Leveraging emerging technologies for monitoring, control and surveillance of high seas marine protected areas: A practical guide

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In 2023, States adopted a new Agreement under the United Nations Convention on the Law of the Sea (UNCLOS) on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction (BBNJ Agreement). This Agreement "provides a global and cross-sectoral legal basis that enables the designation of marine protected areas (MPAs) in all marine areas beyond national jurisdiction and across all sectors of human activities".[1] Lessons learned from existing MPAs and high seas governance demonstrate that a critical factor to ensure the success of future high seas MPAs (HSMPAs) is the development of a tailored compliance strategy. This strategy should address the specific policy, institutional and stakeholder behavioural characteristics of each site, with the goal of ensuring compliance and enforcement through targeted measures and tools. Among the tools that should be considered are those related to the monitoring, control and surveillance (MCS) of human activities, particularly those stemming from emerging technologies (e.g. digital surveillance tools, satellite-based systems, big data analytics, artificial intelligence). This Study aims to serve as a practical guide for States and stakeholders championing high seas MPAs, helping them integrate these MCS tools into their proposals.[2]

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[1] De Lucia, V, (2024). "After the Dust Settles: Selected Considerations about the New Treaty on Marine Biodiversity in Areas beyond National Jurisdiction with Respect to ABMTs and MPAs," *Ocean Development & International Law*, *55*(1–2), 115–136. https://doi.org/10.1080/00908320.2024.2333893

[2] This *Guide* focusses on MCS of human activities (i.e. does not include biological or environmental monitoring).

KEY MESSAGES

Proponents of HSMPA proposals should develop and integrate a compliance strategy into their submission, incorporating relevant MCS tools and leveraging opportunities provided by emerging technologies. To implement such tools, a step-by-step approach can be followed, including: (i) conducting a stocktake of MCS capacities; (ii) identifying tools that align with site-specific needs; (iii) exploring the use of specialized MCS services; and (iv) defining complementary targeted measures.

In many cases, initiatives may build on, and adapt if necessary, existing MCS tools and services already implemented by sectoral/regional organizations or individual States. In other cases, an MCS system will need to be developed from the ground up.

Private companies and non-profit organizations offer the deployment and operation of specialized services tailored to specific contexts, which aim to integrate various data sources from technological tools and apply them to the management of maritime areas. Proponents of HSMPAs may consider using such services, while anticipating that the associated establishment and management costs will widely depend on the tools, services and management measures already in place.

Supporting policy and technical measures—such as addressing capacity gaps, fostering cooperation for maritime patrols, strengthening port State controls, reforming national judicial systems, and ensuring effective information sharing—may be necessary to operationalize technology and ensure the effective management of future HSMPAs.

GUIDE

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1. INTRODUCTION

Adopted in 2023, the Agreement under the United Nations Convention on the Law of the Sea (UNCLOS) on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction (BBNJ Agreement) establishes a specific procedure for the creation of high seas marine protected areas (HSMPAs). This process includes the submission of a MPA proposal by one or several States Parties, an evaluation by a Scientific and Technical Body (STB), a consultation phase, and formal adoption, which can be achieved by a three-quarters majority vote.[1] Proposals must include a "draft management plan encompassing the proposed measures and outlining proposed monitoring, research and review activities to achieve the specified objectives."[2]

The effectiveness of future HSMPAs will undoubtedly be closely scrutinized, making it essential for champion States and coalitions to anticipate implementation challenges carefully. In this regard, lessons learned from existing MPAs and from high seas governance highlight that a key factor in ensuring effective enforcement of management plans and associated regulations is

the development of a robust compliance strategy. This strategy should define the desired outcomes, the behaviors to be influenced, the risks to be mitigated and the development of relevant measures and tools. In this context, integrating monitoring, control and surveillance (MCS) of human activities is of crucial importance. MCS covers "a wide range of tools, technologies and policies that can be used in a variety of contexts to promote compliance, increase transparency and contribute to the conservation and sustainable use of marine resources."[3] Carrying out MCS in areas beyond national jurisdiction (ABNJ) presents unique challenges due to remoteness, reliance on flag State responsibility for compliance and enforcement, limited capacity and resources, and the need for cooperation and coordination within a fragmented governance framework.[4] However, States can draw on existing experiences and seize opportunities offered by new technologies.

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[1]   BBNJ Agreement, Part III.

[2]   BBNJ Agreement, Article 19(4)(f).

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[3]   Cremers, K. *et al.* (2020). "Strengthening monitoring, control and surveillance of human activities in marine areas beyond national jurisdiction: Challenges and opportunities for an international legally binding instrument," *Marine Policy*, Volume 122.

[4]   The relevant international agreements and organizations usually focus on only one sector or their geographical scope is limited to a specific region, which poses considerable obstacles to the cooperation and coordination needed for effective management.

This *Study* aims to provide a practical guide for States and stakeholders championing HSMPAs, helping them integrate these MCS tools into their proposals. It proposes a four-step process: (i) conduct a stocktake of MCS capacities; (ii) identify tools that align with site-specific needs; (iii) consider utilizing specialized MCS services; and (iv) determine complementary targeted measures. This guide is based on extensive research on MCS tools and services, interviews with technology providers and policymakers, and a series of expert consultations held in recent years. The budget figures provided in this document are approximate estimates and will vary depending on the organization supplying the data and services.

2. STEP 1: CONDUCT AN MCS CAPACITY STOCKTAKE

2.1. Preliminary assessment

Most of the ocean, including ABNJ, falls under the mandate of one or several global and/or regional organizations. In many cases, competent organizations may already have developed conservation measures, collected information on human activities, and deployed MCS tools and services within a candidate MPA site. Similarly, one or more States may already conduct activities or operations in this candidate site, such as efforts to combat illegal activities. In this context, a preliminary MCS capacity assessment can help to provide a clear overview of the resources (e.g. tools, services, and providers) currently available or missing in the region. This exercise could also help identify both the States with the capacity to conduct MCS activities in the future HSMPA, and the organizations with a mandate to adopt and implement joint measures in the area.

