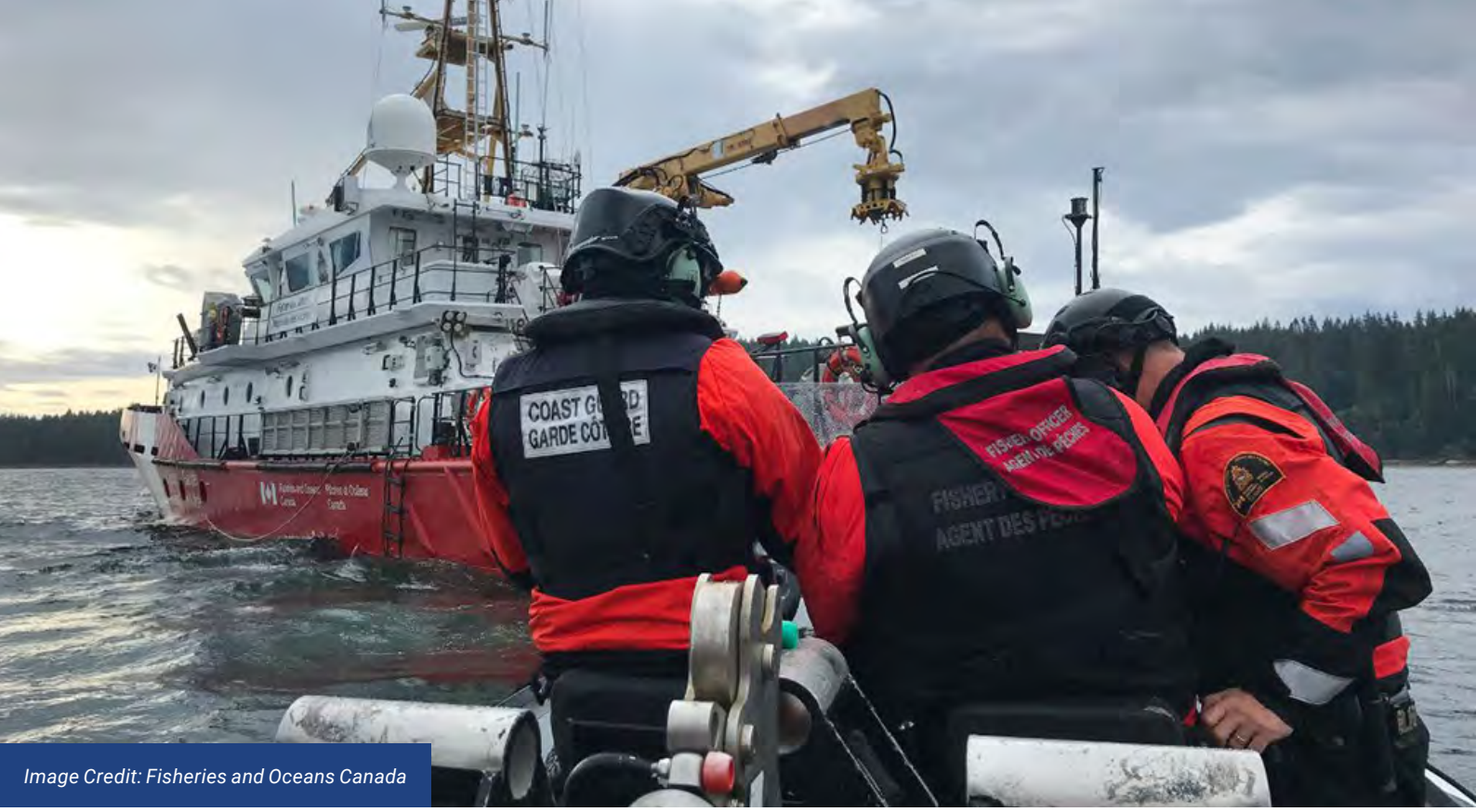

Image Credit: Fisheries and Oceans Canada

- ***Force majeure:*** Define what constitutes *force majeure* and distress, how these situations impact use of vessel tracking systems and how they can be established or proven.[38] A statement of reliance on *force majeure* conditions for disabling a system or other vessel tracking aberration should be verified and not accepted at face value.
- **Communicating the data:** Paying communications bills on time is an affirmative obligation and an important part of the system's operation. Identify who is responsible for payment – for example, a vessel owner or fisher – so data continues to be transmitted. Not paying communications bills on time should be a violation.
- **Obligations to keep the system working:** Include requirements to keep the tracking unit operational at all times and to comply with any additional directions issued by the authorities. Intentionally tampering with the system is a serious violation, including acts such as position falsification, intentionally turning off or disabling a unit, or blocking the antenna to prevent transmission. Documentation of installation or reinstallation by a certified engineer can help show whether tampering has occurred. Patterns of disabling or claimed outages should be monitored for trends and investigated.
- **Cooperation with authorities:** Require the crew to allow authorities to access the unit as part of any boarding or inspection and to provide the unit and any related materials without resistance if requested.
- **Data retention:** Require providers and/or owners to retain data for two years if reasonable in the context and to provide it upon request to the authorities.
- **International obligations:** Laws or regulations addressing VMS or AIS that originate from treaty or RFMO membership obligations should be adopted into national law. States should promptly incorporate these obligations into their jurisprudence, implement the requirements and report back to the RFMO, if required.

[38] There is no single, internationally agreed definition of *force majeure*. Some RFMOs, see, for example, ICCAT, or fisheries partnership agreements (EU/Senegal) have *force majeure* clauses in their instruments. When developing national legislation for *force majeure* it should be defined narrowly with wording chosen carefully and based on the context and jurisdiction.

Image Credit: Pok Rie

Regional and international obligations, approaches and looking ahead

States must understand and respond to international and regional legal obligations that influence the design, implementation and use of vessel tracking systems and the data they generate.

Recommendations

1. **International treaties**
   Identify and incorporate relevant international treaty obligations into national legal frameworks.

2. **RFMO alignment**
   Align VMS systems with RFMO measures where relevant.

3. **Transparency standards**
   Adopt data transparency policies as an efficient way to meet international data-sharing requirements.

4. **Global capacity building**
   Where possible, fund and promote provisions within international bodies to support States in establishing and strengthening vessel tracking systems.

5. **Data standards**
   Explore and plan to move toward recognized global standards for exchange of fisheries data with uniform formats.

6. **Market traceability**
   Follow the evolving landscape around trade-related requirements, including traceability for fish and fish products, and how those requirements relate to vessel positions.

