The challenge of IUU fishing in West Africa and The Potential Technology Solutions: An analysis of international cooperation projects in Ghana and Guinea-Bissau

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Executive Summary

Illegal, unreported, and unregulated (IUU) fishing is a social, economic and environmental problem. It undermines management and drives the depletion of fish stocks, threatens food security, and drains valuable resources from the economy. In recent decades, efforts have been made to build an international regime that can curb IUU fishing. However, implementing this regime and stemming the tides of IUU fishing remains challenging. At the center of this challenge is the necessity to create capacity in states for the monitoring, control, and surveillance (MCS) of fisheries.[1] Monitoring fisheries means measuring fishing effort characteristics and resource yields continuously. The control of fisheries concerns the establishment of regulations for exploiting resources. Surveillance refers to the measures to secure compliance with regulatory controls.

Effective MCS is a costly endeavor that entails gathering accurate information on fishing activities in vast sea areas, which can be a challenge for many states, particularly those with limited management capacity. There are also challenges related to securing evidence of IUU that holds up in the judicial system. In recent years, several technologies have emerged as solutions for states to increase their ability to monitor and surveil fisheries, and many new ones are being developed. International organizations, donor states, and NGOs have been engaged in building the capacity to use MCS technologies in the Global South to close the implementation gap in the IUU regime. This report's main goal is to assess the effectiveness of these tools in concrete contexts where they are the most needed.

West Africa, an important maritime fishing region and target for IUU fishing, is also where projects introducing technological tools for MCS have been implemented recently. This report analyzes projects in two West African countries with a high prevalence of IUU fishing—Ghana and Guinea-Bissau—to assess if and how the technologies introduced through international cooperation projects have helped these states implement MCS strategies. The report relies on extensive literature reviews, interviews, and the review of policy documents.

From the comparative analysis of the projects in the two cases, we conclude the following:

- Technological solutions can only be effective if they produce actionable information for fisheries management authorities. This means that technology-produced data must be compatible with the requirements in regulatory frameworks, helping not only to identify infringements, but also to produce juridically valid evidence for sanctioning perpetrators.
- The most used technologies monitor vessels' location and movement, hence limiting the range of illegal activities that they can capture. Thus, the effectiveness of these technologies tends to depend on executing patrols at sea.
- There is an asymmetry in the volume of projects and diversity of technologies operating in Ghana and Guinea-Bissau that may point to the necessity of interpreting success cases within their specific context.
- Synergies among projects seems most effective when building long-term state capacities in infrastructure and personnel.
- Regional cooperation appears to be an effective way to address asymmetries in capacity to confront IUU, further foster project synergies, and deal with the cross-boundary nature of IUU fishing.
- The potential of technology to contribute to the coordination of port, coastal and flag state responsibilities is still underexplored.

Based on these conclusions and the research, the following recommendations are worth considering for actors engaged in international development cooperation projects:

- Increase effectiveness of measures against IUU by ensuring that data produced by technologies are incorporated with improved governance, regulatory frameworks, and enforcement capacity.
- Further explore the potential of technologies that improve international transparency on fishing activities, such as REMS systems and data sharing platforms.
- Address asymmetry in the distribution of projects among recipient countries.
- Enhance projects synergies and sustainability by prioritizing technological solutions that create long-term capacities for better MCS within states or intergovernmental bodies.
- Utilize regional cooperation as a way to overcome country asymmetries in MCS capacities and address transnational IUU.
- Identify new opportunities for technology to enhance global collaboration between port, coastal, and flag states.

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1 We use the FAO's definition of MCS, as in Berg, Per Erik and Davies, Sandy "Fishery Monitoring, Control and Surveillance," A Fishery Manager's Guidebook (FAO, 2002). Available at: https://www.fao.org/3/y3427e/y3427e0a.htm

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The Challenges of IUU Fishing for Sustainable Ocean Governance

Fishing is considered illegal if not authorized by a relevant state or if in contravention of that state's laws, regulations, and international obligations. Fishing is unreported when efforts and catches are not reported or misreported to the relevant authorities. Finally, unregulated fishing refers to the blind spots of fisheries governance, where fishing activities are conducted by vessels without nationality or in areas without management and where fishing is not regulated.

IUU fishing is a problem in ocean governance because it threatens the sustainability of maritime ecosystems and human activities and communities that depend on oceanic resources. The necessity to sustainably manage marine biodiversity is enshrined in Sustainable Development Goal (SDG) 14, on the conservation of life below water.[2] Seafood is the source of livelihood and staple for the food security of a great part of the Global South, making it necessary to achieve other goals such as ending poverty (SDG 1) and hunger (SDG 2), and increase well-being (SDG 3).[3] By eluding national and international regulations toward sustainable fisheries management, IUU fishing bolsters overfishing, exacerbates the depletion of fish stocks worldwide, and, thus, is an important threat to the health of the biodiversity of the oceans.[4]

In the past few decades, several international agreements have been established to stem the tides of IUU fishing. A steppingstone in the quest to end IUU fishing is the FAO's International Plan of Action of 2001.[5] The 1982 UN Convention on the Law of the Sea (UNCLOS) provides guidelines on the distribution of responsibility for addressing IUU fishing and the course of actions of different authorities. The 1995 UN Fish Stocks Agreement (UNFSA) creates additional rights and obligations in this respect, and the 2003 Compliance Agreement and 2009 Port State Agreement add responsibilities for port states. The FAO has also adopted nonbinding instruments, such as the Voluntary Guidelines for Flag State Performance.

However, IUU fishing remains pervasive because of the complexity of global fisheries governance and the difficulties in implementing such agreements. Flag states with jurisdiction over fishing vessels are responsible for upholding transparent fishing registration and monitoring the activity of their fleets. According to UNCLOS they are also the main responsibility for the securing compliance of fishing vessels towards international obligations as well with the greatest authority to sanction non-compliance. Any effective action against IUU fishing requires the engagement of flag states. FAO has recently provided Voluntary Guidelines Flag State Performance that is meant to help flag states to fulfill their responsibilities. Coastal states have the sovereign right to regulate economic activities within their economic exclusive zone (EEZ), including the monitoring, control, and surveillance (MCS) of fisheries. Along with coastal and flag states, regional and subregional fisheries management organizations are also important when it comes to producing science-based management of fish stocks through regulation of fishing activities, mandatory reporting, observer programs, and the exchange of information. Finally, because they control the linkages between fishing and inland value chains, port states are also crucial in inspecting vessels for compliance with national and international regulations before landing their catch.

The difficulty in resolving the issue stems from several factors. The lack of regulatory harmonization and data transparency among states and Regional Fisheries Management Organizations (RMFOs) creates loopholes for IUU fishing.[6] Complex networks of ownership hinder the identification and sanctioning of all beneficiaries.[7] The use of flags of convenience and flags of noncompliance also help IUU fishing perpetrators explore this jurisdictional complexity. Furthermore, the vastness of the oceans—and even EEZs—makes the monitoring, controlling, and surveillance of marine fisheries difficult to implement. Recent efforts to address IUU fishing have included multilevel coordination among flag states, port states, coastal states, and RMFOs. The Port State Measure Agreement (PSMA), one of the most important developments in the fight against IUU fishing, relies on such coordination; it allows port states to exert their authority to inspect and deny access to vessels that approach their territory and have linkages with IUU fishing. Thus, the PSMA can be an important deterrent to IUU fishing because it limits their ability to land their catch. However, it can only be effective if the port state is a party to the agreement and if the port authorities have access to accurate information on vessels, including the history and licenses of such vessels, which requires strong information sharing and transparency with those authorities engaging in fisheries MCS.

In this sense, the international community has progressively hailed the potential of technology to help close

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2 United Nations. Sustainable Development Goals. Available at: https://www.un.org/sustainabledevelopment/oceans/

3 Okafor-Yarwood, Ifesinachi. "Illegal, unreported and unregulated fishing, and the complexities of the sustainable development goals (SDGs) for countries in the Gulf of Guinea," Marine Policy 99 (2019), 414–422.

4 Widjaja, Sjarief, Tony Long, and Hassan Wirajuda. "Illegal, unreported and unregulated fishing and associated drivers," Blue Paper. High Level Panel for a Sustainable Ocean Economy, 2020.

5 FAO, "International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing," 2001

6 Widjaja, Sjarief, Tony Long, and Hassan Wirajuda. "Illegal, unreported and unregulated fishing and associated drivers," Blue Paper. High Level Panel for a Sustainable Ocean Economy, 2020

7 Widjaja, Sjarief, Tony Long, and Hassan Wirajuda. "Illegal, unreported and unregulated fishing and associated drivers," Blue Paper. High Level Panel for a Sustainable Ocean Economy, 2020

this implementation gap in the international fisheries regime. Technology can assist authorities in taming the elusiveness of activities at sea and provide more accurate data on fisheries and overall vessel activities. Such information can provide actionable intelligence for the MCS of fisheries, thus allowing for more targeted enforcement by coastal and port states. Furthermore, such data can feed shared information systems and help coordinate efforts among authorities in the fight against IUU fishing. Nevertheless, for technology to be effectively used in stemming the tides of IUU fishing, laws and an improved judicial system have a complementary role to play so that the information received can be used to identify perpetrators and arrest and prosecute them. The next section further discusses the role of technology in addressing IUU fishing, reviewing the main technological tools available for this endeavor.

Technology and the Potential for Closing the Implementation Gap in the IUU Fishing Regime

Technology has become central in global strategies to address IUU fishing and promote sustainable fisheries for three interconnected reasons. First, they render fisheries "legible"[8] by the relevant authorities; that is, they allow for knowing the aspects of fishing activities (i.e., efforts, catches, gears) that would otherwise be difficult, costly, or impossible to assess without technological aid. Second, this information can better underpin MCS strategies and guide policy interventions for identifying and sanctioning non-compliant behavior. Third, more accurate data on fishing activities can be translated into better evidence-based fisheries management decision-making, supporting efforts to estimate the status of fish stocks and their maximum sustainable yields (MSYs). If translated into regulation, these data can help enhancing the sustainability of legal fishing activities. Technological tools against IUU fishing can be sorted into three broad groups. The first group comprises various data-generating devices that capture relevant information about fishing activities. The second group comprises technologies for processing and analyzing the data generated by these devices to inform action by the relevant authorities. Finally, the third group is information sharing and transparency technologies, which make already processed data available to multiple relevant authorities nationally and internationally.