There is no single, one-size-fits-all methodology to develop such an assessment. It can be done using a variety of data collection modes, such as questionnaires, interviews and focus group discussions with technical operators to cover different perspectives. **Table 1** below provides an example of a questionnaire that States and coalitions could use to identify the key tools and resources to build upon, as well as the gaps that need to be addressed.

2.2. Complementary Strategic Risk Assessment

A Strategic Risk Assessment (SRA) can usefully complement the MCS rapid assessment by gathering baseline information and gaining awareness of historical activities in the area. An SRA also supports the transition to live monitoring once conservation objectives and management measures are defined, helping to understand current impact risks and compliance challenges. An SRA likely includes:
— A review of Automatic Identification System (AIS) and Vessel Monitoring System (VMS) data, providing a characterization of maritime traffic, temporal and spatial trend

analyses (maps and graphs), an assessment of potential threats and individual risks, and a review of possible implications of establishing an MPA;
— An assessment of complementary MCS technologies, such as remote sensing, to strengthen surveillance and enforcement;
— Recommendations on the most effective approach to MCS; and
— Relevant economically exploitable interests, present (fishery resources) and future (deep sea minerals, MGRs, eolian energy, geoengineering).

Conducting a SRA typically takes approximately three months to one year; however, in certain cases, it may be completed within a shorter timeframe. SRAs can be developed by both private companies and not-for-profit organizations, with costs typically starting at around USD75,000. The cost of the AIS data stream is highly dependent on the size of the area covered.

3. STEP 2: IDENTIFY TOOLS THAT MATCH SITE NEEDS

Step 1 should provide an initial overview of the existing resources in terms of MCS tools and services, as well as identify any potential gaps. To address these gaps, States and stakeholders championing the HSMPA proposal should then identify the required MCS tools that best align with the specific needs of the site and complement what already exist. **Table 2** provides a non-exhaustive overview of MCS tools, highlighting their respective benefits and limitations, and **Box 1** focuses on the case of patrol vessels.

While the MCS toolkit is evolving rapidly, there is no 'one-size-fits-all' solution. Instead, a range of factors should be considered when assessing the suitability of a particular MCS approach, including its purpose, cost, accessibility, reliability, coverage, susceptibility to manipulation, and implications for privacy. Experience in MPA management shows that effective MCS strategies typically rely on a combination of complementary tools and associated services, which are described in Step 3.

TABLE 1. Example of questionnaire for a preliminary MCS capacity assessment

TYPE OF MCS CAPACITY	KEY QUESTION(S)	RATIONALE
Governance	Which international and regional organizations have a mandate to manage human activities in the area?	The International Maritime Organization (IMO) and some regional fisheries management organizations (RFMOs), for example, have put in place obligations for vessels to report on their activities in the high seas.
	Are there any other types of spatial measures established in or close to the site?	There may already be some conservation management measures in place, such as fisheries closures under RFMOs or particularly sensitive sea areas (PSSAs) under the IMO.
	What types of cooperation and coordination are taking place in the region? What are the challenges and opportunities? What legal tools may be used to ensure compliance with conservation management plans? Which justice systems may jurisdiction be delegated to, in order to establish enforcement?	Member States of the North-East Atlantic Fisheries Commission (NEAFC) conduct joint patrols and inspections at sea and allow inspectors from one contracting party to board another contracting party fishing vessel.
	Which flag States are active in this area of the high seas?	Flag States active in the area might be willing to play a championing role in terms of MCS, enforcement or funding of the HSMPA.
Stakeholders	Who are the relevant stakeholders (government, private sector and civil society) that can help with MCS?	Non-State actors, including private companies, non-profit organizations and MCS networks can provide MCS tools and data, conduct analysis, and provide capacity-building and transfer of marine technology. The International Criminal Police Organization (INTERPOL) also regularly supports States in MCS activities by providing intelligence and assisting with enforcement operations.
	Who are the relevant stakeholders responsible for human activities in the area?	The stakeholders active in the area will need to be consulted and informed about any monitoring obligations and new rules to be complied with.
Data	Are there already relevant national, regional and international institutions that host datasets on human activities in the site or possess technical expertise critical to the management of the HSMPA?	In the NEAFC context, States Parties mandate their vessels to share electronic reporting system data with inspectors, regardless of the inspectors' nationality or State of jurisdiction.
	Is there a national or regional MCS center collecting or able to collect data on human activities from the site?	The Fisheries Committee of the West Central Gulf of Guinea (FCWC) established a regional MCS center through which States maintain a regional record of authorized fishing vessels and conduct joint at-sea patrols.
	Are there any available open-source data, such as MCS-relevant satellite observation data?	The European Commission provides freely available satellite data through its Copernicus program. Remote sensing data can be used for ship detection at a set frequency, e.g. every 12 days. Vessel tracking through AIS (Automatic Identification System) can follow vessel activity in near-real-time. Some NGOs derive information from AIS data and other sources to create maps to make data on vessel activities publicly available.
	What challenges or barriers are present at the institutional or individual level, which prevent successful prosecution of non-compliance? What are the cyber security standards for such databases?	Many cases of non-compliance fall through because of weak cases or problems with the collection of evidence of the non-compliant activities. Beyond the collection and sharing of data, there also needs to be capacity to analyze the data. This data only has an impact if it is effectively gathered, delivered and used by decision-makers. There need to be follow-up procedures after violations are detected, such as patrols and correspondence with relevant flag States.
Tools	What kinds of MCS tools are available in the region? What are the national legal frameworks related to the use of such tools in court (electronic evidence, possibly including artificial intelligence) by flag or coastal States that may seize jurisdiction?	In the last decade, a range of new technological tools such as satellite technology and artificial intelligence has supplemented traditional approaches to MCS, such as onboard observers, logbooks and surveillance vessels and aircraft (see Table 2 below). Courts need to be able to use evidence coming from emerging technologies; otherwise MCS has no capacity to deliver actual enforcement.
	Are there coastal or RFMO patrol assets available in the area that can be used for high seas patrolling? If coastal States have vessels, drones, or aircraft, are they able to effectively patrol the high seas regularly and/or intervene efficiently when suspicious activities are detected?	Most States do not have vessels to patrol the high seas. On the other hand, Contracting Parties to NEAFC and to the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) conduct joint high seas patrolling.
	Are there joint and/or high seas inspection/shiprider or aerial patrol schemes in place in the area?	Certain States have established "shiprider agreements" that allow the flag State of a patrol vessel to carry onboard compliance and enforcement officers from another coastal State. These officers have the authority and jurisdiction to conduct boardings and take enforcement action when non-compliance is documented. Under the CCAMLR System of Inspection, States Parties conduct aerial and at-sea joint patrols. Beyond cooperation across neighboring States, there are also other joint patrolling examples. In certain areas in West Africa, French patrol vessels conduct joint patrols with coastal States. Non-State actors, such as Sea Shepherd, also help coastal States with their patrolling efforts.
Services	What are the standards of training of the personnel that may be employed in MCS and enforcement?	Soft skills are essential to ensure compliance, including maritime domain awareness (MDA) analysis capacities, vessel operation, navigation, enforcement, operational planning and evidence management.