7. **Global standardization**
   Adopt voluntary guidelines or advocate for an international vessel tracking instrument that promotes standardization, sets minimum requirements and facilitates interoperability across jurisdictions.

Laws or regulations addressing VMS or AIS may originate from legal obligations that a State has due to a treaty or other agreement it has ratified. For example, Annex A of the PSMA requires vessels wanting to enter port to indicate whether they have VMS for national or RFMO compliance.[39] This allows port States to request data checks and evaluate the risk of allowing a vessel into port. Evaluating risk is a time-sensitive task when vessels seek access to a port; it requires efficient evaluation of available data and information, which can be hampered by an inability to assess the information provided. One source of this inability is data error, incompleteness, or other issues that prevent authorities from readily or fully understanding the data.

Member States are expected to promptly incorporate international and regional measures into national laws.

RFMOs which require use of VMS:

- South Pacific Regional Fisheries Management Organisation
- International Commission for the Conservation of Atlantic Tunas
- North East Atlantic Fisheries Commission
- Commission for the Conservation of Antarctic Marine Living Resources
- Western and Central Pacific Fisheries Commission
- General Fisheries Commission for the Mediterranean
- Northwest Atlantic Fisheries Organization
- Inter-American Tropical Tuna Commission
- Indian Ocean Tuna Commission
- Southern Indian Ocean Fisheries Agreement
- North Pacific Fisheries Commission
- South East Atlantic Fisheries Organisation
- Commission for the Conservation of Southern Bluefin Tuna

These RFMO requirements also trigger obligations at national level. Member States are expected to promptly incorporate measures into national laws, implement and enforce requirements, and report back to the RFMO if required.

Offenses, jurisdiction and sanctions

Legal provisions should include the following three major elements:

- **Specify and define the offenses:** "Offense" is a term used generically here to include all sorts of violations, crimes, infractions and other appropriate terms. Offenses could be administrative, civil or criminal. Clearly delineate each offense in terms of what actions constitute the offense and who is responsible for complying, if appropriate. The offense can be a prohibited action or require an affirmative action. This latter category would include things like having an operational unit on board and providing the required data in the timeframes mandated. For some examples of how to draft language, see Annex 2.

[39] Food and Agriculture Organization of the United Nations (FAO), Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing, art. 1, approved Nov. 22, 2009, https://openknowledge.fao.org/server/api/core/bitstreams/515b81dc-ad65-41c9-ab02-6ff081103cc3/content.

- **Define jurisdiction.** For example, specify whether each offense will be an administrative offense exclusively or not. Include civil, criminal and any other option that exists in the country.
- **Specify sanctions.** For each offense, specify what sort of sanctions might be levied:[40]
  - Monetary fines or penalties, range or absolute amount. Consider appending these on a schedule so amounts can be updated or adjusted easily and quickly, if needed.
  - License or authorization sanctions.
  - Suspensions, temporary or permanent.
  - Incarceration, if appropriate.
  - The laws should note how repeat offenders will be treated, including whether the same or harsher penalties will apply and what constitutes a repeat offender, such as whether the offense must be the same or similar and how many times they committed violations.
  - Sanctions should also include provisions for any aggravating or mitigating factors, such as major role in the offense or leadership of a conspiracy.

Seized property:
Include treatment and possible disposition, such as forfeiture, of any seized property like fish, vessels or other assets. The proportion of fish able to be seized in the catch on board or in the process of being brought on board should be addressed. In other words, are all fish on board able to be seized? If not, what will differentiate fish which are qualified to be seized? Is there an implicit or explicit presumption that all the fish on board have been caught illegally?

Release of data and transparency:
Specify any required restrictions on the public release of information about the vessel, the owner, other individuals, the offense, the company, the investigation, charges and any sanction or related data. Existing laws with general application may already address this. Take due account of any transparency or public data protection provisions. Full transparency is considered best practice, with data sharing allowed.

The criteria for assigning which sanctions and the range/duration or amount, if monetary, can vary but often includes some combination of the following factors:

- Circumstances of the offense (seriousness, one or more offenses committed)
- Fair market value of the catch and whether all or a portion will be deemed illegal
- Past convictions/repeat offender
- Role in the offense
- Species involved/protected/prohibited/endangered/restricted/life cycle stage/stock health
- Location of violation
- Use of prohibited or restricted gear, closed area, closed season/protected habitat
- Impact of violation
- Duration of violative behavior
- Associated offenses
- Benefits derived from offense
- Intention/state of mind
- Vessel size, if related to the amount of illegal catch or damage done

[40] Sanctions will be determined in different ways in different jurisdictions. They may be imposed by a committee, a designated official, a judge or in some other manner. The important point is to have a process that is transparent, fair and consistent.

Image Credit: Ekaterina Bolovtsova

Going to court

A final legal measure is to ensure the tracking system and all associated activity is sufficient to prepare for bringing a case in court.

Recommendations

1. Be aware of any evidentiary procedures that need to be satisfied to admit vessel tracking data, especially if no presumption of accuracy exists.
2. Be prepared to provide expert testimony to fully explain vessel tracking and the conclusions which can be drawn from it – this may be necessary for vessel tracking data to be admitted as evidence.
3. Collect and secure vessel tracking data using standard evidence protocols, including maintaining a strict chain of custody.
4. When vessel tracking data is used in a legal case, strategize about case selection and presentation carefully. Ensure a strong factual case can be presented and that evidence meets applicable legal standards and can be understood by those not familiar with the technology. If vessel tracking data has not been used as evidence in a jurisdiction previously, carefully plan the strategy for case presentation.

Vessel tracking data as evidence

Using tracking data in court proceedings is one of the ultimate tests of the system.

- Will a court accept the evidence as proof of wrongdoing or as evidence that supports a violation?
- What probative value or weight will be given to the vessel tracking evidence?

In some jurisdictions, rules of procedure, legal and judicial precedent, and specific evidentiary statutes are often also part of how the legal process around admission of certain types of evidence becomes institutionalized.

States that have not yet had experience of using vessel tracking data in legal cases are likely to have questions around whether vessel tracking data be admitted and used as evidence in court, what it can be used to prove and how it should be used. Often, legal systems have special requirements for technical or scientific evidence, which are likely to apply to vessel tracking data used as evidence. Such evidence can be treated differently from other forms of evidence, which are often covered by more generalized rules of evidence.

Understanding these requirements will be important for an investigator assembling potential evidence, an attorney or prosecutor evaluating or preparing the legal case, a judge or adjudicating official, and any experts called on to present, explain or evaluate the evidence in advance or during the proceeding.