Data-Generating Devices

Vessel monitoring systems
Vessel monitoring systems (VMSs) are the most established of these technologies. There are several different types of VMS technologies; they automatically report vessels' position at sea to an inland monitoring center. They allow MCS authorities to enforce closed fishing seasons and area restrictions better, estimate catches, and identify suspicious behavior (such as transshipments) for more effective maritime patrolling. Some VMS systems allow for reporting fishing activities and catches, integrating fisheries MCS.[9] VMSs are a widespread MCS tool, with many states and RMFOs mandating their use. However, VMSs most often use proprietary technology, which is costly and restricts access to information to states and RMFOs.

Automatic identification system
An AIS is a technology intended to help navigate and avoid collisions among boats. It has a shorter range than a VMS and is transmitted automatically among vessels and coastal authorities. The main purpose of an AIS is not monitoring and surveillance. However, it has been progressively used to complement VMSs because it provides quasi-continuously transmitted and publicly available information on the vessel's position, course, and speed, both in EEZs and on the high seas.[10] The main limitation of an AIS is that vessel information is set by the vessel crew, facilitating tampering and providing misleading information.[11] It can also be turned off and is not required by many RMFOs.

Satellite imagery
Satellite imagery can be used to supplement VMSs in monitoring vessel positioning and activities because the coverage of VMSs still has several blind spots. Currently, a few devices use satellite imagery to monitor fishing vessels. The visible infrared imaging radiometer suite (VIIRS) uses an optical sensor to identify vessels using light to attract catches.[12] According to the Global Fishing Watch, which processes these data, 85% of vessels identified

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8 James C Scott. Seeing like a State: How Certain Schemes to Improve the Human Condition Have Failed. Yale University Press, 2008.
9 The electronic recording and reporting system (ERS) is an example. https://joinup.ec.europa.eu/collection/eu-semantic-interoperability-catalogue/solution/electronic-recording-and-reporting-system-ers/about
10 K. Cremers et al. "Options for strengthening monitoring, control and surveillance of human activities in the Southeast Atlantic region," Strong High Seas Project, 2021
11 K. Cremers et al. "Options for strengthening monitoring, control and surveillance of human activities in the Southeast Atlantic region," Strong High Seas Project, 2021
12 Global Fishing Watch. Our Technology. Available at: https://globalfishingwatch.org/our-technology/

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through this method were not broadcasting VMSs.[13] Other technologies use satellite imagery to identify vessels through object recognition "object detection" models to distinguish vessels from other objects in the images, thus allowing for tracking their position and movement. Synthetic aperture radar (SAR), for instance, provides clear images of the earth's surface, regardless of weather conditions, facilitating accurate object detection. Although a promising way of overcoming the limitations of AIS and VMS, these are still costly and technology intensive in terms of requiring specialized human resources and data storage.[14]

Remote electronic monitoring systems (REMSs)

Remote electronic monitoring systems (REMSs) work as a way of complementing the work of at-sea observers and overcoming some of their limitations.[15] These systems require equipping vessels with CCTVs to record fishing activities, which are securely stored on board and transmitted to a monitoring center inland. Combined with VMS data, it allows authorities to monitor catches, bycatches, discards, gear, and other information that in-person observers could only gather.[16] The main claimed advantages of REMSs are being more cost-efficient in using human resources than at-sea observers, besides preventing their exposure to coercion, harm, and the risks of corruption. Research has pointed to positive outcomes in both industrial and small-scale fisheries.[17] The main pitfall of REMSs is that these are very costly technologies, both in terms of equipment and operation. The use of live images also raises concerns about privacy and management of personal information.

Body cameras

Body cameras have been used as a way of enhancing accountability in the work of law enforcement agents around the world. In fisheries, they can also be worn by inspectors and observers as a means to facilitate the exchange of information with relevant authorities, deterring the possibility of threats, harassment, and corruption. The main challenge is securing internet coverage to transmit images in real time and establishing human resources to effectively analyze footage. Using live images also raises the same concerns about personal data management as REMSs.

Decentralized data-gathering devices

Although these are the main widespread solutions for enhancing the capacity of central authorities to monitor, the community of actors engaged in the fight against IUU fishing has continuously been seeking technologies to complement them. One example is a mobile phone application that allows artisanal fishers to record potential IUU fishing violations by simply registering a photo of the offending vessel with a time and location tag, which is then sent to the relevant state authorities. This device promises to help engage local fishing communities in protecting their fisheries. However, using such evidence in the prosecution chain may be challenging. More importantly, it may risk exposing volunteer watchers to violence and retaliation.

Data Analysis

For technology-generated data to help curb IUU fishing, it needs to be translated into information upon which MCS authorities can act. A necessary step in this process is creating interfaces that can systematize and interpret the data produced by one or more data-generating devices for the relevant authorities. Data processing analysis technologies depend on the availability of relevant and competent human resources; without them, the potential of technologies to aid MCS cannot be fulfilled. Some states and regional organization count on such a system. The European Maritime Safety Agency (EMSA) has developed its own Integrated Maritime Service (IMS) that serves these purposes. In West Africa, the Yaoundé Architecture Regional Information System (YARIS), which will be discussed below, also offers actionable information.

Still, building analytical capacities can be costly for several states. A growing number of NGOs have been exploring this gap, offering data analysis platforms and helping train state officials to use them in partnership with states and RMFOs. For instance, Global Fishing Watch (GFW) and Skylight invested in combining VMSs, AISs, and satellite imagery data. Trygg Mat Tracking (TMT) has created the Fisheries Analytical Capacity Tool, which processes data from different sources according to the needs of their partner states. More recently, during the United Nations Oceans Conference in 2022, GFW, TMT, Skylight, and the International MSC Network announced

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13 Global Fishing Watch. Our Technology. Available at: https://globalfishingwatch.org/our-technology/
14 K Cremers et al. "Options for strengthening monitoring, control and surveillance of human activities in the Southeast Atlantic region," Strong High Seas Project, 2021
15 Lotte Kindt-Larsen, Eskild Kirkegaard, Jørgen Dalskov, "Fully documented fishery: A tool to support a catch quota management system," ICES Journal of Marine Science, 68.8 (September 2011), 1606–1610.
16 Lotte Kindt-Larsen, Eskild Kirkegaard, Jørgen Dalskov, "Fully documented fishery: A tool to support a catch quota management system," ICES Journal of Marine Science, 68.8 (September 2011), 1606–1610.
17 Bartholomew, David C., et al. "Remote electronic monitoring as a potential alternative to on-board observers in small-scale fisheries," Biological Conservation 219 (2018), 35–45.

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their Joint Analytical Cell, which aims to combine their multiple data processing tools. These global efforts can make data analytical tools widely available, and potentially powerful if they are coupled with building capacities for autonomous use by state authorities.

Data Sharing and Transparency

A final set of technologies can facilitate the flow of information among relevant authorities within and across states in their fight against IUU fishing. These technologies include communication platforms that help coordinate and cross-check information and shared databases on vessels and fishing activities. Data sharing, transparency, and communication are required to close the loopholes of jurisdictional overlap in fisheries governance. For instance, something as simple as an accurate and updated list of vessels registered as IUU fishing offenders, which exists in several RMFOs, can be fundamental to effectively implement the PSMA. These initiatives can also be most effective if they can be triangulated across scales, helping to close loopholes of fisheries patchy governance. The FAO Global Record of Fishing Vessels, Refrigerated Transport Vessels and Supply Vessels is crucial steppingstone to help states build more fine-grained data sharing and cooperation strategies. However, data sharing raises relevant issues regarding personal data privacy and management. For instance, REMS technologies are based on hours of footage of individuals that must be protected based on an adequate data protection framework.

Fishing in Ghana and Guinea-Bissau

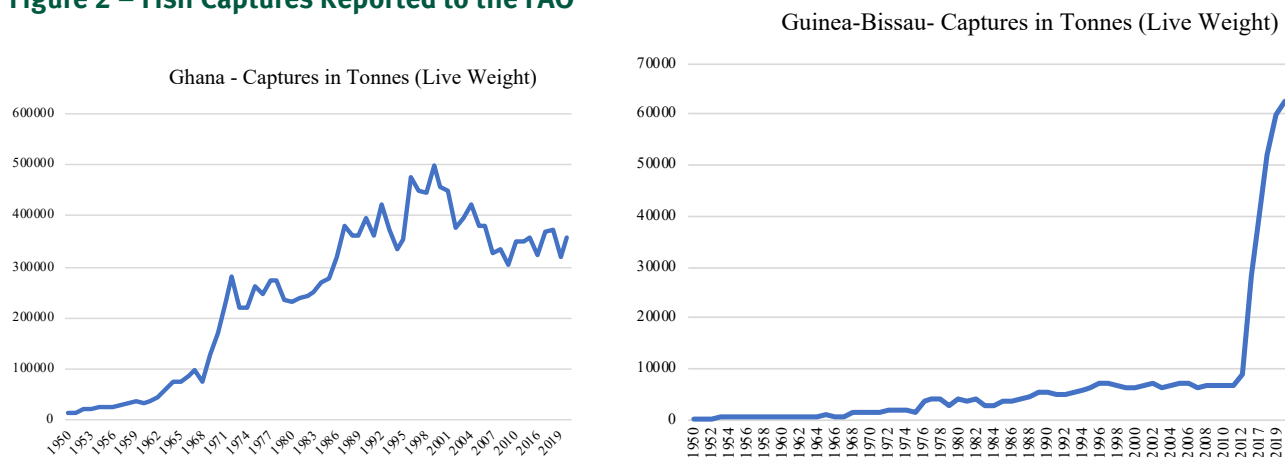|	Ghana	Guinea-Bissau
Population (2020)	31,078,945*	1,967,998*
GDP (2020, current USD)	68,532,281,805*	1,431,758,243*
GDP per capita (2020, current USD)	2,205*	727*
GDP growth (average 2017–2019)	6.93%*	3.90 %*
Territory size	238,540 km² *	36,130 km² *
EEZ	225,000 km² **	105,839 km² ***
Length of continental coastline	550 km **	274 km (plus 80 islands) **

Sources: *World Bank; **FAO; ***Sea Around Us

Figure 1 – Map of West African Exclusive Economic Zones and Large Marine Ecosystems
Source: Belhabib et al. (2016)

Ghana and Guinea-Bissau are situated in a region with rich sea life and fisheries. However, they are very different countries in many respects. Ghana has one of the highest per capita incomes in West Africa, while Guinea-Bissau has one of the lowest.
These differences are also manifest in the profile and size of fishing in each country. According to data reported to the FAO, Ghana has a much bigger and older fishing economy, as the graphs below show. Guinea-Bissau, in turn, has had small fisheries experiencing a significant expansion in recent years.