TABLE 2. A non-exhaustive overview of MCS tools, their benefits and limitations for high seas MPAs

Aerial and vessel manned surveillance

Description. Aircraft or vessels occupied and operated by humans for MCS operations at sea.

Main benefits. High deterrence; compliance officers onboard can cross-check reported information; accepted as proof in court; interruption of ongoing illegal activity; possibility to take immediate action.

Main limitations. Expensive; risky for human life; significant human resources required; limited jurisdiction of patrol vessels in ABNJ; low detection rate of infringements if not combined with risk assessments or previous detection of suspicious activities (rerouting patrols).

Observer programmes

Description. Observers record information about the vessel they are on, and this information can be used for compliance purposes. Most observer programmes have been established by RFMOs to document data and information for scientific purposes, but some allow for independent human presence on fishing vessels to document compliance and potential non-compliance with regulatory requirements.

Main benefits. Can be done through joint operations organized by States on the high seas; live cross-checking of reported data; already in place for some activities and adding data to collect is not expensive.

Main limitations. In most cases, observers do not have enforcement power; risk to their integrity and safety; vessels do not always have the conditions to host onboard observers; the number of observers is too small compared to the number of operating fishing vessels.

Electronic recording and reporting services (ERS)

Description. A set of digital tools designed to record and report fishing activities. At the core of ERS data is the fishing logbook, in which the master records all fishing operations, indicating specifically all quantities of each species caught and kept on board.

Main benefits. Less time-consuming to fill in than paper-based logbooks; easier to cross-reference with data coming from other tools.

Main limitations. High costs of training, equipment and technological infrastructure; self-reporting, misreporting and non-reporting; fisheries data is often subject to legal and confidentiality constraints.

Automatic identification systems (AIS)

Description. Satellite-enabled systems that transmit a vessel's position to alert other ships to avoid collisions and for search and rescue actions. The IMO requires ships over 300 metric tonnes to install AIS systems. Some flag and coastal States also require fishing vessels to use AIS and many fishing vessels use AIS voluntarily for navigation and safety purposes.

Main benefits. Publicly accessible for basic use (limited in resolution or delayed in time); can be used to identify ships suspected of criminal activities; signals are sent automatically.

Main limitations. Risk of tampering; can be turned off; confidentiality and safety concerns; not used by all vessels; based on declaration from the boat, which means data needs to be cleaned up and processed to have a reliable dataset.

Vessel monitoring systems (VMS)

Description. Satellite-based system that enables fisheries authorities to monitor fishing vessels by receiving regular updates on their position, course and speed. This data is recorded and transmitted through shipboard tracking devices, allowing vessels to be automatically identified and located.

Main benefits. Admissible as evidence in several courts; more difficult to tamper with compared to AIS; most of the long-distance fishing fleets are already equipped with VMS.

Main limitations. Expensive for small fleets; no global regulation or standard; data is reported once every 1 to 4 hours; VMS data is subject to legal and confidentiality constraints and the flag State does not have to share the data with other stakeholders.

Satellite surveillance technology, e.g. use of satellite imagery, Satellite Synthetic Aperture Radar (SAR) and Visible Infrared Imaging Radiometer Suite (VIIRS)

Description. Pictures and data collected by imaging satellites orbiting the Earth. Also includes the identification of objects from a distance by satellite either by using radar to detect objects (SAR) or detecting light emitted by vessels (VIIRS).

Main benefits. High-resolution satellite imagery from commercial data can be used to identify smaller vessels; the combination with AI software enhances analysis of satellite imagery data.

SAR ensures the detection of vessels up to a size of 10–15 m that are not using or transmitting AIS or VMS data; SAR can operate in any weather condition; VIIRS is particularly efficient at capturing images at night.

Main limitations. Requires significant financial and human resources for data access, storage and analysis; since satellite image data is large, it often requires a combination with other tools or AI, algorithms and software for data analysis; the frequency of satellite image capture is variable

depending on the satellite constellation orbit (from hours to days); global coverage is not available on a daily basis; some images may lack the necessary quality to fully identify vessels or determine their actual activity at sea; not yet admissible as evidence in several courts.

Long-Range Identification and Tracking (LRIT) system

Description. System for global identification and tracking of ships mandated by the IMO to enhance the security and safety of shipping and marine environment protection. Positional and identification data are collected and transmitted by shipborne equipment using the Global Navigation Satellite System (GNSS).