For vessel tracking data to be used in legal proceedings, system operators need standard operating procedures to establish relevance, reliability and accuracy. These standard procedures may need to be shown as part of the evidence to assure the court that it can be confident in the data produced and offered as proof.

Vessel tracking evidence should be collected and maintained like any other type of evidence in accordance with the applicable rules of evidence in the jurisdiction. This will mean things like establishing and maintaining a chain of custody.

Admitting scientific or technical evidence

A jurisdiction's general rules of evidence should apply to vessel tracking data and its admission into a court proceeding. Data derived from vessel tracking, such as maps or screenshots, may be classified as technical or scientific evidence or some other suitable label based on existing domestic legal precedent. This classification often requires proof of the accuracy and reliability for the data to be accepted in court. In some jurisdictions, this proof can be provided by showing use of a type-approved unit, continuous unit operation and data position accuracy. Transmitted data should have position accuracy based on Horizontal Dilution of Precision value.[41]

Presumptions

If possible, legislation should include a presumption around the accuracy and reliability of the vessel tracking data, allowing a court to admit and take legal notice of the accuracy and reliability of VMS and AIS so these concepts do not have to be proven anew in each proceeding.[42] Different terminologies may be used depending on the type of process – administrative, civil or criminal – and the legal system, but the overall result is the same. The presumption, if allowed, would be rebuttable, meaning it can be challenged by the accused.[43]

For vessel tracking data to be used in legal proceedings, government officials need standard operating procedures to establish relevance, reliability and accuracy.

[41] Horizontal Dilution of Precision (HDOP) value is a metric used in GPS and GNSS systems to quantify the geometric quality of the satellite's arrangement to the receiver and its impact on the horizontal position. A lower HDOP value indicates better satellite geometry and higher horizontal accuracy (precision of latitude and longitude position) and more reliability.

[42] The report of an authorized officer which relies on VMS or AIS can be used to establish the position of the vessel. See e.g., Mauritius and Chile: Fisheries Act 2023 (Mauritius), Act No. 15 of 2023, secs. 189–190, https://faolex.fao.org/docs/pdf/mat222957.pdf.

[43] English translation of a Spanish article about a recently adopted legal presumption on vessel tracking evidence in Argentina. "Histórico. El Gobierno fijó normas para detectar actividad pesquera ilegal de buques extranjeros en la ZEEA," Pescare, Feb. 5, 2026, https://pescare.com.ar/historico-el-gobierno-fijo-normas-para-detectar-actividad-pesquera-ilegal-de-buques-extranjeros-en-la-zeea/.

Image Credit: Albert Ismagilov

Presenting the evidence

VMS and AIS remain relatively new technology in many jurisdictions, particularly in legal proceedings, and this must be considered in the strategy of how a legal case is presented. What the vessel tracking evidence can show or support needs to be presented in a way that is readily understood by those who may not be familiar with how the systems work. This need extends to the terminology and concepts associated with each type of system. It applies to both oral testimony, such as testimonies from investigators and experts, and demonstrative evidence, such as exhibits like enlarged visuals showing vessel movements.

Experts may be called upon to explain how the system works or to provide expert opinion, either orally via sworn testimony or in writing. They should be chosen carefully. An expert should be able to explain complex concepts in a way that can be readily understood by non-experts. They should be able to explain why vessel position data is highly accurate, account for any variations based on the source of data being presented as evidence and explain the existing degree of positional error (generally 10 meters or less).[44]

The same general approach applies to documentary evidence and to any exhibits offered. Introducing vessel tracking evidence is a learning process, and it is important to make sure there is understanding at each step. This extends to prosecutors, who may not have encountered cases involving vessel tracking evidence.

Weight

Judges and other decision makers may have discretion over what weight or probative value to give to vessel tracking evidence or conclusions to be drawn from it in a case. This weight may depend upon precedents established in that jurisdiction or elsewhere, as well as the other evidence presented.

[44] This is based on the Differential Global Positioning System and is an enhanced version of the standard GPS that provides higher accuracy and allows the calculation of more precise positions.

Cases using vessel tracking as evidence

For jurisdictions without experience of using vessel tracking data as evidence in a court of law, examples from other countries may be useful. These cases and their outcomes can be offered to the court and shown to judges as instructive precedents, if appropriate. They can also be studied by investigators and prosecutors to see how cases were constructed and the arguments each side made to the court.

The cases below, drawn from a range of jurisdictions and legal systems, give examples of different ways that vessel tracking provides support to legal cases or shows the failure to use tracking as required. Some are fisheries cases, some MPA cases, some use VMS and some use AIS — even in fisheries cases as its use is not limited to safety issues — some use tracking data as the sole evidence, and in other instances tracking data is one piece of a larger evidentiary package.

Spain

In 2023, Spain sanctioned 25 Spanish-flagged fishing vessels for repeated disabling of their AIS devices while fishing on the high seas during 2018-2021, when doing so was illegal under Spanish law.[45] The vessels were fined up to €60,000.[46]

Earlier Spanish cases administratively sanctioned two fishing vessels for turning off their AIS devices in excess of 1,000 hours over the course of four years. NGOs brought the evidence and analysis to the government for action.[47]

Panama

A total of 14 Panamanian vessels have been fined by the Panamanian Authority of Aquatic Resources for fishing within the Coiba Ridge Marine Protected Area, where longlining is prohibited. The fines on some of the vessels were among the highest given to the longline fleet.[48] They were also charged with traveling at a speed below 6 knots for extended periods within the protected area. VMS evidence was a critical part of the evidence.[49]

United States

While some cases are recent, others go back many years. One of the first cases using VMS evidence was prosecuted administratively by the U.S. more than 20 years ago, helping prove a fishing violation in a closed area.[50]

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[45] Article 307.3.o of the Spanish Merchant Marine law specifically classifies the failure to keep AIS equipment active as a serious administrative infraction. "An administrative sanctioning procedure was initiated by the Maritime Administration (through the Maritime Captaincies of Vigo and Las Palmas) against the companies owning 25 of the vessels listed, for a serious administrative infraction consisting of the vessel navigating without maintaining its AIS equipment operational at all times during the periods reported, in violation of Article 307.3.o of the Revised Text of the Law of State Ports and Merchant Marine (Royal Legislative Decree 2/2011). (Translated)"
Spain, Ministry of Transport and Sustainable Mobility, Administrative Sanctioning Procedure against Owners of 25 Vessels for AIS Operational Violations, citing Royal Legislative Decree 2/2011, art. 307.3.o (Revised Text of the Law of State Ports and Merchant Marine), https://cdn.mitma.gob.es/portal-web-drupal/RESOLUCIONESDENEGATORIAS/001_080686_concesion_parcial_art_14_1_e_g.pdf.