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Figure 2 – Fish Captures Reported to the FAO

Ghana - Captures in Tonnes (Live Weight)

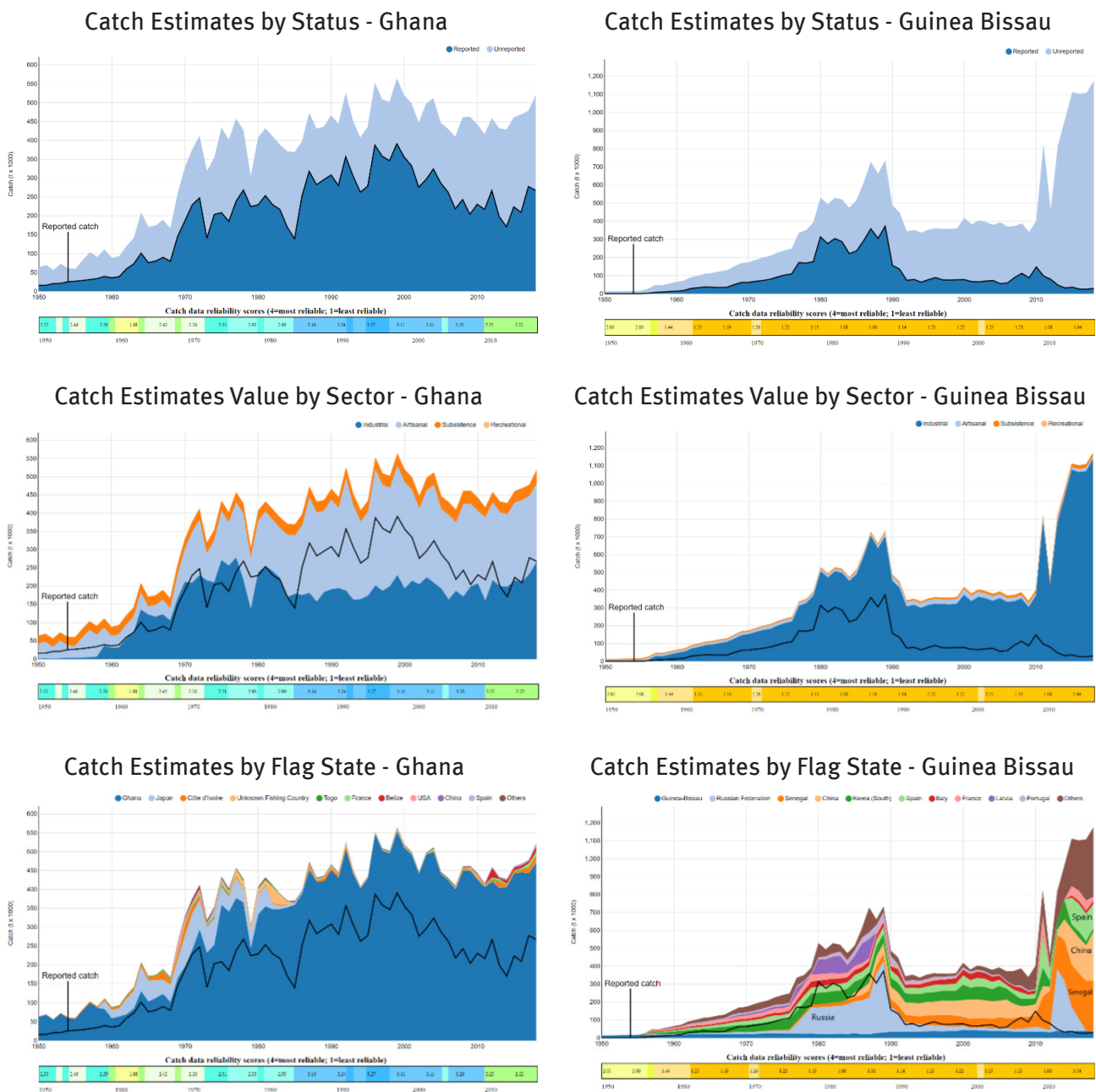Guinea-Bissau- Captures in Tonnes (Live Weight)

Source: FAO (2022).

In Ghana, artisanal and industrial fishing have a long tradition. As estimates by Sea Around Us suggest and as illustrated in the figures below, industrial and artisanal fishing in Ghana's EEZ have been mostly conducted by fleets under the Ghanaian flag for decades. Although this reflects the country's robust fishing economy, this figure is also a result of Ghanaian law requiring that all fishing be conducted by national vessels. Still, over 90% of trawlers under Ghanaian flag are owned in joint ventures with nationals of other countries (mostly with Chinese beneficial owners), which Ghana's Fisheries Act also prohibits. This raises important challenges regarding the impact of third countries fishing in Ghana. The artisanal sector has been responsible for the majority of catches in Ghana. This is partially because of the practice of Saiko, a cooperative relationship between artisanal canoe fishing and large trawlers, where the latter sell their bycatch to the former. Transshipment, in general, and Saiko, in particular, are prohibited in Ghana because they allow trawlers to overfish and disguise their illegal activities by landing them as small-scale artisanal fishing. Although a minority, subsistence fishing, which is not intended for commercialization, is also considerable in Ghana. Ghana's legislation also requires that all catches from Ghanaian waters be landed at its ports. This connects fishing with the processing industry, adding value to exports and domestic markets. Hence, in Ghana, fishing is not only a source of economic revenue linked to industrial fisheries, but also a source of income for local food processing chains and a key source of protein for its population. While this makes the long-term sustainability of fisheries a central political issue in the country, it also makes fisheries regulations a target of multiple and often conflicting interests.

In Guinea-Bissau, artisanal and subsistence fishing represents a small proportion of overall catches and is not tied to a long fishing tradition. Estimates by the Sea Around Us suggest, as illustrated below, that most of the country's growing fishing activity is conducted by industrial fleets flagged by distant water nations, such as China, Senegal, Spain, and Russia. This makes fishing activities in Guinea-Bissau vulnerable to policies of distant water flag states, including potential harmful subsidies. Besides lacking a substantive domestic fleet, Guinea-Bissau also lacks the capacity to land and process fish.

  Despite Guinea-Bissau General Fisheries Law mandating that a minimum of all catches must be landed in the country, a good number of catches in Guinea-Bissau's EEZ are landed elsewhere. A recent study reviewing illegal fishing losses in 22 countries on West Africa's coast found that Guinea-Bissau loses the most fish protein because of catches from its waters never reaching its coast. Hence, the benefits Guinea-Bissau earns from fishing activities in its EEZ are limited to government revenues from licensing and international agreements. Although this represents an important proportion of national proceeds, the income from international agreements amounts to only 15% of the market value of these catches. Furthermore, even with only a small proportion of its fisheries yields reaching Guinea-Bissau's lands, seafood is the country's most important source of animal protein. Building ports, storage, and processing capacity has been pointed out as a priority by the Bissau government to ensure that a larger proportion of the population can benefit from fishing as a source of income and food security.

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Figure 3 – Evolution of Catches in Ghana and Guinea-Bissau

Catch Estimates by Status - Ghana

Catch Estimates by Status - Guinea Bissau

Catch Estimates Value by Sector - Ghana

Catch Estimates Value by Sector - Guinea Bissau

Catch Estimates by Flag State - Ghana

Catch Estimates by Flag State - Guinea Bissau

Source: Sea Around Us

Despite these differences, the EEZs of Guinea-Bissau and Ghana are both heavily targeted for IUU fishing. The clandestine nature of IUU fishing activities renders the quantification of activities elusive and reliant on indirect estimates.[18] According to the Sea Around Us estimates of catches, as illustrated in figure 3, almost half of the catches in Ghana and the majority of those in Guinea-Bissau are not reported. Based on these data on unreported fishing, Petrossian and Clarke claim that Guinea-Bissau is the country that loses the most economically and in terms of food security for IUU fishing conducted by foreign vessels.[19] GFW, in turn, uses satellite images to identify loitering and two-vessel encounters as indicators of potential IUU fishing because such behavior may indicate transshipment activity, which is forbidden in several countries and is a key practice of IUU modus operandi.[20] According to the GFW, Ghana and Guinea-Bissau had the highest incidence of vessel loitering in West Africa

18 Witbooi, Emma, et al. "Organized crime in the fisheries sector threatens a sustainable ocean economy," Nature 588.7836 (2020), 48–56.
19 Petrossian, Gohar A., and Ronald V. Clarke. "Disaggregating illegal fishing losses for the 22 countries of the West African Coast," Maritime Studies 19.4 (2020), 445–455.
20 Widjaja, Sjarief, Tony Long, and Hassan Wirajuda. "Illegal, unreported and unregulated fishing and associated drivers," Blue Paper. High Level Panel for a Sustainable Ocean Economy, 2020

between 2017 and 2020, and the EEZ of Guinea-Bissau also presents a high incidence of two-vessel encounters.[21] Identified transshipments between trawlers and canoes (Saiko) have been one of the reasons for the EU issuing a warning ("yellow card") to Ghana for the second time in 2021,[22] which could lead to suspension of trade if not addressed.[23]

The first step in addressing IUU fishing has been regulatory. Both Ghana and Guinea-Bissau have recent legislation regulating fishing activities in their EEZ. In Ghana, since the country received its first yellow card from the EU in 2013, the government has implemented new regulatory measures, which we discuss below. The more complex and robust fishing industry in Ghana also means a more complex web of local interests to accommodate when implementing new regulations. In Guinea-Bissau, the General Law of Fisheries is from 2011 and is subject to a revision process. Regarding international obligations, Ghana is a party to the main international agreements addressing IUU fishing, including the UNCLOS, UNFSA, and PSMA. Among these, Guinea-Bissau has only ratified the UNCLOS. Persistent political instability, along with resulting lack of political will, are among the reasons for Guinea-Bissau's limited engagement with global initiatives against IUU fishing and other related initiatives aimed at sustainable fisheries. Further, despite its regulatory and enforcement limitations, Guinea-Bissau is still able to collect significant revenues from fisheries agreements with distant water nations, including in the EU, thus offering little incentive for improvement. Concrete improvement towards sustainable fisheries would require harmonizing fisheries regulations with international standards and taking on international responsibilities against IUU fishing.