Main benefits. States may request the position of a vessel at the frequency of 6-hour intervals or higher; the regulations that require ships to participate in the LRIT system apply to the following types of ships engaged on international voyages: Passenger ships, including high-speed passenger craft; Cargo ships, including high-speed craft, of 300 gross tonnage and upwards and Mobile offshore drilling units.

Main limitations. While AIS only requires vessels to turn the receiver on, LRIT requires active participation by the vessel owner; data is not publicly available; data exchanges between LRIT users (contracting States such as flag States, port States and coastal States as well as search and rescue services) is supported by a system of National, Regional, Cooperative and International LRIT Data Centres, using the International LRIT Data Exchange where necessary.

Analytical software i.e., "Big Data", cloud computing, machine learning and Geographic Information Systems (GIS)

Description. Computer programs and tools designed to analyse data, extract meaningful insights, and support decision-making processes.

Main benefits. Optimizes MCS services leading to targeted interventions, thereby saving time and effort that would otherwise be used on manual operations.

Main limitations. Human resources required to operate analytical software are highly qualified and can be costly. However, the use of AI can mitigate some of these costs.

Unmanned vehicles (UVs) i.e., drones (unmanned surface vehicles (USV), unmanned underwater vehicles (UUV) and remotely operated vehicles (ROV))

Description. Aircraft or vessels that are pre-programmed or operated remotely by humans.

Main benefits. More cost-effective than manned patrols; does not expose staff to high-risk areas; discretion; conducts more extensive surveillance; covers long distances for extensive periods.

Main limitations. The initial investment can be expensive if the conception and creation of the vehicle are not internalized; for data collection purposes only: if the vehicle intercepts illegal or suspected activity, then no immediate follow-up action is possible on the water.

Remote electronic monitoring systems (REMs) i.e., closed-circuit television (CCTV) cameras

Description. Electronic devices that record or give a live view of onboard activities. The captured photos or videos are then reviewed and analyzed during or after vessel activities at sea through artificial and/or human intelligence.

Main benefits. Can be used to identify and record non-compliant behaviour; serves as a deterrent; images can be used in court; REM systems offer a cost-effective and safer alternative to human observers, especially in contexts where onboard observer coverage remains critically low.

Main limitations. Reluctance due to privacy considerations; cameras can easily get dirty, covered or not focus on the right target; large quantities of data to analyze with implications for human resources whether manually reviewed or processed automatically; data storage costs; and highly accurate for some specific tasks, but highly inaccurate for others.

1. Logan, R. K. et al. (2020). Sleuthing with Sound: Understanding Vessel Activity in Marine Protected Areas Using Passive Acoustic Monitoring. Marine Policy, Volume 120.

2. Traditionally, logbooks and other reporting equipment have been paper-based. ERS can be combined with paper-based reporting tools. As exemplified in Table 2, most MCS activities that rely on digital tools often include a paper-based minimum requirement in case the electronic system malfunctions.

3. However, the fisheries data could be made available through an agreement between the organization in charge of the HSMPA MCS and the flag States/RFMO in question. There are multiple agreements on data sharing between RFMOs, for example.

4. Global Fishing Watch (GFW). What is AIS? Retrieved August 1, 2024, from https://globalfishingwatch.org/faqs/what-is-ais/.

5. Some RFMOs allow AIS to be turned off in areas where safety is an issue.

6. Food and Agriculture Organization (FAO). Fishing Vessel Monitoring Systems (VMS). Retrieved August 2, 2024, from https://www.fao.org/figis/pdf/fishery/vms/en?title=FAO%20Fisheries%20%26amp%3B%20Aquaculture%20-%20Fishing%20Vessel%20Monitoring%20Systems%20.

7. Appleby, T. et al. (2021). Sea of Possibilities: Old and new uses of remote sensing data for the enforcement of the Ascension Island marine protected area. Marine Policy, Volume 127.

8. Depending on gear, data storage and management capacity of the regulatory body.

9. Ewell, C. et al. (2017). Potential ecological and social benefits of a moratorium on transshipment on the high seas. Marine Policy, Volume 81.

10. SAR is an active satellite-based remote sensing technology that creates high-resolution images of the Earth's surface.

11. VIIRS is a type of passive satellite-based remote sensing technology, designed to detect nighttime lights, such as artificial illumination from fishing boats.

12. Remote sensing usually occurs through satellite imagery but can also be done using aircraft. Emphasis should be placed on being "remote" from the object trying to be identified. See Earthdata. What is Remote Sensing? Retrieved August 3, 2024, from https://www.earthdata.nasa.gov/learn/backgrounders/remote-sensing.

13. Beukema, P. et al. (submitted on December 6, 2023). Satellite Imagery and AI: A New Era in Ocean Conservation, from Research to Deployment and Impact. NeurIPS Computational Sustainability 2023, http://arxiv.org/abs/2312.03207.

14. Reggiannini, M. et al. (2024). Remote Sensing for Maritime Traffic Understanding. Remote Sensing, Volume 16; Paolo, F.S. et al. (2024). Satellite Mapping Reveals Extensive Industrial Activity at Sea. Nature, Volume 626.

15. Li, Y. et al. (2023). Nighttime Fishing Vessel Observation in Bohai Sea Based on VIIRS Fishing Vessel Detection Product (VBD). Fisheries Research, Volume 258.

16. Rolf, E. et al. (2021). A Generalizable and Accessible Approach to Machine Learning with Global Satellite Imagery. Nature Communications, Volume 12; Beukema, P. et al., ibid; Hay, G.J. et al. (2005). An Automated Object-Based Approach for the Multiscale Image Segmentation of Forest Scenes. International Journal of Applied Earth Observation and Geoinformation, Volume 7.