[46] Oceana, "Spain Sanctions Vessels for Disabling Tracking Devices Following Eye-Opening Oceana Report," Dec. 14, 2023, https://oceana.org/press-releases/spain-sanctions-vessels-for-disabling-tracking-devices-following-eye-opening-oceana-report/.

[47] "Spanish Government Sanctions Two Fishing Vessels for Turning Off AIS," The Fishing Daily, Jun. 27, 2023, https://thefishingdaily.com/latest-news/spanish-government-sanctions-two-fishing-vessels-for-turning-off-ais.

[48] Panama, Aquatic Resources Authority of Panama (ARAP), "Edictos – Dirección General de Inspección, Vigilancia y Control," accessed May 5, 2026, https://arap.gob.pa/edictos-direccion-general-de-inspeccion-vigilancia-y-control/. Global Fishing Watch, "From Detection to Deterrence: How Vessel Tracking Is Helping Protect Panama's Coiba Ridge," Feb. 18, 2026, https://globalfishingwatch.org/article/from-detection-to-deterrence-how-vessel-tracking-is-helping-protect-panamas-coiba-ridge/.

[49] Panamanian regulations prohibit traveling at speeds below 6 knots in a prohibited area without justification except in cases of force majeure that have been duly notified to ARAP.

[50] "First US Prosecution Using Satellite-Based VSM," IntraFish, Feb. 2, 2006, https://www.intrafish.com/news/first-us-prosecution-using-satellite-based-vsm/1-1-542839. While part of the case was later contested on appeal, reliance on VMS was not overturned. United States v. George, 761 F.3d 42 (1st Cir. 2014), https://caselaw.findlaw.com/court/us-1st-circuit/1664817.html.

Iceland

In 2012, Iceland successfully prosecuted two longline vessel captains for illegally fishing in a protected area. Iceland was unable to send a patrol aircraft or vessel and relied on data from AIS to successfully make the case.[51]

Papua New Guinea

In 2024, Papua New Guinea, with assistance from the Pacific Islands Forum Fisheries Agency, investigated a number of AIS-disabling incidents from the Indonesian-flagged fishing vessel MITRA JAYA 6. It was shown that the vessel turned off its AIS 22 times for periods as long as 42 hours, a serious gap in monitoring coverage. Significant fines were imposed.[52]

United Kingdom

Not all cases using vessel tracking data have been successful. A 2018 case from Devon in the U.K. that relied partially on VMS evidence resulted in a loss, in part due to uncertainty around activity during longer polling intervals and presentation of evidence. But the case provided useful lessons for the government authority, which has since improved its practices and been successful in subsequent cases.

Argentina

Relying on a new 2026 regulation, Argentina fined the BAO FENG, a Vanuatu-flagged vessel with Chinese beneficial ownership, $1.2 million for illegal fishing. It relied on vessel tracking evidence showing location, direction and speed as proof of the illegal activity. This new regulation includes a legal presumption that a foreign-flagged vessel in the Argentine EEZ is engaged in fishing if its speed, course changes and movement patterns are consistent with fishing.[53]

RFMOs

Some RFMOs have already determined that VMS and AIS can and should be part of the package of evidence submitted and examined when a vessel has been proposed to be placed on the RFMO's IUU vessel list. For example, the Indian Ocean Tuna Commission Resolution 24/03 requires that any proposal to include a vessel on the IUU list be supported by detailed evidence, such as information from coastal States including VMS transponder or AIS data.[54]

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[51] "Dæmdir fyrir ólöglegar veiðar," Morgunblaðið, Apr. 2, 2012, https://www.mbl.is/frettir/innlent/2012/04/02/daemdir_fyrir_ologlegar_veidar/.

[52] "Papua New Guinea Leverages Global Fishing Watch Data in Fight against Illegal Fishing," Global Fishing Watch, Apr. 25, 2024, https://globalfishingwatch.org/success-story/papua-new-guinea-leverages-global-fishing-watch-data-in-fight-against-illegal-fishing/.

[53] La Argentina rompe la impunidad en el Atlántico Sur. Aplican multa multimillonaria al pesquero Bao Feng por pesca ilegal," Pescare, Mar. 27, 2026, https://pescare.com.ar/la-argentina-rompe-la-impunidad-en-el-atlantico-sur-aplican-multa-multimillonaria-al-pesquero-bao-feng-por-pesca-ilegal/. "Histórico. El Gobierno fijó normas para detectar actividad pesquera ilegal de buques extranjeros en la ZEEA," Pescare, Feb. 5, 2026, https://pescare.com.ar/historico-el-gobierno-fijo-normas-para-detectar-actividad-pesquera-ilegal-de-buques-extranjeros-en-la-zeea/.

[54] Indian Ocean Tuna Commission (IOTC), On Establishing a List of Vessels Presumed to Have Carried Out Illegal, Unreported and Unregulated Fishing in the IOTC Area of Competence, Resolution 24/03, May 17, 2024, https://iotc.org/sites/default/files/documents/compliance/cmm/iotc_cmm_2403.pdf.

Image Credit: Mikhail Preobrazhenskiy

Image Credit: Zheng Zhengyu

Conclusion

This guide was developed in response to a growing demand for practical, experience-based support in a field where no comprehensive reference previously existed. While not exhaustive, it provides a comprehensive foundation for informed decision making and effective implementation and use of vessel tracking systems. The recommendations here, if put into practice, will make a significant contribution to ocean governance and protection.

The dynamic field of fisheries technology continues to evolve, bringing exciting new developments but also making it a challenge for governments to stay up to date. Vessel tracking technologies will continue to improve and evolve, making this best practice guide a product of a certain time, even as it attempts to anticipate future changes.

It is expected that the recommendations here, if implemented, will go far to improve ocean governance and the goals for ocean protection. While the use of vessel tracking systems has increased, a number of serious deficiencies remain. An international agreement could deliver much-needed standardization of practices and data, facilitating data sharing and improving the value States get from the data they collect, both for themselves and for others. The standards should be arrived at through widespread and expert consideration of the issues, allowing input from all. Among other things, an agreement could deliver increased efficiencies and automation to reduce workload and improve tracking system performance. Standardization would also improve data interoperability, allowing States to meet regional and international obligations and furthering cooperation. In turn, States could more readily and effectively respond to suspected illegal activities, helping preserve ocean resources for all.