At the national level, both states have provisions for defining what counts as IUU fishing in terms of catches, gears, and zones. This is summarized in Table 2. However, although both states need to strengthen their fisheries regulations, securing compliance with existing regulations remains the main challenge in the fight against IUU fishing. This often requires the construction of resource-consuming capacities for the MCS of fisheries, and such capacities are demanding in terms of not only technology but also relevant manpower. In the next section, we examine the efforts of these two states, here in conjunction with international partners, to establish MCS systems and build technological capacities to close this gap in the fight against IUU fishing.

Table 2 – Characterization of Illegal Fishing in Guinea-Bissau and Ghana

	Ghana	Guinea-Bissau
Catch Restriction	- Prohibition of discards suitable for human consumption.	- Limitations on the percentage of bycatch. (Set annually). - Minimum fish size by species. (Set annually). - Prohibition on endangered species (set annually).
Gear Restrictions	- Prohibition of light attraction, aggregators, explosives, toxins, driftnets, and pair trawling. - Minimum mesh sizes: trawls (60 mm), shrimp trawl (50 mm), small seine (25 mm), large seine (100 mm).	- Prohibition of light attraction, explosives, and toxins. - Limitation on mesh size (Set annually).
Zone Restriction	- Prohibition of industrial fishing on the inshore fishing area. - Prohibition of trawling shallower than 30 m deep.	- Prohibition of industrial fishing on the inshore fishing area.

21 Boerder, Kristina, Nathan A. Miller, and Boris Worm. "Global hot spots of transshipment of fish catch at sea," Science Advances 4.7 (2018): eaat7159.

22 The first yellow card was issued in 2013 and lifted in 2015 after Ghana instituted new legislation and a clear fisheries management plan. However, the lack of subsequent implementation has allowed the situation to deteriorate, hence leading to the issuance of a second yellow card in June 2021.

23 European Commission. Fighting against illegal, unreported and unregulated fishing: Commission notifies the Republic of Ghana with a yellow card. Available at: https://ec.europa.eu/commission/presscorner/detail/en/IP_21_2745

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Seasonal Restrictions	- Two months of the closed season for industrial fishing since 2016. - One-month closed season for all fisheries since 2019.	- One-month closed season for industrial fishing was first implemented in January 2022.
Additional restrictions	- Transshipments. - Prohibition on landings outside Ghana. - Mandatory use of VMS, reporting to national and regional authorities.	- Minimal landing requirements. - Mandatory use of VMS, reporting to national and regional authorities.

Multilevel Efforts against IUU in Ghana

The Ministry of Fisheries and Aquaculture Development (MOFAD), particularly through its Fisheries Commission, is the main institution in charge of fisheries governance in Ghana. Efforts to curb IUU fishing are spearheaded by the Monitoring, Control, and Surveillance Division (MCSD) of the Fisheries Commission, which operates the Fisheries Enforcement Unit in collaboration with Ghana's Navy and Marine Police. Ghana's fisheries management and MCS efforts are also embedded in two broader regional frameworks: the International Commission for the Conservation of Atlantic Tunas (ICAT) and the Fisheries Commission of the West Gulf of Guinea (FCWC). Ghana is also a party to key binding and nonbinding international instruments for addressing IUU fishing, such as the UNCLOS, UNFSA, and PSMA.

Domestic Policies

Ghana's actions as a flag state
Ghana's responsibilities as a flag state are central to fighting IUU fishing in its waters. Ghana's Fisheries Act requires that all vessels fishing in its EEZ must be owned by its nationals and bear a Ghanaian flag. However, about 90% of the industrial vessels operating in Ghana have a beneficial owner from China.[24] A recent study has found that Ghana charges less than the average in the region for issuing fishing licenses, which should work as an incentive for local fisheries but can indirectly subsidize foreign entities if they are the main beneficial owners of licensed vessels. Furthermore, Ghana's Sustainable Fisheries Management Plan has long indicated that the country has overcapacity and excessive fishing efforts, further depleting overfished stocks and highlighting the necessity of restricting licensing and MSY.[25] By limiting fishing activities to vessels flying its flag, Ghana is well positioned to use its licensing power to secure compliance and sustainability of its fisheries. The second yellow card received by Ghana from the EU included a demand for sanctions against illegal fishing activities with greater deterring power.[26] The National Plan of Action against IUU Fishing 2021–2025 was issued a few months before the yellow card, highlighting the necessity of more effectively 1) preventing vessels with a history of IUU fishing from being reflagged to Ghana's flag; 2) introducing administrative sanctions (with severe economic penalties and swifter processing of charges than criminal prosecution); 3) deregistering vessels when found to have a history of IUU fishing, and 4) cancelling licenses of vessels when they commit an IUU fishing violation. The first three steps require greater transparency of information on licensed vessels, including on beneficial owners, in Ghana and other states, to facilitate the identification of vessel history and connections. To be effective, the fourth step also depends on the capacity of enforcement authorities to identify IUU fishing offences. Overall, these steps may also be more efficient if they are used in cooperation with distant water fishing states to identify networks of individuals involved in IUU fishing and how their illegal activities may be incentivized by undue subsidies and benefits from those countries.

Ghana's actions as a port state
As a port state, Ghana's actions are mostly tied to the implementation of the PSMA. The Fisheries Act requires that all fish caught in Ghana's EEZ be landed in one of its ports. As with flag regulations, this allows Ghana to concentrate on identifying and sanctioning IUU fishing through PSMA provisions. These measures depend on

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24 Environmental Justice Foundation. "Stolen At Sea: How illegal 'saiko' fishing is fueling the collapse of Ghana's fisheries." Available at: https://ejfoundation.org/reports/stolen-at-sea
25 Republic of Ghana, "Fisheries management plan of Ghana: A national policy for the management of the marine fisheries sector 2015-2019," 2014.
26 European Commission. "Fighting against illegal, unreported and unregulated fishing: Commission notifies the Republic of Ghana with a yellow card," Press release (June 2021). Available at: https://ec.europa.eu/commission/presscorner/detail/en/IP_21_2745

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information sharing among national and international authorities.

Ghana MSC strategies on its EEZ

Controlling the activities within EEZs is challenging because it requires the ability of states to monitor fishing activities at sea. However, MCS strategies are important because they produce the most relevant information when it comes to making port and flag state measures effective. In Ghana, the main institution responsible for MCS is the Fishing Commission. Its Fisheries Enforcement Units (FEUs)—in coordination with the navy and marine police—are responsible for securing compliance. The MCS strategy in Ghana includes an observer program, a VMS center, and regional cooperation through the FCWC West Africa Task Force. Some of these capacities have been built through international cooperation. Ghana has attracted many projects to develop MCS capacities, and many of these projects rely on technological solutions.

International Cooperation and Technology in MSC

Ghana has been part of multiple projects with multiple partners to help fight IUU fishing. We discuss those projects promoting the adoption of technological solutions to improve Ghana's MCS capacity. We describe which technology has been introduced to address which problems and whether it has achieved its objectives.

West Africa Regional Fisheries Program (WARFP)

The WARFP is a project led by the World Bank in Ghana and other West African countries. The program disbursed US$35.3 million in Ghana from 2011 to 2019, with the broader "aim of improving the sustainable management of fish and aquatic resources" in the region. [27] Reducing IUU fishing was one of the project's main components, which received US$9.3 million, mostly to increase the frequency of patrols in coastal fisheries and their efficiency.[28] The program created key relevant nontechnology capacities—such as establishing the first FEU, introducing closed seasons, improving license transparency, and reducing the number of trawlers operating in Ghana—while also helping introduce technological solutions. The project helped the MOFAD create a web-based vessel registry for industrial and semi-industrial boats (active since 2013), which is crucial for introducing transparency and monitoring fishing activities—a necessary step toward identifying and sanctioning IUU fishing. The project also built capacities for using VMS to monitor the activities of industrial fleets and allowed for a more targeted use of enforcement. A VMS room was established in the FEU headquarters, and transponders were installed in the entire industrial fleet. This allowed the relevant authorities to fully enforce their prohibition of industrial fishing in waters less than 30 m deep and ensure compliance when they introduced closed seasons in 2016–2017. However, in its final report, the World Bank found that the potential of using VMS to address the more elusive IUU fishing practices contributing to overfishing was not realized.[29]

- Technological tool: VMS for monitoring industrial fleets.
- Key achievement: Enhanced compliance with closed seasons and inshore zone restrictions.
- Key shortcoming: Limited use of evidence in the identification, sanctioning, and prosecution of IUU fishing.

Sustainable Fisheries Management Project (Ghana SFMP)

The Ghana SFMP is a USAID-funded project conducted in parallel with the WARFP, both in scope and duration. It was implemented between 2014 and 2021, having mobilized approximately US$35.6 million with the goal of helping Ghana rebuild its declining fish stocks, particularly of small pelagic fishes that are the most crucial for artisanal and subsistence fisheries.[30] The SFMP originally did not have an explicit IUU fishing goal, but it helped build capacities for tackling this issue. In partnership with local universities, it helped construct the "Guide on Illegal Fishing Activities in Ghana," providing an overview of illegal methods and gears practiced in the country to help identify and sanction these activities.[31] It also worked with the WARFP to extend the measures applied to the industrial fleet, such as the institution of closed seasons and vessel registry to artisanal fishers. It also helped mediate a moratorium on new licensees with the Ghana National Canoe Fishermen's Council, which could help curb the pressure of overfishing on small pelagic fishes.