17. Elvidge, C. (June 8, 2018). Identification of 'dark vessels'. GFW. Retrieved August 4, 2024, from https://globalfishingwatch.org/research/viirs/.

18. Appleby, T. et al. (2021). Sea of Possibilities: Old and New Uses of Remote Sensing Data for the Enforcement of the Ascension Island Marine Protected Area. Marine Policy, Volume 127.

19. IMO. Long-Range Identification and Tracking (LRIT). Retrieved July 23, 2024, from https://www.imo.org/en/OurWork/Safety/Pages/LRIT.aspx.

20. While the IMO has set a standard of 6-hour intervals for all shipping vessels bearing a LRIT system, States can request the position of a vessel at a higher frequency: See: https://www.imo.org/en/OurWork/Safety/Pages/LRIT.aspx.

21. Regulation V/19-1 of the 1974 SOLAS Convention.

22. "Active participation" means that vessel managers have to manually send signals of their position to the relevant authorities. See: https://www.dgshipping.gov.in/Content/LRITNationalDataCentre.aspx

23. For instance, AI can conduct data analysis on areas in the high seas where IUU fishing is most likely to occur. Authorities can then prioritize these areas for MCS activities, making those more targeted and more cost-effective.

BOX 1. **THE CASE OF PATROL VESSELS**

Manned aerial and surface patrol vessel surveillance remains one of the traditional methods used to monitor MPAs. By definition, high seas MPAs will be located in remote marine regions. Deploying conventional patrol assets to these areas will therefore be both costly (e.g. fuel, maintenance, crew, and other operational expenses) and time-consuming, especially when compared to remote satellite detection systems. However, past experiences, including in the Southern Ocean, have demonstrated the deterrent value of sustained patrol presence, which continues to justify maintaining a certain level of such efforts.

Clearly, not all States have the same capacity to conduct high seas inspections, some lacking vessels capable of operating in these areas. In addition, depending on national regulations, military vessels patrolling the high seas are often not mandated to enforce environmental regulations, being primarily focused on security and defense objectives. Moreover, constructing or assigning a dedicated vessel solely for the surveillance and enforcement of a HSMPA would be prohibitively expensive and financially unfeasible within the framework of the BBNJ Agreement.

As a result, maritime patrol-based surveillance of future high seas MPAs will largely rely on existing assets and on the voluntary contributions of individual States that have both the capacity and the political will to support such efforts. For States and coalitions developing HSMPA proposals, this implies that:

– The mapping of existing MCS tools and human capacity should help identify opportunities or gaps to conduct patrols in the proposed area; and

– The cost of such surveillance does not necessarily need to be fully anticipated or budgeted, as it may rely not on the collective international community, but on in-kind contributions from willing States.

Within national jurisdiction, there are various public-private partnerships where non-profit or commercial actors supply logistical support, including vessels, to enforcement officers to conduct patrols. This type of support could be expanded to the high seas context in the case of HSMPAs.

4. STEP 3: CONSIDER UTILIZING SPECIALIZED MCS SERVICES

4.1. Setting up an initial MCS framework

MCS tools are only effective if they are integrated within a dedicated structure or platform, forming what can be referred to as an MCS framework. For technological MCS tools in particular, the development of a **dedicated software platform to monitor vessels** may be necessary in case there is no existing platform that could be used. This could include the creation of a ship register covering several thousands of vessels and the establishment of communication channels with flag States. Such a system would allow the processing of VMS positions and, where applicable, the recording and transmission of fishing logbooks through the electronic recording and reporting system. The estimated cost of this setup is approximately USD115,000.

In some countries or marine regions, **MCS centers** have been established, especially in the fisheries context. These are dedicated facilities tasked with coordinating, managing, and implementing activities related to the MCS of fishing activities. MCS centers function as operational hubs for data collection, real-time vessel tracking, information sharing, legal and regulatory enforcement support, and the coordination of patrols, observer programs, and other surveillance tools. As of today, it is uncertain whether the creation of an HSMPA would, on its own, lead to the establishment of a new national or regional MCS center, given the high associated establishment costs. However, in regions or States where there is a need to strengthen MCS in their national waters, the designation of a HSMPA in adjacent areas could reinforce the rationale for establishing such a center.

If the MCS capacity stocktake under Step 1 reveals that certain elements, such as a vessel database or ship registry, are already in place in the area, the key question will be to what extent existing MCS activities need to be adapted or supplemented to effectively cover the proposed HSMPA.

4.2. Ensuring the daily MCS operations

Beyond ensuring there is a way to collect relevant MCS information, it is also essential to ensure there is capacity to visualize and analyze the data for decision-makers. Technology providers, whether private companies or non-profit organizations, can help States with the daily MCS operations by offering a range of tailored tools and services. The most common include:

— **Automatic Identification System (AIS) platform** that collects, processes and stores AIS positions and can be used to visualize vessel positions and movements in real-time. Some AIS platforms focus on showing vessel positions, whereas others also process data and automate events with the help of AI models to predict vessel activities.