Ultimately, this guide serves as the foundational architecture for a new ground breaking global instrument on vessel tracking — a necessary step to dismantle IUU fishing and secure a resilient, bountiful ocean for generations to come.

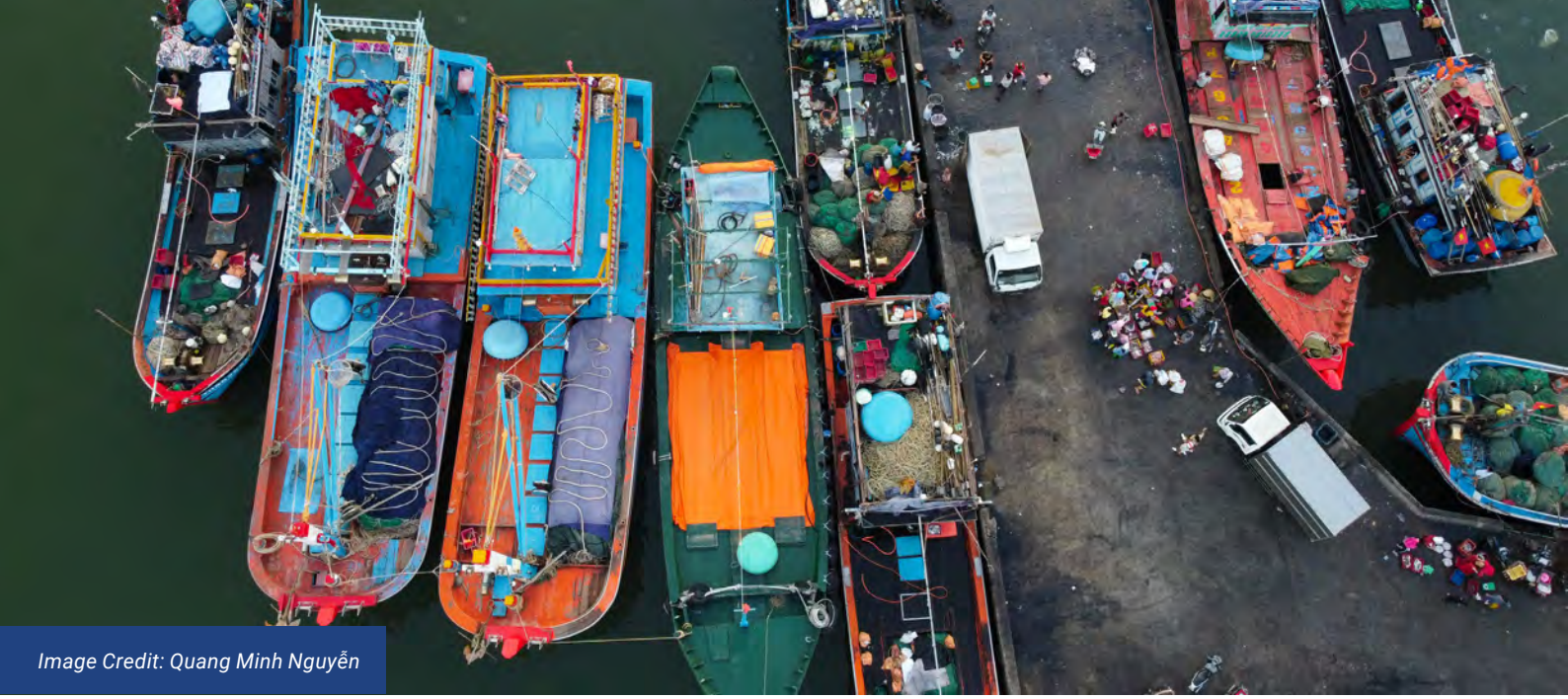

Image Credit: Quang Minh Nguyễn

Abbreviations and Acronyms

AIS - Automatic identification system

API - Application programming interface

AREP - Advance Request for Entry into Port

EEZ - Exclusive economic zone

EU - European Union

FAO - Food and Agriculture Organization of the United Nations

FLUX - Fisheries Language for Universal Exchange

FMC - Fisheries monitoring center

GDST - Global Dialogue on Seafood Traceability

GMDSS - Global maritime distress and safety system

GNSS - Global navigation satellite system

GPS - Global Positioning System

GR - Global Record of Fishing Vessels, Refrigerated Transport Vessels and Supply Vessels

GSM - Global System for Mobile Communications

GT - Gross tonnage

GUI - Graphical user interface

IMO - International Maritime Organization

ISO - International Organization for Standardization

ISSCFG - International Standard Statistical Classification of Fishing Gear

ITU - International Telecommunications Union

IUU - Illegal, unreported and unregulated fishing

iVMS - Inshore vessel monitoring system

LEO - Low Earth orbiting

LOA - Length overall

MCS - Monitoring, control and surveillance

MID - Maritime identification digits

MMSI - Maritime mobile service identity

MPA - Marine protected area

PSMA - Port State Measures Agreement

RFMO - Regional fisheries management organization

SOLAS - International Convention for the Safety of Life at Sea

SOS - International distress signal

UTC - Coordinated Universal Time

UVI - Unique vessel identifier

VHF - Very high frequency

VMS - Vessel monitoring system

Image Credit: Michael Heldw

Glossary of terms

Authorities
Those in government, such as individuals, officers, agencies, departments or other bodies which often have responsibilities to administer programs or decide on the acceptance, direction and associated budget of programs as mandated by the relevant legal responsibilities.

IUU
Illegal, unreported and unregulated fishing is a broad term that captures a wide variety of fishing activity. IUU fishing is found in all types and dimensions of fisheries, occuring both on the high seas and in areas within national jurisdiction. It concerns all aspects and stages of the capture and utilization of fish, and it may sometimes be associated with organized crime. A more elaborated definition of IUU is found in the International Plan of Action on IUU.[55]

Illegal fishing

- Conducted by national or foreign vessels in waters under the jurisdiction of a State, without the permission of that State, or in contravention of its laws and regulations.
- Conducted by vessels flying the flag of States that are parties to a relevant regional fisheries management organization but operate in contravention of the conservation and management measures adopted by that organization and by which the States are bound, or relevant provisions of the applicable international law; or
- In violation of national laws or international obligations, including those undertaken by cooperating States to a relevant regional fisheries management organization.