A three-year moratorium on all new fishing licenses has been included in the new Marine Fisheries Management Plan 2022–2026,[32] but the document has not been published yet, so the moratorium is not in place. These limitations on small-scale fisheries have been justified by the focus of the project being on the recovery of small

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27 World Bank, WARFP Project Terminal Evaluation, 2019.
28 World Bank, WARFP Project Terminal Evaluation, 2019.
29 World Bank, WARFP Project Terminal Evaluation, 2019.
30 USAID, "Sustainable Fisheries Management Project (SFMP)," 2014. Available at: https://www.crc.uri.edu/download/GH14_SMFPbrief_final.pdf
31 USAID, "A Guide on Illegal Fishing Activities in Ghana," 2018
32 Mistry of Fisheries and Aquaculture Development. 2022-2026 Marine Fisheries Management Plan Validated. Available at: https://www.mofad.gov.gh/press-release/2022-2026-marine-fisheries-management-plan-validated/

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pelagic stocks. Nevertheless, it has brought about controversy and criticism since Saiko, which is the main driver of these stocks' depletion, depends on industrial fishing, and could be addressed with stronger control and sanctions on them solely.[33] Despite this, the SFMP also invested in fostering dialogue and participation among artisanal fishers and between them and the authorities, particularly focusing on raising awareness about the harm Saiko and other illegal fishing practices brought to local fishing communities.[34] In collaboration with Ghana National Canoe Fishermen Council (GNCFC), MOFAD, the Fisheries Commission, and WARFP, the project created the Fisheries Watch Volunteer groups inspired by the Philippine "Sea Watch" program. The initiative ended up not being fully implemented because of the resistance of some fisher organizations, but it worked as a baseline for an EU-funded project (Securing Sustainable Fisheries), which would use the technological applications to engage local fishers in the fight against IUU fishing.

Finally, though not directly linked to curbing IUU fishing, the project's most successful outcomes seem to have been creating local analytical capacity, both in the government and scientific community, to generate accurate data on fish stocks, which are crucial to ensuring that legally licensed fishing is also sustainable. The challenge now, as included in IUU-NPOA 2021–2025, is translating this knowledge into fisheries regulations.

- Technological tool: Improved analytical capacity for fish stock assessment
- Key advantage: Enhanced capacity for informing fisheries regulations (i.e., licensing and closed seasons)
- Key shortcoming: Sociopolitical challenges in aligning science and regulations.

Securing sustainable fisheries (Far Dwuma Nkodo)

This project is implemented by the NGO Environmental Justice Foundation in partnership with the local NGO Hen Mpoano and funded by the EU delegation in Ghana, with the specific goal of involving the local fishing community to improve the sustainability of fisheries.[35] One of the main outcomes is to build on the pilot of the Fisheries Watch Volunteer groups, creating tools for engaging fishers in the surveillance of Ghana's waters, thus helping the government gather the necessary evidence to sanction these illicit fishing practices. The tool is a mobile phone application called "DASE" (evidence in Fante), which allows the fishers to register violations by other vessels when at sea by simply taking a photo of the offending vessel's name and identification and then tagging the time and location of the offense. The app promises to help identify vessels that are eluding VMS monitoring, those that damage canoes and artisanal fishing gears, and, most importantly, those engaging in Saiko. The broader hope is to both work as protection for local fishers and an incentive to dissociate them from Saiko. The program went into effect in late 2020, and it is still unclear how effective it has been. In an interview a few months after the launch, the leader of Ghana National Canoe Fishermen Council, Nana Jojo Solomon, showed some skepticism: "You send [the evidence] to the authorities, like the regulators or the commission, and then it ends there. You don't see prosecution. You don't hear anything about it. And that is beyond us."[36] There are also concerns about whether this exposes users to retaliation from the denounced offenders or can even encourage vigilantism. Another of the artisanal fishers, Nana Kweigyah, from the Canoe and Fishing Gear Owners Association of Ghana, sees potential in the project if stakeholder engagement is improved, the selection of fishers is reviewed, and it is followed up with appropriate and regular training of all fishers involved in the monitoring activities, hence fostering collaboration between the fishing communities and MCS authorities.[37] Authorities in the Fisheries Commission see the most potential of the application as a way of triangulating evidence generated by data gathered by the authorities using technological tools such as VMS, AIS, or REMS.[38]

- Technology: Mobile phone application.
- Key positive outcomes: Engage small-scale fishers in the fight against IUU fishing. Potential for overcoming the limitations of VMS elusion, enhancing the enforcement of the prohibition of fishing in Ghana's inshore areas. Potential for identifying Saiko. Potential for helping protect small-scale fisheries against damage to canoes and gears by industrial vessels.
- Key shortcoming: Unclear impacts on the effectiveness of the prosecution chain and sanctioning. The potential risk of exposing users to retaliation from denounced offenders and encouraging vigilantism

33 Okafor-Yarwood, Ifesinachi, et al. "Survival of the richest, not the fittest: How attempts to improve governance impact African small-scale marine fisheries," Marine Policy 135 (2022).

34 Hen Mpoano. Far Dwuma Nkɔdo. Available at: https://henmpoano.org/far-dwuma-nk%c9%94do/

35 Environmental Justice Foundation. "Securing sustainable fisheries: Ensuring sustainability and social equity in Ghana's fisheries." Available at: https://ejfoundation.org/what-we-do/ocean/ghana

36 Reset. In Ghana, a New App is Striving to Save Fishermen's Livelihoods. Available at: https://en.reset.org/ghana-new-app-striving-save-fishermens-livelihoods/

37 Interview with Nana Kweigyah, from the Canoe and Fishing Gear Owners Association of Ghana.

38 Interview with Official from the Fisheries Commission (MOFAD, Ghana).

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Common oceans' tuna project in Ghana

This project was a pilot for introducing REMS in Ghana's Tuna fisheries. The project is part of the broader project "Common Oceans – A Partnership for Sustainability and Biodiversity in the Areas Beyond National Jurisdiction," which focuses on securing the conservation of highly migratory species such as tuna.[39] It focuses not only on fishing in Ghana's EEZ, but also on its fleet targeting tuna. REMSs work by installing video cameras on board fishing boats and devices storing and transmitting video near real time to land-based observers.[40] The REMSs' main function is to replace at-sea observers, limiting their exposition to risks and opportunities for co-optation; the system provides more accurate estimates of catches (such as species and size), bycatches, and discards, along with allowing for the identification of other illegal practices, such as transshipment and the use of prohibited methods and gears. So far, the fleet of tuna vessels has been equipped with REMSs. Besides funding the installation of REMS equipment in 14 tuna vessels, the project invested in creating capacity in the government for analyzing the collected data.[41] The project seems promising and effective regarding its data-generating goals, but its efficacy, compared with the at-sea observer program, still needs to be assessed. The program's final evaluation suggests that if the efficiency is similar, the in person at-sea observer program could focus more on scientific goals and become more complementary to REMS compliance efforts. The report mentions concerns with data protection issues, highlighting those current regulations that need to be amended for REMS data to be considered evidence for administrative sanction or criminal prosecution of IUU fishing. Finally, the evaluation expresses concern about the project's sustainability, which demands that Ghana's government cover the recurring costs associated with operating expenses of the equipment, cover equipment maintenance, and allocate human resources to analyze the data continuously. The current MOFAD 2022–2024 budget includes provisions for operating REMSs in tuna vessels in 2022. The Fisheries Commission is also revising its legislation to expand the use of REMSs in the entire fleet of trawlers beyond the tuna.[42]

- Technology: REMSs.
- Key positive outcomes: Possibility of replacing at-sea observer programs with land-based observation, avoiding the risks and challenges of in-person observation. It can also help shield at-sea observers from compliance duties, allowing for a greater focus on scientific goals.
- Key shortcoming: Needs better integration and comparison with at-sea observer programs. The admissibility of REMS data as evidence for prosecution and sanctioning may require regulatory changes. Demands for securing the integrity and protection of collected data. Demands continuous resource allocation by states to cover operating costs.

Ports task force

The ports task force in Ghana is a project by Stop Illegal Fishing, with funding from the German Development Bank (GiZ), to help the country implement the PSMA.[43] One of the main challenges for making the PSMA an effective tool against IUU fishing is the necessity of accurate information on vessels' backgrounds to allow states to better target inspections and potentially deny access to IUU fishing offenders. Hence, a central task is to build the capacity for information sharing among relevant authorities in Ghana and other port states. The project then works as a central hub for the broader African Ports Network, which is structured around a platform in which port states can share information on vessel identification, licenses, catches, routes, and records of noncompliance, among other things.[44] In Ghana, the ports task force builds the capacity for the state to act, among other measures, by

structuring nonstop communication channels between Port and Harbor Authorities, Fisheries Commission, and all the relevant law enforcement and prosecution agencies. With the goal of facilitating coordination between authorities, the project introduced a very small pilot using body-worn cameras during port inspections in 2020. Around eight vessels and four reefers were inspected by officials using a body camera.[45] The evaluation of the project has been positive; it seems successful in facilitating interagency coordination, but it also shows the potential for increased accountability of port inspection if protocols are established to use the technology in that regard.[46] The capacity to store, analyze, and securely manage the images produced in these inspections is also

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39 Food and Agriculture Organization. Electronic Monitoring System (EMS) pilot activities onboard. Available at: https://www.fao.org/in-action/commonoceans/news/detail-events/en/c/380064/

40 MRAG, "Building the business case for EMS in the Ghanaian Tuna Purse Seine Fleet," 2017

41 Food and Agriculture Organization. "Terminal evaluation of the areas beyond national jurisdiction (ABNJ) program," 2020.

42 Interview with Official from the Fisheries Commission (MOFAD, Ghana).

43 Stop Illegal Fishing. Port Task Force Ghana. Available at: https://stopillegalfishing.com/initiatives/ports-task-force-ghana.

44 Stop Illegal Fishing. Port Task Force Ghana. Available at: https://stopillegalfishing.com/initiatives/ports-task-force-ghana.

45 Stop Illegal Fishing. Port Task Force Ghana. Available at: https://stopillegalfishing.com/publications/sif-case-study-17-using-body-worn-cameras-to-provide-remote-support-for-fisheries-enforcement/

46 Stop Illegal Fishing SIF Case Study 17: Using body worn cameras to provide remote support for fisheries enforcement. Available

an intrinsic concern.

- Technology: National communication platforms, international information-sharing platforms, body cameras for port inspections.
- Key positive outcomes: Facilitates PSMA implementation, with a strong potential for curbing IUU fishing. The body camera pilot seems to have yielded promising results if integrated into the broader MCS strategy and securing appropriate data management.
- Key shortcoming: The effectiveness of the project is still unclear.