— **Vessel Monitoring System (VMS) platform** that monitors fishing vessels equipped with VMS within a defined area using a dedicated software platform. The pricing model and

the polling rate (the frequency at which data is sent to the platform) is typically based on the size and complexity of the fleet, such as the number of flag States and the degree of fleet homogeneity, rather than the surface area of the MPA.
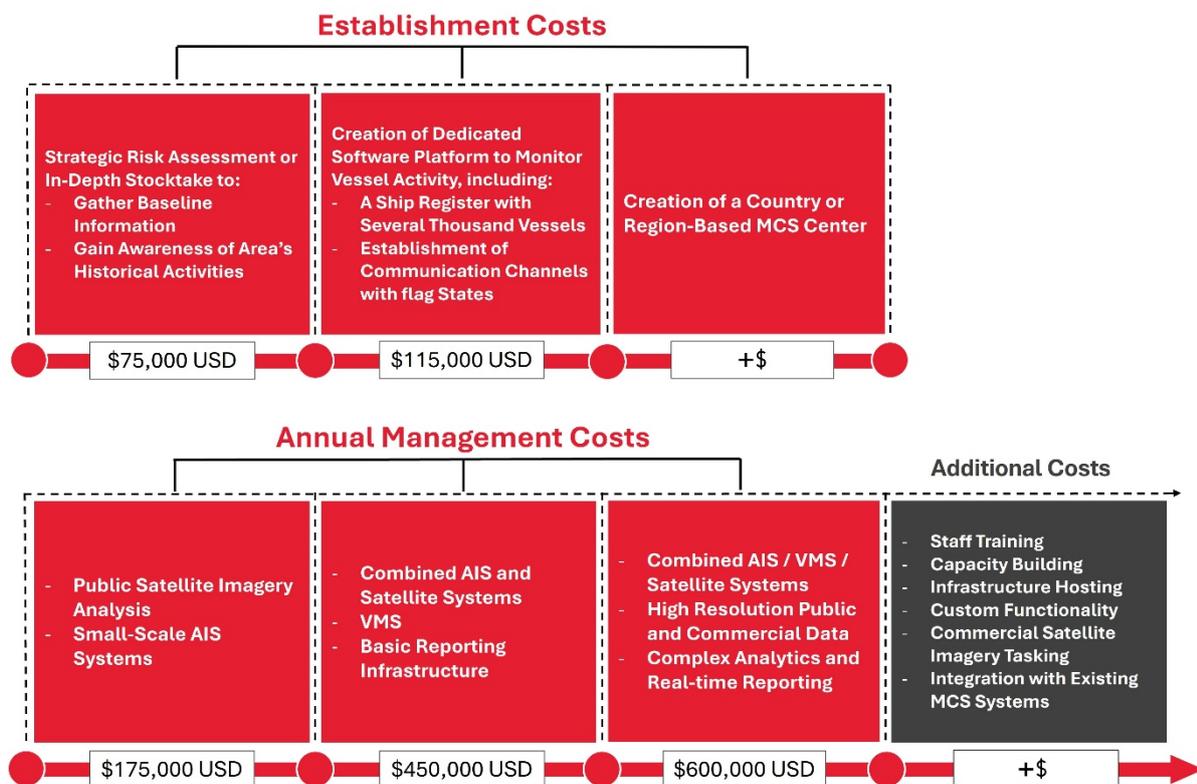
— **Satellite imagery detection services** that can identify vessels even when AIS or VMS systems are turned off. These services can be significantly enhanced by using open-source data, such as imagery from the Copernicus Sentinel-1 constellation, which is available free of charge for analysis. However, the European Space Agency (ESA) manages the operation of the Sentinel-1 satellite, which does not provide full global coverage and generally operates close to the coast. Still, if there is political will, ESA could task Sentinel-1 to collect satellite imagery over future HSMPAs under its coverage area. On-demand image acquisition is possible through commercial operators, who offer a wider range of resolutions and more targeted coverage, but this comes at a significantly higher cost.

— **Data analysis services**, tailored to address specific monitoring and enforcement needs, depending on the site in question. These services rely on site-based evidence and information produced through tools such as AIS/VMS and satellite imagery to draw conclusions that support management objectives. These services may include, for example:

assessments of AIS coverage and transmission gaps; predictive probability modeling of an event of interest based on available observations; investigations into specific vessels or fleets; and risk analyses that integrate data from multiple sources. Many emerging technologies are centered around the use of machine learning and AI in improving the efficiency and accuracy of analysis.

— **Capacity building services**, to create and/or maintain the expertise of the data users.

Figure 1 summarizes the establishment and annual management average costs of an MCS framework for a HSMPA, assuming that no tools or services are currently in place in the area. However, in the vast majority of cases, this MCS framework can be built, either directly or with some adaptations, on existing tools and services already implemented by sectoral and regional organizations, including RFMOs that cover a large part of the global ocean. In addition to the costs mentioned below, there may be an annual license fee that determines the number of analysts who can use the platform simultaneously, as well as necessary training sessions for data use or experience-sharing workshops. **Box 2** provides a non-exhaustive overview of factors that will influence the cost of MCS activities for future HSMPAs and their distribution.

FIGURE 1. Indicative Establishment and Management Costs of a MCS framework for High Seas MPAs where no previous MCS Systems Exist

4.3. Evaluation

The MCS framework, and more broadly the entire compliance strategy, should be based on an adaptive management cycle that enables continuous improvement by learning from the outcomes of past and current practices. This could include a reality check to ensure that management measures are aligned with available resources.

5. STEP 4: DETERMINE COMPLEMENTARY TARGETED MEASURES

The use of the most relevant tools and technologies alone may not be sufficient to ensure effective MCS of HSMPAs.[8] In many cases, complementary technical and policy measures are also required to: (i) address capacity gaps, (ii) foster cooperation in maritime patrols, (iii) strengthen port State controls, (iv) reform judicial systems, and (v) ensure effective information sharing.