Unreported fishing

- Which have not been reported, or have been misreported, to the relevant national authority, in contravention of national laws and regulations; or
- Are undertaken in the area of competence of a relevant regional fisheries management organization which have not been reported or have been misreported, in contravention of the reporting procedures of that organization.

Unregulated fishing

- In the area of application of a relevant regional fisheries management organization that are conducted by vessels without nationality, or by those flying the flag of a State not party to that organization, or by a fishing entity, in a manner that is not consistent with or contravenes the conservation and management measures of that organization; or
- In areas or for fish stocks in relation to which there are no applicable conservation or management measures and where such fishing activities are conducted in a manner inconsistent with State responsibilities for the conservation of living marine resources under international law.

[55] Food and Agriculture Organization of the United Nations (FAO), "What is IUU fishing?," accessed May 7, 2026, https://www.fao.org/iuu-fishing/background/what-is-iuu-fishing/en/.

Monitoring, control and surveillance
A three-part framework used to ensure compliance with fisheries management. Brief, technical definitions of each element of MCS were developed in an FAO Expert Consultation in 1981.

- **Monitoring:** The gathering and analysis of data – logbooks, VMS, EMS and observers – to track fishing activity and inform management decisions.
- **Control:** The legal and regulatory framework – licenses, catch limits and gear restrictions – that establishes the rules for sustainable fishing.
- **Surveillance:** The systematic observation of activity patrols – AIS/VMS tracking and satellite imagery – to detect, document and deter noncompliance.

Polling
The act of taking vessel position data. It can be set at certain time intervals, for example at every 15 minutes. Currently many polling rates set by authorities are at a low resolution, which means they do not occur frequently, and therefore are not effective in determining if illegal activity may be happening.

Presumption (legal)
A legal mechanism, which is often stipulated in legislation, that may be used in certain jurisdictions. It allows the court to take notice, without specific evidence being presented in each case, of certain facts. Legal presumptions should be rebuttable. In the case of vessel tracking, a legal presumption may allow the court to find that the systems are accurate and reliable without this being proven anew in every case. A legal presumption rests on facts that the law has confidence are true.

Regional fisheries bodies/Regional fisheries management organizations
Intergovernmental organizations through which States cooperate on regional fisheries management. These bodies are referred to as regional fisheries management organizations or arrangements are a subset of regional fisheries bodies. While many regional fisheries bodies have a mandate over waters under national jurisdiction, some have competence areas that extend to the areas beyond national jurisdiction. Some regional fisheries bodies deal with specific stocks only, for example, tuna and tuna-like species, or deep-sea stocks.

Service provider
Private company which supplies the equipment and associated services including communication services, such as transmission of data needed for vessel tracking, through a fee-for-service contract with the government, the fishers/owners or both.

Image Credit: 2019 SweeMing Young

Annex 1

Comparative table of definitions for small-scale fishing vessels

Tracking obligations almost always attach to a vessel category. National rules typically require industrial or large-scale vessels to carry VMS, while “small-scale” boats face lighter requirements or none at all. The boundary between those two groups is therefore one of the most consequential decisions in any monitoring framework. It determines which part of the fleet sits under continuous oversight, which part does not, and where the next investment in coverage will be required.

The difficulty is that there is no shared definition of “small-scale.” Countries use different combinations of length overall, gross tonnage, engine power, gear type, distance from shore, ownership and crew size. Two vessels of similar specification but a slightly different length or engine capacity can end up with very different monitoring requirements depending on which category they were registered in. It also means that the tracking system has to be able to accommodate the types of vessels which fall under the regulation, that has real consequences for the design needs and equity of any monitoring regime. The small-scale category usually contains the greatest number of vessels, the lowest technology uptake and the strongest livelihood dependence on the resource, so how a vessel is categorized shapes how equitable the management is, who carries the regulatory burden and who is left out of the picture of what is happening on the water created from tracking data.

The table below is included as a reference, not as a recommendation. It can be used in two ways. First, as evidence of how widely interpretations vary across jurisdictions with sizable small-scale fleets. Second, as a starting point for officials drafting or revising their own definition. It is included here not only to show how States perceive small-scale fishing vessels, but since this guide has mentioned its focus on large-scale vessels, it demonstrates what is not included in that category.

Table 16. Brazil

Definition: Artisanal fishing: When it is practiced directly by professional fishermen*, independently or in a family economy regime, with their own means of production or through a partnership contract, landed, and may use small boats. ** Note: Text from external sources is quoted verbatim. Global Fishing Watch uses the gender-neutral term “fisher” rather than “fisherman” in all original reporting*
Main features: Small boats, up to 20GT
Foundation: Defined in Law 11,959/2009

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Table 17. Chile

Definition: Artisanal fishing: Artisanal fishing corresponds to the extractive fishing activity carried out by natural or legal persons. It is made up of fishermen who operate personally, directly and habitually, and can carry out the activity in boats up to 18 meters in length and 50 gross register tons (GRT).
Main features: Artisanal fishing mainly consists of smaller boats (<18 meters in length) operated by local fishermen and 50 tonnes of gross register tonnage. Artisanal fishing has the first five miles reserved to carry out its work, called the Artisanal Fishing Reserve Area. In addition, the Fisheries Law establishes the first maritime mile for the exclusive use of vessels less than 12 meters in length, from the northern limit of the country to the southern limit of the island of Chiloé.
Foundation: Fisheries Law

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Table 18. Costa Rica

Definition: Artisanal fishing is the activity of fishing made in the form artisanal by natural persons, with the use of a boat, in continental waters or in the coastal zone and with autonomy to fish, up to a maximum of five nautical miles from the coastline that is carried out for commercial purposes.
Main features: Boats 12 meters in length. Traditional methods and equipment, linked to local communities and oriented towards subsistence. Artisanal vessels preferably operate in the Gulf of Nicoya or near the coasts. They work at a maximum distance of 5 nautical miles from the coast.
Foundation: Fisheries and Aquaculture Law of Costa Rica

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Image Credit: East Sea Fisheries Management Service

Table 19. Ghana

Definition: On a small scale, with traditional or simple, non-industrial methods, mainly for local consumption.
Main features: Traditional, non-industrial methods, local consumption, coastal/inland waters. Wooden canoes, often propelled by outboard motors, are the main vessels used by artisanal fishermen. They can be up to 70 feet in length and are very vulnerable to sea conditions. Various forms of driftnets and seines are used in motorized canoes.
Foundation: Ghana Fisheries Law

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Table 20. Indonesia

Definition: Fisheries that use boats <10 GT or without boats, and low-tech gear. Small fisherman is a fisherman that catches fish to meet daily needs, either not using a fishing vessel or using a fishing vessel of not more than 10 gross tons. Traditional fisherman is a fisherman that catches fish in waters that serves as traditional fishery right used hereditary according to the local culture and wisdom.
Main features: Vessels <10 GT, low tech, small capital investment, coastal/onshore.
Foundation: Indonesian Ministry of Marine Affairs and Fisheries Programa Smart Fisheries Village Protection And Empowerment Of Fishermen, Fish Raisers And Salt Farmers (Law of the Republic of Indonesia No. 7/2016 dated April 14, 2016)

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Table 21. Kenya

Definition:
Fishing carried out with small non-motorized boats or simple fishing gear, mainly subsistence fishing within 12 nautical miles.