FCWC – West Africa Task Force

This project has been funded by NORAD and implemented by the NGO TMT in cooperation with Stop Illegal Fishing (SIF), the FCWC, and its member states. The project's key goal is to foster joint action among regional states to address IUU fishing. Hence, one key component of the project is to enhance the ability of states to use intelligence produced by their MCS agencies and FCWC.[47] In the first phase of the project, the establishment of a National Working Group was created in each country and, regionally, a communications platform was created to facilitate the exchange of information among member states, along with regular meetings in person among MSC officials of all countries.[48] This resulted in some successful joint enforcement actions. The project was renewed to a second phase, which was initiated in 2018, continuing the same lines of action.[49] It further streamlined information-sharing mechanisms, allowing real-time cooperation to identify potential violations and coordinate efforts. It harmonized routines for background checks before licensing and flagging in the region, creating the "Regional Record of Authorized Fishing Vessels."[50] It also promoted continuous VMS training of local officials to render data useful for MCS. The Regional MCS Center was established in 2020 and has been fully operational since 2021, allowing for the joint oversight of vessel activities in the region, cross-checking of vessel information, and coordinated inspections and enforcement action.[51] The FCWC has considered this a crucial step for more effective use of the region's limited resources for addressing IUU, not only by scaling up measures to a regional level, but also by fostering coordination of actions at ports, at the EEZs, and among relevant agencies within and across states. The TMT uses a "train the trainer" approach to building national capacities resilient to staff turnover, yet this was still identified as a key challenge to the long-term sustainability of the project's outcomes. An example of West African Task Force (WATF) synergies is the emblematic rescuing of the Hai Lu Feng 11 vessel in 2020, which was noted as missing by Côte d'Ivoire authorities.[52] This was reported through the WATF platform, allowing all relevant states to jointly use their VMSs to track the ship to Nigeria, where the navy was able to rescue passengers and arrest pirates.[53] This shows the potential of similar synergies being used to handle cases of suspicious vessel behavior concerning fishing.

- Technology: VMS intelligence and information-sharing platforms.
- Key positive outcomes: Promoted effective coordination of fisheries governance among a number of countries, including joint inspections efforts, and enforcement actions. This is instrumental to the full implementation of the PSMA.
- Key shortcoming: Provides a strong baseline for the autonomous continuation of operations after the project through capacity building in equipment, technologies, and human resources. Operations are likely to demand continuous resource allocation to maintain national working groups and Regional MCS Center activities, which can only be a shortcoming if political will wanes.

PESCAO

The project "Improved Regional Fisheries Governance in Western Africa" (PESCAO) is funded by the EU through the Economic Community of West African States (ECOWAS) and partially implemented by the FCWC. Its main goals include preventing and responding to IUU fishing through improved regional MCS.[54] A key part of the project

at: https://stopillegalfishing.com/publications/sif-case-study-17-using-body-worn-cameras-to-provide-remote-support-for-fisheries-enforcement/
47 Fisheries Committee for the West Central Gulf of Guinea. Available at: https://fcwc-fish.org/projects/watf
48 Fisheries Committee for the West Central Gulf of Guinea. Available at: https://fcwc-fish.org/projects/watf
49 NORAD Fish for Development Report, 2019.
50 TMT. West Africa Task Force. Available at: https://www.tm-tracking.org/west-africa-task-force
51 TMT. West Africa Task Force. Available at: https://www.tm-tracking.org/west-africa-task-force.
52 Fisheries Committee for the West Central Gulf of Guinea. Region's Interagency Cooperation Leads to Arrest of Vessel Hijackers. Available at: https://fcwc-fish.org/our-news/fcwc-regions-interagency-cooperation-leads-to-arrest-of-vessel-hijackers
53 Fisheries Committee for the West Central Gulf of Guinea. Region's Interagency Cooperation Leads to Arrest of Vessel Hijackers. Available at: https://fcwc-fish.org/our-news/fcwc-regions-interagency-cooperation-leads-to-arrest-of-vessel-hijackers
54 European Fisheries Control Agency. PESCAO. Available at: https://www.efca.europa.eu/en/content/pescao

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is focused on harmonizing regulations, promoting adherence to international legal instruments, and fostering collaboration among MSC agencies across the region.[55] PESCAO also funded the creation of FCWC's Regional MCS Center, which is equipped with VMSs and aids to share information on vessels and licenses across the regions.[56] This was an appropriate step in building capacities for the subregional fisheries organization to provide intelligence for states to collaborate in their efforts against IUU fishing. However, this solution faces the limitation of turning VMS data and information-sharing practices into joint action. The WATF was created to bridge this gap and is supported by PESCAO.[57] PESCAO and the WATF also have joint together to provide IT equipment to MCS authorities of member states, such as tablets equipped with software developed by TMT that provide near-immediate information on vessels to facilitate national inspections.[58]

- Technology: Regional MCS with VMSs.
- Key positive outcomes: Provide intelligence for regional cooperation against IUU fishing, which has rendered effective joint operations.
- Key shortcoming: VMSs utility for producing evidence in the identification, sanctioning, and prosecution of IUU fishing depends on additional data analytics and on-the-ground cooperation.

Yaoundé Architecture Regional Information System (YARIS)
The YARIS platform has been funded under the EU project Gulf of Guinea Interregional Network (GOGIN) and implemented by Expertise France to help implement the Yaoundé Code of Conduct[59] provisions through the Yaoundé Architecture. This framework stems from a joint declaration by members of three regional organizations in West Africa—ECOWAS, ECCAS, and the GCC—to lay a common strategy to address illicit activities in the waters of the Gulf of Guinea.[60] Although the main focus is on sharing information vital for combating piracy and armed robbery at sea in the region, the project builds the capacity to help address IUU fishing. The YARIS platform interconnects national maritime security authorities into operation centers with nested regional scopes: one Interregional Coordination Center in Yaoundé, two regional centers— the West Africa Regional Maritime Security Center (CRESMAO) in Abidjan, Cote D'Ivoire, for ECOWAS members, and Maritime Security Regional Coordination Center for Central Africa (CRESMAC) in the Pointe Noire, Congo Republic, for ECCAS members; as well as five Multination Coordination Centers covering five contiguous maritime operational zones in Cape Verde (Praia), Ghana (Accra), Benin (Cotonou), Cameroon (Douala), and Angola (Luanda).[61] The platform's main functionality is sharing information in a timely and harmonized way, including integrating VMS, AIS, and satellite imagery.

IT equipment has also been provided in partnership with the United Nations Office on Drugs and Crime Global Maritime Crime Program (UNODC-GCMP).[62] All national and regional operational units can conduct their monitoring activities independently, share information, and communicate in real time with other units.[63] It was preceded and paralleled by a training and education platform to continuously prepare officials for using YARIS.[64] The YARIS platform has been fully operational since 2021. This system is currently housed in France. EU partners are discussing the terms of the transfer of the platform to regional partners.[65] Although having a broad range of maritime security goals, the YARIS platform has already been shown to be useful in the fight against IUU fishing. The system allowed authorities from the Guinea Conakry to identify and then inspect a vessel that entered its waters to fish without a license and during a biological rest period. However, this success story also points to a relevant limitation: the information was only useful as long as it helped law enforcement act promptly at sea for

55 Fisheries Committee for the West Central Gulf of Guinea. PESCAO Component 2. Available at: https://fcwc-fish.org/projects/pescao/pescao-component-2-fcwc-pescao
56 Fisheries Committee for the West Central Gulf of Guinea. Regional MCS Centre. Available at: https://fcwc-fish.org/regional-mcs-centre
57 TMT. West Africa Task Force. Available at: https://www.tm-tracking.org/west-africa-task-force
58 Fisheries Committee for the West Central Gulf of Guinea. FCWC Hands Over Equipment to Ghana to Improve MCS Efforts. Available at: https://fcwc-fish.org/pescao-news-pescao/fcwc-hands-over-equipment-to-ghana-to-improve-mcs-efforts
59 In 2013, the Heads of States of West and Central African countries met in Yaoundé, Cameroon. They signed the "Code of Conduct concerning the Repression of Piracy, Armed Robbery against Ships, and Illicit Maritime Activity in West and Central Africa," which is widely known as the "Yaoundé Code of Conduct." In accordance with the code of conduct, signatories set up regional information-sharing and coordination centers to address the threat of piracy and armed robbery at sea in their waters.
60 EU GOGIN. Yaoundé Architecture. Available at: https://www.gogin.eu/en/about/yaounde-architecture/
61 EU GOGIN. Yaoundé Architecture Regional Information System (YARIS). Available at: https://www.gogin.eu/en/information-sharing/yaris-yaounde-architecture-regional-information-sharing/
62 United Nations Office on Drugs and Crime. Global Maritime Crime Program. Briefing Package. Available at: https://www.unodc.org/documents/Maritime_crime/UNODC_GMCP_Briefing_Package.pdf
63 EU GOGIN. Yaoundé Architecture Regional Information System (YARIS). Available at: https://www.gogin.eu/en/information-sharing/yaris-yaounde-architecture-regional-information-sharing/
64 EU GOGIN. Tess Platform. Available at: https://www.gogin.eu/en/information-sharing/tess-platform/
65 EU GOGIN. Yaoundé Architecture Regional Information System (YARIS). Available at: https://www.gogin.eu/en/information-sharing/yaris-yaounde-architecture-regional-information-sharing/

intercepting and inspecting a boat.

- Technology: Regional platform for communication and intelligence sharing.
- Key positive outcomes: Helps produce actionable intelligence and can facilitate joint action against IUU fishing at a regional level.
- Key shortcoming: The project is very recent. It relies on proprietary systems, whose subscription is very costly, and its financial viability after the project elapses is unclear. The platform is housed outside the region in France, raising questions about the independent further development of the platform in the longer term.

  Finally, the project depends on the ability of states' enforcement capacity to act on information.