5.1. Closing capacity gaps

The effective use of MCS technologies requires robust institutional and technical capacity, particularly for analyzing collected data, interpreting results, and translating them into appropriate policy or technical measures. The MCS capacity stocktake (Step 1) may have identified gaps and/or disparities in capacity between States that need to be addressed. Capacity-building programs provided by various donors and organizations can help bridge these gaps. Additionally, the financial mechanism established under the BBNJ Agreement offers further opportunities to support capacity development. The Clearing-House Mechanism[9] (CHM) established by the BBNJ Agreement could also play a key role in facilitating targeted match-making to meet States' MCS needs by supporting the development of both financial and technical capacities.[10] The CHM can link States requiring financial support for MCS with donor States or non-State actors able to provide funding or in-kind contributions.[11] From a technical perspective, the CHM can also serve as a platform for identifying and facilitating the transfer of marine technology and access to relevant MCS data and expertise.[12] By engaging non-State actors—such as non-profit organizations and networks—the CHM can promote broader sharing of marine technology and technical know-how. This multi-stakeholder approach will be critical to ensuring the effective enforcement of HSMPAs under the BBNJ Agreement

5.2. Developing cooperation for maritime patrols

States Parties to the BBNJ Agreement could consider expanding upon or setting up cooperation agreements for joint maritime patrols that would allow for coordination, cooperation and

5   Rochette, J., Cremers K., Oliveira Pinto, A., Okoth-Menya, F., Ruston, L. (2024). Assessing the management costs of future high seas marine protected areas: an initial methodological approach. IDDRI, *Issue Brief* N°09/24.

6   Ban, N. *et al.* (2011). Promise and problems for estimating management costs of marine protected area. *Conservation Letters*, Vol. 4/3, 241-252.

7   Cremers, K., Oliveira Pinto, A., Okoth-Menya, F., Rochette, J. (2024). Monitoring, control and surveillance of future high seas MPAs: what role for emerging technologies? IDDRI, *Study* N°06/24.

8   Cremers, K., Oliveira Pinto, A., Okoth-Menya, F., Rochette, J. (2024). Monitoring, control and surveillance of future high seas MPAs: what role for emerging technologies? IDDRI, *Study* N°0624.

9   BBNJ Agreement, Article 51.

10   BBNJ Agreement, Article 51(3)(b).

11   BBNJ Agreement, Article 51(3)(b).

12   *Ibid.*

sharing of the burden of monitoring and enforcement in remote HSMPAs. This is especially beneficial for States with limited capacity for MCS activities on the high seas. Through joint MCS activities, States can minimize costs, improve overall monitoring and surveillance coverage, and increase trust amongst compliance and enforcement authorities. Joint patrols may need a specific Memorandum of Understanding (MoU) that States could either directly include as part of the MPA management plan or adopt after designation of the MPA through some kind of BBNJ Conference of Parties (CoP) endorsement.

5.3. Strengthening port State controls

Contrary to (adjacent) coastal States, the BBNJ Agreement does not mention the role of port States. However, flag States with limited control capacity on the high seas mostly rely on controls in port. The global minimum standards set by regional MoUs and the Port State Measures Agreement (PSMA) on inspecting foreign vessels when entering ports of another State in terms of shipping and fishing activities respectively can be useful in the context of HSMPAs. These port State control measures can support compliance and have a deterrent effect. Therefore, to facilitate the management and enforcement of HSMPAs, more States have to become party to the PSMA, expanding its coverage. The expansion of PSMA MoU models could be part of the management plan of the BBNJ MPA, requiring COP endorsement. However, the inclusion of such MoUs into MPA management plans may require parallel agreements as the COP endorsed MPA management plan may not suffice to provide mandatory PSMAs measures.

5.4. Reforming national judicial systems

MCS in high seas MPAs will only be effective if national judicial systems adapt to technological development. A challenge in relation to follow-up actions after identifying suspected illegal human activities in HSMPAs is ensuring there is a 'legal finish,' meaning that "the suspected persons are duly prosecuted and convicted by a court of law, if found guilty".[13] This is frequently missing because of a lack of domestic legislation or international cooperation.[14] Moreover, an essential aspect of the capacity for follow-up law enforcement actions in ABNJ is to ensure that the State which is proceeding to enforce the law has the jurisdiction. For example, there is the possibility to apply flag State jurisdiction or national jurisdiction of the crew and management company, the choice of which will have an impact on which actors to hold accountable.[15] In addition, the regulatory framework often does

not keep up with the rise of innovative technology. For example, courts do not always accept images coming from satellite technology as sole evidence. Prosecution authorities also need permission from the vessel and/or flag State to have access to VMS data or need to rely on the PSMA and other international information-sharing agreements.[16] Strengthening and updating the judicial system and ensuring sanctions are deterrent can also significantly enhance MCS efforts.[17] Applying deterrent fines for not respecting the MPA management plan could help enforce HSMPAs. States Parties to the BBNJ Agreement should therefore carefully assess their domestic legal frameworks and undertake the necessary reforms to ensure that MCS technologies can be effectively used for enforcement purposes. States could also develop exchanges and cooperation on enforcement mechanisms, and invest in capacity building for prosecutors and judges to handle technology-based cases. Such measures would help bridge the gap between technological capability and formal legislative reform.

Moreover, fisheries-related crimes are often interconnected with other types of crime, such as money laundering and human trafficking, requiring a cross-sectoral and inter-ministerial approach.[18] This is the approach that is advocated by the International Criminal Police Organization (INTERPOL) and the UN Office of Drugs and Crime (UNODC) as a global standard for combating fisheries crime.[19] From 2013 onwards, INTERPOL served as the central coordination hub for global law enforcement, driving intelligence sharing, joint operations, and legal action against organized fisheries crime networks through Project Scale.[20] However, INTERPOL's Global Fisheries Enforcement team was disbanded in recent years due to a lack of funding.[21] States parties to the BBNJ Agreement could look into ways to fund INTERPOL to help with the enforcement of HSMPAs. Through Project GAIA, INTERPOL continues to provide mentoring and capacity-building to its member countries to strengthen law enforcement capabilities aimed at detecting and investigating fisheries-related crimes.[22] UNODC also helps

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13   UNODC. (2023). Flag State Jurisdiction and Transnational Organized Crime at Sea: Issue Paper.

14   Ibid.

15   UNODC issue paper "Surveillance and enforcement of high seas MPAs and related measures", Available at: https://www.unodc.org/documents/Maritime_crime/UNODC_GMCP_Surveillance_and_Enforcement_of_High_Seas_MPAs_and_Related_Measures.pdf

16   Appleby, T. et al. (2021). Sea of possibilities: Old and new uses of remote sensing data for the enforcement of the Ascension Island marine protected area. Marine Policy, Volume 127.