"Artisanal fisheries" means small scale traditional fisheries that may be carried out for subsistence or commercial purposes in which the owner is directly involved in the day-to-day running of the enterprise and relatively small amounts of capital are used;

"Artisanal fishing vessel" means any local fishing vessel, canoe or undecked vessel with a length overall of not more than 10 meters, which is motorized or not motorized by an outboard or inboard engine not exceeding forty horsepower, or powered by sails or paddles, but does not include decked or undecked semi-industrial fishing vessels or vessels used for recreational fishing;

"Semi-industrial fishing vessel" includes — (a) a decked fishing vessel with an overall length of not less than 10 meters and not more than fifty GRT and not powered by an inboard engine ; and (b) an undecked fishing vessel with an overall length of not less than ten meters and not more than 20 meters with less than fifty GRT and powered by engines of at least forty horse power;

"Industrial fishing vessel" means a decked fishing vessel with an overall length of 20 meters or greater and with an inboard engine;

Main features:
Small boats, traditional arts, subsistence focused, coastal/lacustrine waters.

These vessels operate in shallow lagoons of coral reefs and seagrass beds, which usually do not exceed 20 meters in depth.

The most commonly used artisanal fishing gear is gillnets, basket traps, longlines, harpoons and beach seines.

Foundation:
Kenya Fisheries Management and Development Act No. 35 of 2016

Paul Mboya Tuda, "Dealing with the changing face of artisanal fisheries on the Kenyan coast: rationale for strengthening local institutions, challenges and way forward" (paper presented at the Global Conference on Tenure and User Rights in Fisheries, Yeosu, South Korea, Sept. 10–14, 2018), Food and Agriculture Organization of the United Nations, https://www.fao.org/fishery/static/tenure-user-rights/root/volume2/C29.pdf

© 2026 Global Fishing Watch

Image Credit: David Clode

Image Credit: Charles Kilgour

Table 22. Panama

Definition: Artisanal fishing is considered to be that carried out by national natural persons, cooperatives or associations of artisanal fishermen. Small-scale or artisanal vessels are those whose length does not exceed 12 meters and depth does not exceed 1.5 meters, whose means of propulsion is oars or outboard motor(s) that in its entirety does not exceed 150 horsepower of force per vessel and that do not use mechanized capture techniques such as a hydraulic winch turner.
Main features: Reserved for vessels that do not use mechanized capture techniques and are carried within continental waters and marine areas under the sovereignty of Panama. Length not greater than 12 meters, no longer than 1.5 meters, with oars or an outboard motor of no more than 150 horsepower.
Foundation: Executive Decree 13 of 2023, which regulates the Fisheries Law 204 of 2021

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Table 23. Philippines

Definition: Philippines uses the term Municipal Fishing for small-scale fishing: Fisheries that use vessels with a capacity of ≤3 GT or no vessels, operating in municipal waters.
Main features: Vessels ≤3 GT, low technology, municipal waters (up to 15 kilometers from the coast).
Foundation: Philippine Fisheries Code

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Table 24. Madagascar

Definition: Community fishing with traditional methods, often without motorization or with minimal motorization. Artisanal fishing: Fishing activity using decked or undecked vessels, whose total engine power is between 15 horsepower and 50 horsepower maximum. Small-scale fishing: Fishing activity reserved for individuals, practiced in waters under Malagasy jurisdiction using motorized boats, whose total engine power is less than 15 HP, non-motorized boats or on foot.
Main features: Community-based, traditional methods, low or no motorization, coastal waters. Artisanal fishermen use various gears, such as traps, hooks and lines, cast nets, small gill nets, harpoons and beach seines. These vessels fish in shallow lagoons of coral reefs and seagrass beds, which usually do not exceed 20 meters in depth.
Foundation: Madagascar fisheries and aquaculture policy Traditional fishing or small-scale maritime fishing in Madagascar: a state of play – Coalition for Fair Fisheries Arrangements Law No. 2015-053 on the Fishing and Aquaculture Code

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Table 25. Senegal

Definition: Artisanal boats, often family-owned, that use traditional, non-industrial methods.
Main features: Family, traditional methods, artisanal, coastal/inland waters. Small excavated canoes: They usually measure between 3 to 5 meters in length. Wooden boats: From 6 to 15 meters in length, they are propelled by blades, sails or inboard/outboard engines.
Foundation: Senegalese fishing code

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The same variables show up across the table. Length and gross tonnage are most common, usually backed by one or two of engine power, gear, distance from shore, trip

length, ownership and crew size. The actual numbers vary between States, and within them where artisanal, subsistence and small-scale commercial are treated as separate groups. There is no single correct definition. Each State has built one based on their own needs and context.

FAO does not set a global threshold either. The Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries recommend definitions should be set at national or sub-national level, with small-scale fishers and their organizations involved in the process. Both the guidelines and the more recent Illuminating Hidden Harvests assessment push governments to look beyond a single number and define small-scale through a set of characteristics, the Hidden Harvest report proposes a matrix that covers a number of characteristics including vessel and gear, fishing area, labor and ownership and the role of the catch in local food and livelihoods.[56]

For a country setting up or updating a vessel tracking framework the advice is short. Define "small-scale" before you set the threshold. Do it with the fishers it will apply to. Make sure the cut-off matches how the fleet actually operates and where the risks are that the monitoring needs are meant to address.

Annex 2

Examples of effective prohibition drafting

If a governmental authority wants to use vessel tracking data as evidence of noncompliance, then the language of a statute, regulation or other legal mechanism matters and can make a significant difference in how a case may be presented and what evidence will establish the violation. Understanding the alternative ways to formulate the prohibited or required activity is important to the outcome.