Multilevel Efforts against IUU in Guinea-Bissau

The main institution responsible for fisheries governance in Guinea-Bissau is the Ministry of Fisheries, which concentrates MCS efforts within the Fisheries Control and Oversight Authority (FISCAP). Fisheries management is also supported by the National Center for Applied Fisheries Research (CIPA), which is responsible for stock assessments and establishing MSY. Enforcement of fisheries regulations is the duty of the FISCAP, along with the Navy and Coast Guard. Guinea-Bissau is a member state of the Subregional Fisheries Commission (SRFC), which is a relevant actor in MCS and fisheries management in the country. Guinea-Bissau is also a party to key binding and nonbinding international instruments for addressing IUU fishing, such as the UNCLOS and UNFSA, but it is not a party to the PSMA.[66]

Domestic Policies

Guinea-Bissau's actions as flag state
Most fishing efforts in Guinea-Bissau are conducted by foreign vessels. For the industrial fleet, almost all vessels currently operate under fishing agreements with China, Senegal, and the EU, respectively.[67] This makes the country's actions as a flag state mostly limited to regulating artisanal fisheries, which are small in volume. The government of Guinea-Bissau still regulates industrial fishing (i.e., limiting effort, catch, and gear) through licensing these foreign-flagged vessels. However, as recently as last year, the government confirmed difficulties in overseeing compliance with the total allowable catches established by CIPA MSY estimation.[68] Therefore, without appropriate cooperation with distant flag water states, Guinea-Bissau may have a limited capacity to levy sanctions against states that are conducting IUU fishing in its waters, nor can it affect the benefits and subsidies that may be incentivizing these activities.

Guinea-Bissau's actions as a port state
Most of the seafood from Guinea-Bissau's waters has not been landed in the country. The main port in the country, Alto Bandim, which has been recently expanded, still has limited landing capacity. This makes the ability of the country to oversee fishing through port state measures almost absent. International cooperation has been directed at helping build these capacities. In the early 2010s, the European Union and African Development Bank funded the expansion of an industrial port (Alto Bandim) to increase the capacity to land catches from industrial and artisanal fisheries.[69] A new round of investment in the port was announced in 2017, with funding from China, as part of the broader national efforts to create a postharvest seafood processing capacity in Guinea-Bissau.[70] Currently, the country also seeks certification of its laboratories to certify its fisheries for export, which is a crucial step in linking fishing efforts with the inland economy.[71] These steps could help make port measures more pertinent to curb IUU fishing in the country. However, on the regulatory side, Guinea-Bissau is the only West African state not to have acceded to the PSMA.[72]

Guinea-Bissau's MCS strategies on its EEZ
Given the small number of vessels operating under its flag and fish being landed in its ports, the effective MCS of

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66 Food and Agriculture Organization. PSMA Parties. Available at: https://www.fao.org/port-state-measures/background/parties-psma/en/. Information also confirmed by the SRFC secretariat.
67 República da Guiné-Bissau, "Plano Estratégico do Desenvolvimento das Pescas," 2014.
68 Revista Sapo. Responsável por fiscalização das pescas na Guiné-Bissau quer mais meios para control. Available at: https://visao.sapo.pt/atualidade/mundo/2021-08-05-responsavel-por-fiscalizacao-das-pescas-na-guine-bissau-quer-mais-meios-para-controlo/
69 República da Guiné-Bissau, "Plano Estratégico do Desenvolvimento das Pescas," 2014
70 FAAPA. Pescas: Governo satisfeito com materialização do projecto de unidade de conservação e tratamento do pescado. Available at: http://www.faapa.info/blog/pescas-governo-satisfeito-com-materializacao-do-projecto-de-unidade-de-conservacao-e-tratamento-do-pescado/
71 Available at: http://www.faapa.info/blog/pescasuniao-europeia-capacita-tecnicos-do-cipa-em-materia-de-certificacao-de-pescados/
72 Food and Agriculture Organization. PSMA Parties Available at: https://www.fao.org/port-state-measures/background/parties-psma/en/. Information also confirmed by the SRFC secretariat.

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fisheries in Guinea-Bissau´s waters is the main way to address the challenge of IUU fishing. However, the country has a very limited capacity to patrol its waters. The FISCAP and coast guard have a very small fleet of rapid boats,[73] boats for patrolling the country's EEZ, along with its 88 islands.[74] The country has established a VMS-equipped fishery monitoring center with foreign aid and four coastal surveillance centers. The country depends on external funding to organize surveillance operations at sea. As described below, some international cooperation initiatives have funded these operations. Research has shown that these waves of enhanced MCS presence at sea can deter IUU fishing, even if only intermittently.[75]

International Cooperation and Technology in MCS

Guinea-Bissau has been part of a smaller number of projects introducing new technologies to improve its MCS capacity. The main technologies introduced and explored in the country are VMSs and AISs, which seem to have improved monitoring capacity but have limited capacity to curb IUU fishing and secure more sustainable fisheries.[76] We describe which technology has been introduced to address which necessities and whether it has achieved its objectives.

West Africa Regional Fisheries Program (WARFP)

The aforementioned WARFP, which played a role in strengthening fisheries management in Ghana, was initially designed for SRFC member states and funded the initiatives in Guinea-Bissau. The project aimed to strengthen the capacities for governing and managing targeted fisheries, reducing illegal fishing, and increasing local value added to fish products.[77] Concretely, Guinea-Bissau received US$8 million between 2011 and 2017.[78] The project funded the construction and launch of a fishery monitoring center for FISCAP, equipped with facilities for monitoring via VMSs and AISs, and the rehabilitation of coastal surveillance stations along the coast, which are equipped with radio and radar.[79] Regionally, the project initiated the establishment of an SRFC dashboard for an integrated MCS. WARFP also promoted integrated training and capacitation of personnel involved in MCS activities. In other states, the project contributed to efforts to register artisanal fishers and establish community

management rights, but these were not implemented in Guinea-Bissau because of the small size of the artisanal fishing community there. The combination of increased surveillance capacity through VMS technology, training of personnel, and increased joint patrols has been evaluated as successful in enhancing efforts against IUU fishing.[80] Additional research has pointed in the same direction. However, in Guinea-Bissau, acting on VMSs and AISs to enhance surveillance has depended on the short-term lease of boats from other states, mostly Senegal, and, thus on external funding to pay for these leases. Currently, the government still uses VMSs and AISs, but the navy and coastal guard lack the capacity to act on this information.[81] A second phase of WARFP, focusing on further integrating fisheries management and strengthening postharvest value chains in the region, was approved in 2017. Guinea-Bissau would have received US$3 million, but the project funding was canceled in 2020.

- Technological tool: VMSs and AISs for monitoring the industrial fleet.
- Key achievement: Increased capacity to identify fishing in restricted zones and target surveillance. Helped secure compliance when accompanied by patrolling.
- Key shortcoming: Limited capacity to act on information without external aid to fund patrolling.

PESCAO

Implemented by the SRFC, the EU-funded PESCAO project is also present on the northern coast of West Africa. The project operates along the same lines and goals as in the FCWC, helping address IUU fishing through improved cooperation with MCS.[82] In the SRFC, PESCAO funded the creation of a Regional MCS Center in Gambia,

73 Interview with official from the Ministry of Fisheries of Guinea-Bissau.
74 MAVA Foundation. Bigajos Islands in Guinea-Bissau. Available at: https://mava-foundation.org/about-us/our-story/bijagos-islands-in-guinea-bissau/
75 Intchama, J. et al. "Assessing Guinea Bissau's legal and illegal unreported and unregulated fisheries and the surveillance efforts to tackle them," Frontiers in Marine Science 5 (2018), 79.
76 Intchama, J. et al. "Assessing Guinea Bissau's legal and illegal unreported and unregulated fisheries and the surveillance efforts to tackle them," Frontiers in Marine Science 5 (2018), 79.
77 Global Environmental Facility. "West Africa Regional Fisheries Program - Phase 2 in Cabo Verde, the Gambia, Guinea Bissau and Senegal," Project Information Document 2017.
78 Global Environmental Facility. "West Africa Regional Fisheries Program - Phase 2 in Cabo Verde, the Gambia, Guinea Bissau and Senegal," Project Information Document, 2017.
79 World Bank. "Implementation Completion and Results Report for the West Africa Regional Fisheries Program," Report No: ICR00004008
80 World Bank. "Implementation Completion and Results Report for the West Africa Regional Fisheries Program," Report No: ICR00004008
81 Interview with official from the Ministry of Fisheries of Guinea-Bissau.
82 European Fisheries Control Agency. Available at: https://www.efca.europa.eu/en/content/pescao

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equipped with VMS and AIS.[83] It also organized regional and national workshops to train officials in using these technologies.[84]Another key component of PESCAO was supporting joint operations among members of SRFC against IUU fishing. To that end, it made available to EU's IMS and imagery from the Copernicus satellites. Between 2018 and 2022, PESCAO funded at least six operations, all of which included inspections in Guinea-Bissau's EEZ.[85] These joint operations have also been a way for Guinea-Bissau to overcome limited enforcement capacity.

- Technological tool: Regional MCS center equipped with VMSs and AISs.
- Key achievement: Provides intelligence for regional cooperation against IUU fishing.
- Key shortcoming: Limited capacity to act on information apart from joint operations.

Support for the sustainable management of small pelagic populations (AGD-Pelagic)
This project has not had the direct goal of addressing IUU fishing but of increasing the capacity of SRFC member states to manage small pelagic fish populations using technology. The project, with funding from the MAVA foundation, amounted to 1.17 million euros distributed between Guinea-Bissau and four other states and was implemented between 2018 and 2022.[86] Given that most fishing is neither conducted by vessels under its flag nor landed in its port, the ability to estimate catches and stocks is limited. This project offers two solutions: One is the use of tablets to facilitate harmonized data collection by the CIPA, which is the entity responsible for the scientific knowledge production underpinning fisheries management in Guinea-Bissau.[87] A second solution is to build on existing VMSs and AISs to enhance the capacity for estimating efforts and catches.[88] Although not directly aimed at addressing IUU fishing, being able to better estimate fishing activity can help Guinea-Bissau validate the reporting of the fleets operating under its fishing agreements, help establish sustainable quotas, and potentially identify underreported fishing. Authorities in Guinea-Bissau are transitioning to a quota system that establishes limits on the amount of fishing allowed under the EU agreements in terms of a total allowed catch by species.[89] However, there is no indication of the potential use of these data in MCS activities.

- Technological tool: The use of tablets, VMSs, and AISs to collect data on small pelagic fisheries.
- Key achievement: Increase the quality of data, with the potential to help identify underreporting and establish more sustainable MSY.
- Key shortcoming: The potential use of data to increase MCS capacity has not yet been explored.