17   Cremers, K. et al. (2020). Strengthening Monitoring, Control and Surveillance in Areas Beyond National Jurisdiction. STRONG High Seas Project.

18   Cremers, K. et al. (2021). Options for Strengthening Monitoring, Control and Surveillance of Human Activities in the Southeast Atlantic Region. STRONG High Seas Project; UNODC. UNODC Approach to Crimes in the Fisheries Sector. Retrieved June 7, 2024, from https://www.unodc.org/documents/Wildlife/UNODC_Approach_to_Crimes_in_the_Fisheries_Sector.pdf.

19   This was politically endorsed by the International Copenhagen Declaration (15 October 2018) on transnational organized crime in the fishing industry, supported by Norway and several oceanic states (Indonesia, Ghana, Kiribati, etc.), now led by the Blue Justice initiative: https://bluejustice.org/copenhagen-declaration/

20   https://www.interpol.int/en/News-and-Events/News/2013/INTERPOL-launches-Project-Scale-to-combat-fisheries-crime.

21   https://www.nationalgeographic.com/environment/article/interpol-illegal-fishing-detectives.

22   https://www.interpol.int/en/Crimes/Environmental-crime/Projects/Project-GAIA.

ongoing capacity-building efforts by delivering law enforcement trainings and encouraging the use of advanced monitoring tools, such as satellite-based surveillance for the protection of MPAs, including aspects related to marine pollution beyond crimes in the fisheries sector. If needs arise, countries should engage with INTERPOL and UNODC to seek support in reforming their national systems.

5.5. Ensuring effective information sharing

The MCS capacity stocktake may highlight that there are already multiple organizations collecting data on human activities in the area of the proposed HSMPA. This means that States likely do not start from scratch when collecting relevant data for HSMPAs. The fragmented governance framework in the high seas and data confidentiality rules have led to a situation where not all data collected by intergovernmental organizations, such as RFMOs, is shared with other organizations, non-contracting Parties and the general public. The consequence is that there are implementation gaps and interoperability challenges. The BBNJ Agreement provides an opportunity to advance existing global initiatives to ensure cross-sectoral traceability of human activities at sea. Data exchanges between organizations require systems designed for interoperability, which is currently far from being systematic. For instance, States should aim to make flag State ship registers interoperable with thematic registers (e.g. the FAO's Global Record, the IMO's Global Integrated Shipping Information System and the ISA's DeepData Database) considering the multi-sector surveillance that will likely be required for HSMPAs.

The BBNJ CHM could also be an opportunity to share MCS data and pool analytical resources. It aims to enhance transparency and coordination among States involved in HSMPAs by making information accessible. While concerns about sensitive data persist, improved information sharing can reduce costs for parties with limited capacities and enhance MCS coverage on the high seas through international cooperation. This is why it would be cost-efficient to either designate or create a MCS center for one or more HSMPAs with a dedicated department and staff responsible for collecting, sharing and analyzing information. The CHM might be able to fulfil some of these roles, but it is likely going to be limited in what it can do in terms of follow-up actions. In addition, BBNJ States Parties could support the proposal by Norway to establish a new binding international agreement that requires the use of vessel tracking systems on board of fishing vessels and obliges States to share position data with other States.[23] This

agreement could be an opportunity to help make vessel data more interoperable and standardized. This would enhance transparency and facilitate access to and exchanges between all States of the same data. In turn, this can help coastal States who have limited MCS capacity play a role in monitoring vessels in HSMPAs.

6. CONCLUSION

As HSMPAs move from negotiation to implementation, their credibility will largely depend on their demonstrated effectiveness, placing particular responsibility on champion States and coalitions to anticipate and address implementation challenges from the outset.

In this regard, traditional tools, such as maritime and aerial surveillance, will require complementary technological solutions that are becoming essential for monitoring human activities in the remote areas of the high seas. Over the last decade, there has been a rapid increase and dissemination of innovative MCS technologies, driven by falling costs, open access to satellite data, and greater investment in artificial intelligence, big data solutions, cloud computing, and skilled human resources. These technological tools, provided by companies, the public sector, and non-profit organizations, can deliver significant added value to the implementation of management plans for future high seas MPAs, optimizing resource allocation and providing near-real-time insights into suspected illegal activities at sea.

However, technology alone will not be sufficient. Supporting policy and technical measures—such as addressing capacity gaps, fostering cooperation for maritime patrols, strengthening port State controls, reforming national judicial systems, and ensuring effective information sharing—will be critical to operationalizing technology and ensuring the effective management of future high seas MPAs.

Furthermore, a precise assessment of the budgetary requirements to establish and sustainably operate technological tools and associated services is essential to anticipate funding needs. Data collected from various technology providers suggest that the annual management costs could be in the range between USD175,000 and USD600,000 per year. That said, this scenario is likely less common, given the existing activities carried out by international organizations such as the IMO and RFMOs. In many cases, these bodies already have MCS structures available on which future high seas MPAs can partially or fully rely. Therefore, a precise financial assessment will need to be conducted on a site-by-site basis, taking this context into account.

By conducting an MCS stocktake, matching tools to site needs, considering specialized services, and implementing complementary measures, States will be better equipped to anticipate these various challenges. In doing so, these four steps will guide those championing high seas MPAs to ensure the effective integration of MCS policies and tools into their forthcoming proposals.

[23] https://www.fao.org/fileadmin/user_upload/COFI/COFI35/statements/NorwayAgenda7COFI35.pdf; https://www.fao.org/fishery/services/storage/fs/fishery/documents/COFI-FM/COFI-FM-2024/statements/members/NORAgenda3COFI-FM1.pdf