One area where this can be readily seen is in closed or restricted area regulations. It can be difficult and resource heavy to conclusively prove that prohibited activities, such as fishing, have taken place. One approach is to formulate the prohibition with behavior that tracking data can be used to prove. This could include being inside the restricted area below a set transit speed, or failing to report entry, rather than fishing *per se*. This is not suggesting being disingenuous in designing prohibited action language but rather having a realistic understanding of the behavior that comprises the prohibited action and how to establish this with evidence in court. Examples of aligning the prohibited behavior with what vessel tracking data can reliably show include:

- **Entry/reporting requirement.** Require vessels to notify authorities when they enter a defined boundary (such as an EEZ, MPA, or other restricted area). Set clear requirements about when notice must be given, what information must be included, and how it should be sent. This creates a straightforward, auditable event that can be checked against tracking data to identify cases where reporting protocols have not been met.
- **Speed/presence rule.** Define the offense as being present inside the closed or restricted area below a minimum transit speed (commonly >5 to 6 knots). Tracking data can be used as the primary source of evidence of noncompliance. Protocols for vessels to report incidents of force majeure or mechanical failure should be included.

While behavior-based rules such as these can make enforcement using vessel tracking data more effective, they must not eliminate legitimate defenses and explanations for the behavior. A vessel might slow down due to weather, mechanical problems or nearby traffic

[56] Food and Agriculture Organization of the United Nations (FAO), Duke University, and WorldFish, Illuminating Hidden Harvests – The Contributions of Small-Scale Fisheries to Sustainable Development (Rome: FAO, 2023), 21, https://doi.org/10.4060/cc4576en.

and be wrongly flagged as noncompliant. Errors in tracking data, such as gaps or inaccurate positions, can also trigger false alerts. To avoid these risks, the rules must be both technically sound and procedurally fair. The regulation should clearly define how compliance is assessed, but it must also provide safeguards that reflect broader legal principles, including due process and the right to respond fully to an allegation or charge. The precise formulation will depend on the national legal system but a well-framed requirement supports enforcement while respecting fairness and established legal principles.

Table 26. Australia – Fisheries Management Regulations 2019[57]

Regulatory text:
86 Navigating in area that is a closed zone

Offense
(1) The master of a boat commits an offense of strict liability if the boat is navigated in an area that is a closed zone that relates to the boat.

Exceptions
(2) Subsection (1) does not apply if information given by the boat's vessel monitoring system shows, for the period that the boat was in the closed zone:
(a) that the boat was travelling at a speed of 5 knots or more as worked out under subsection (4); or
(b) that: (i) the boat was navigated in the closed zone for a period of 30 minutes or more; and
(ii) the boat was stationary (see subsection (5)).

Note: A defendant bears an evidential burden in relation to the matter in subsection (2) (see subsection 13.3(3) of the Criminal Code).

(3) Subsection (1) does not apply if:
(a) AFMA had given approval for the boat to be navigated in the closed zone because of an unforeseen emergency, or circumstances beyond the control of the master of the boat; and
(b) the boat was navigated in the closed zone in accordance with any instructions given by AFMA.

Note: A defendant bears an evidential burden in relation to the matter in subsection (3) (see subsection 13.3(3) of the Criminal Code).

Working out a boat's speed

(4) To work out a boat's speed in knots for the purposes of this section:
(a) for each consecutive pair of points identified by the boat's vessel monitoring system, identify the shortest distance between the pair of points in a straight line; and
(b) divide the distance by the time taken by the boat to travel between the two points.

(5) For the purposes of this section, a boat is taken to be stationary if it is travelling at a speed of 0.5 knots or less as worked out under subsection (4).

Comment:
The regulation directly incorporates vessel tracking system data as a source of evidence, making tracking data central to compliance and legal action.

[57] Australia, Fisheries Management Regulations 2019, Select Legislative Instrument No. 38, 2019, https://www.legislation.gov.au/F2019L00383/latest/text.

The regulation also identified where the burden of proof lies for specific clauses and details how speed is calculated from tracking system data.

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Table 27. South Africa – Regulations Relating To the Entry of Foreign Fishing Vessels into South African Waters[58]

Regulatory text:
4. Notification of entry into South African waters

The master of a foreign vessel which intends to traverse South African waters, but which does not intend to enter a port, must notify the minister of the intention to enter and traverse South African waters at least 24 hours prior to entry and that notification must include the following:
(a) an estimated date, time and GPS position of entry into South African waters;
(b) an estimated date, time of and GPS position of exit from South African waters;
(c) the reason for entry; and
(d) a description of the path to be traversed.

Comment:
An entry-reporting obligation creates a verifiable compliance point. Tracking data can be used to confirm whether entry occurred as reported, and the catch declaration adds accountability.

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Table 28. United Kingdom – Category B Licence: Schedule (31) Over 10 meters Vessels[59]

Regulatory text:
Rockall (Area 6b) – All Closed or Restricted Areas

All vessels transiting such areas must maintain a transit speed of 6 knots or more (except in the case of force majeure or adverse conditions). Any vessel falling below 6 knots in a restricted area must make contact with the U.K.'s FMC immediately, detailing i) why they are in a restricted area below 6 knots ii) how long they intend to be there and estimated time of departure.

Comment:
This regulation shifts the prohibited action from fishing activity to vessel presence and speed. It allows compliance to be determined using tracking data alone, without needing to prove gear use.

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[58] South Africa, Department of Forestry, Fisheries and the Environment, "Marine Living Resources Act (Act No. 18 of 1998): Regulations for the Entry of Foreign Fishing Vessels into South African Waters," Government Gazette 53208, Notice R. 6524, Aug. 22, 2025, https://www.gov.za/sites/default/files/gcis_document/202508/53208rg11873gon6524.pdf.

[59] United Kingdom, Marine Management Organisation, Fishing Vessel Licence Conditions: Category B Licence Schedule 31, Version 7, effective Oct. 1, 2025, https://assets.publishing.service.gov.uk/media/68d694ef29e2934106866442/Cat_B_Licence_Schedule_31_V7_01Oct2025.pdf.

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Contact

info@globalfishingwatch.org
globalfishingwatch.org
@globalfishingwatch.org
@globalfishwatch
/globalfishingwatch
/globalfishingwatch

Global Fishing Watch is an international nonprofit organization dedicated to advancing ocean governance through increased transparency of human activity at sea. By creating and publicly sharing map visualizations, data and analysis tools, we aim to enable scientific research and transform the way our ocean is managed. We believe human activity at sea should be public knowledge in order to safeguard the global ocean for the common good of all.

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