Yaoundé Architecture Regional Information System (YARIS)
Guinea-Bissau is also part of the interregional Yaoundé Architecture and benefits from the YARIS platform. YARIS is an information-sharing platform designed to help countries in West Africa members of three regional organizations—ECOWAS, ECCAS, and the GGC—coordinate their maritime security. The country's EEZ is integrated into the maritime operations center monitored in the Maritime Multinational Coordination Center located in Praia, Cape Verde. By facilitating the integration of MCS efforts among different states, it can be relevant for Guinea-Bissau because of its limited patrolling capacity, allowing it to increase synergy with neighboring states with a stronger law enforcement capacity. Besides potentially benefiting from the cooperative network of YARIS, the platform can also help integrate national efforts to address IUU fishing. A YARIS workshop held in May 2022 kickstarted the process of using the platform to coordinate several agencies involved in MCS in Guinea-Bissau, including FISCAP, the navy, and the coast guard.[90] The platform facilitates communication and provides actors with a tool for the joint real-time monitoring of maritime activities. Although this integration can help make scarce enforcement resources more efficient, the limited resources for enforcement can also limit its effects on helping address IUU fishing. Nevertheless, the project is recent, and the effects of the YARIS, here through enhanced cooperation among MCS domestic agencies and international actors, have yet to be assessed.

83 European Commission. Action Document for improved regional fisheries governance in Western Africa (PESCAO). ROC/FED/038-922
84 Available at: https://www.efca.europa.eu/en/content/pressroom/efca-trains-officials-west-africa
85 Data collected from: European Fisheries Control Agency. Available at: https://www.efca.europa.eu/
86 Sub-Regional Fisheries Commission. Support for the sustainable management of small pelagic populations. Available at: http://spcsrp.org/en/project-support-sustainable-management-small-pelagic-populations-csrp-zone-agd-pelagics
87 Sub-Regional Fisheries Commission. Support for the sustainable management of small pelagic populations. Available at: http://spcsrp.org/en/project-support-sustainable-management-small-pelagic-populations-csrp-zone-agd-pelagics
88 Sub-Regional Fisheries Commission. Support for the sustainable management of small pelagic populations. Available at: http://spcsrp.org/en/project-support-sustainable-management-small-pelagic-populations-csrp-zone-agd-pelagics
89 EU and Guinea-Bissau Comission-Mixte. "Procès-verbal 26-27 avril 2022."
90 EU Gogin. The YARIS national network connects the maritime agencies of Guinea-Bissau. Available at: https://www.gogin.eu/en/2022/05/11/the-yaris-national-network-connects-the-maritime-agencies-of-guinea-bissau/

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- Technology: Regional platform for communication and intelligence sharing.
- Key positive outcomes: Helps produce actionable intelligence and can facilitate joint action against IUU fishing.
- Key shortcoming: The project is very recent and relies on proprietary systems, whose subscription is very costly. In addition, its financial viability after the project elapses is unclear. The platform is housed outside the region in France, raising questions about the independence of further development of the platform in the longer term. Finally, the project is dependent on the ability of states' enforcement capacities to act on information. In the case of Guinea-Bissau, this can render the project ineffective if it is not combined with joint operations with neighboring states.

Conclusions and Recommendations

This report has analyzed the potential of technologies in helping coastal states in the Global South build MCS capacities to address IUU fishing. Technological tools have been hailed for their potential to overcome the main challenges in the fight against IUU fishing, the fragmented governance of fisheries and intrinsic difficulties in enforcing fisheries regulations.[91] The present report has assessed such potential in the context of West Africa. It has focused on two cases—Ghana and Guinea-Bissau—which face important but different challenges in curbing IUU fishing. Based on an extensive analysis of policy documents, interviews, and secondary sources, several international cooperation projects that have introduced novel technologies into the MCS strategies of these two countries have been reviewed. Considering the contexts of each country and the region, it was possible to assess the extent of the contribution of these technologies in addressing IUU fishing, along with their challenges and limitations.

The analysis supports the following conclusions:

- **Data produced by technologies can only be effective if incorporated with improved governance, regulatory frameworks, and enforcement capacity**

Technologies can be effective at producing a vast amount of information, but this information will be innocuous against IUU fishing if it cannot be acted upon by the relevant authorities. Making information actionable is not only a matter of producing a friendly user interface for MCS authorities but also making sure it is well harmonized with the regulatory framework in place and the authority's capacity to enforce regulations. First, that means that technologies must produce information tailored to surveilling illegalities established in national regulations and that this information can be used in sanctioning misconduct. Some project evaluations have reported concerns with the admissibility and strength of technology-generated evidence in the prosecutorial chain. This is often because of important legal rights and safeguards that indeed must be considered, but it can also be due to a lack of adequate regulatory framework.

Second, in parallel, it is often the case that the information produced by technology, particularly VMSs and AISs, needs to be followed by patrols and at-sea inspections to identify illegalities. The comparative analysis shows how there are discrepancies in the countries in the region to do so. Although Ghana has capacity to patrol its coast, Guinea-Bissau has a much smaller fleet and needs to rely on external funding to patrol its coast. In both cases, mobilizing technology to address IUU fishing requires adequate governance. Inadequate regulatory frameworks and limited enforcement capacity can stem from multiple governance issues, such as lack of political will, recurring political instability or simply lack of resources. All these factors must be accounted for when considering the effectiveness of technology.

- **Untapped potential for image-based monitoring and surveillance**

Technologies that use nonaerial videos and photos—such as REMSs, body-worn cameras, and even the cell phone app for engaging artisanal fishers in monitoring industrial vessels—have been used only in pilots and only in Ghana. REMSs, for instance, have the capacity to monitor and surveil a wide range of fishing activities within vessels, with a lower exposure of observers and inspectors to harassment and corruption. Although its equipment and operating costs need to be considered, it seems to be a promising way of securing the compliance of the

Widjaja, Sjarief, Tony Long, and Hassan Wirajuda. "Illegal, unreported and unregulated fishing and associated drivers," Blue Paper. High Level Panel for a Sustainable Ocean Economy, 2020

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industrial fleet, particularly if followed with transparent licensing practices. Body cameras can potentially to increase accountability and coordination among authorities during inspections. The DASE app seems to be a way to engage stakeholders in sustainable fishing management. Nevertheless, these initiatives demand appropriate data management, training of end users, and security architecture before they can be applied on a larger scale.

- **Asymmetry in the distribution of projects**

The research has shown asymmetry in the volume and diversity of projects conducted in Ghana and Guinea-Bissau. Ghana has been able to gather a more complex network of partners and experiment with a vast array of tools to enhance its MCS strategies. In Guinea-Bissau, which has a more reduced MCS capacity, projects have been limited to introducing VMSs and AISs, as well as integrating the country within regional arrangements. Although these regional collaborations may well be an avenue to overcome the resource limitations of Guinea-Bissau, there is further room to build and enhance the MCS capacities in the country. Addressing the asymmetries in the distribution of cooperation in the region may be necessary to avoid creating blind spots in global strategies against IUU fishing.

- **Project synergies and sustainability by strengthening local capacity**

In West Africa, there is a considerable array of projects intended to enhance maritime security, promoting fisheries sustainability, and contributing to addressing IUU fishing. Most synergies among projects appear to be derived from a cumulative capacity building. For instance, in Ghana, the WARFP project funded a VMS center that would later benefit from the training programs and analytical platforms provided by the WATF and PESCAO. Similar integration can be found between PESCAO and WATF at the regional level, where the first initially funded Regional MCS Center whose operation the latter further developed. Therefore, there is potential for greater sustainability of outcomes if projects build upon the capacities built by previous projects. This can also create internal long-term political commitment within coastal and port states. Furthermore, enhancing capacities in the coastal states can be a necessary step to ensure that they can engage effectively in broader efforts against IUU fishing.

- **Regional cooperation as a way to overcome asymmetries and address transnational IUU**

Some of the most promising and effective projects reviewed have a regional component. Regional cooperation for integrating MCS strategies, sharing information, and coordinating enforcement responses seem to be an effective avenue to address IUU fishing in the region for two main reasons. First, given the transnational nature of fishing activities and IUU fishing, the regional level is a highly appropriate scale to address this issue. Second, in a region with important asymmetries, these initiatives can be a way to increase the surveillance and enforcement capacity of states that lack the necessary resources. The case of Guinea-Bissau indicates the relevance of joint operations with neighboring states to effectively patrol its coast and deter IUU fishing. In the region, there seems to be a large amount of potential for collaboration between regional fishery governance and maritime security cooperation. The focused action of subregional fisheries organizations such as the SRFC and FCWC has presented a recent history of success that warrants further investment. The YARIS platform is more recent advancement but shows good potential to help connect regional efforts and integrate fisheries MCS with a broader maritime security framework.

- **New opportunities for technology to enhance global collaboration between port, coastal, and flag states**

Increased transparency and data-sharing initiatives at the regional level are yet to be scaled up and linked with global collaboration against IUU fishing. The good prospects of regional cooperation among coastal and port states can be further effective if better tied with extra-regional distant water flag states and beneficial owners. In the case of Guinea-Bissau, the fact that most fishing is conducted by vessels flagged in Europe or China limits the country's ability to sanction individuals involved in IUU fishing in its waters. In this case, data sharing and cooperation between Guinea-Bissau and fisheries authorities of the flag states could more fairly distribute the

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burden of regulatory responsibility and allow for more effective sanctioning of non-compliant behavior. It can also help ensure that subsidies by major flag states are not supporting IUU fishing elsewhere. In Ghana, while all industrial vessels carry its flag, many have foreign beneficial owners, especially from China, raising a similar but more complex jurisdictional problem. Nevertheless, Ghana can still benefit from technology afforded information sharing and transparency to identify the network of individuals linked to IUU fishing and restrict subsidies and other benefits provided by their government to their foreign joint ventures.

Based on these conclusions and the research, the following recommendations are worth considering:

- International development initiatives for building technological solutions for MCS should assess their compatibility with the local realities of the recipient states.
- International development initiatives should prioritize technological solutions that can be effective in the specific context of recipient states but also work with them on improving their governance, regulatory frameworks, and enforcement capacity.
- International development initiatives should consider further exploring the potential of technologies that improve international transparency on fishing activities, such as REMS systems and data sharing platforms.
- International development initiatives should prioritize technological solutions that create sustainable capacities within states or intergovernmental bodies for better MCS.
- International development initiatives should prioritize projects that enhance capacities for coordinated actions regionally to address the intrinsically cross-border issue of IUU fishing and mitigate countries' asymmetries in MCS capacities.
- International development initiatives should explore further how technologies can increase data sharing and collaboration globally, helping engaged flag states involved in distant water fishing in the fight against IUU fishing perpetrated by their vessels.

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