Improving data in artisanal IOTC fisheries using electronic monitoring tools

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Summary

The parlous data situation for artisanal tuna fisheries in tuna commissions, including the IOTC, is due in part to reliance on technology that is literally thousands of years old - handwriting on paper - to record data. Fisheries management bodies (business, national and inter-governmental, including in IOTC) are transitioning to electronic fisheries information systems. However, the IOTC data holdings and management are reliant on actions taken by Parties to the Commission (CPCs). Primary data recording for logbooks, monitoring or catch documentation schemes remains overwhelmingly paper-based. Information on paper must be captured into an electronic system by CPCs before it can be shared or used for national reporting purposes. This is a cumbersome, expensive and error-strewn process. Furthermore, paper-based systems are highly scale-dependent, meaning that as the scale of the data requirements grows (more fishing operations, more volumes and types of information), so too does the effort to meet those requirements. Not all coastal CPCs consistently meet their data submission and reporting obligations to the IOTC. ABALOBI is a social enterprise working with artisanal fisheries, and has developed a suite of electronic tools for fishing data recording, including for monitors recording catch information at landing. Its systems are fully digital, but are designed to work with paper information sheets if needed, and can be configured to work without an internet connection, making this the ideal electronic system for the vast numbers of widely dispersed and often remote artisanal fishing communities that catch tuna in the Indian Ocean. While ABALOBI's e-logbook and other apps are also available, we believe that the ABALOBI MONITOR platform, constituted by a smartphone application feeding a secure data warehouse via cloud-based tools, together with the suite of analysis, visualisation and access-management tools, can provide multiple benefits to both meeting CPCs' data submission and Regional Observer Scheme obligations, and to artisanal fishers. It can further substantially strengthen governments' capabilities to detect and address illegal activities while transforming the provision of data from artisanal fisheries to the IOTC. For the latter, obvious benefits extend to a wide range of IOTC activities, most pertinently stock assessment and scientific advice. ABALOBI invites any interested party to explore a joint program of work, and proposes to collaborate closely with the IOTC Secretariat to develop heuristics and Standards for electronic systems in and use of digital data from artisanal fisheries.

Introduction

The transition from analogue to digital information systems has happened to varying degrees in most major economic sectors, with the move being virtually complete in finance. Fisheries have been exceptionally slow to adopt electronic systems. Electronic information systems, once adopted and integrated, can be dramatically cheaper, more reliable and more efficient than paper-based systems. The timeous provision of accurate and reliable catch and effort data remains an enormous challenge for bodies such as the Indian Ocean Tuna Commission (IOTC). The lack of, delayed, incomplete and/or unreliable catch and effort data makes scientific analyses and recommendations for stock and bycatch management exceptionally challenging. Parties to the IOTC (hereafter CPCs) are bound by Res 15/02 to report specific aspects of their fleets' fishing activity, behaviour and outcomes. Additionally, CPCs have a binding obligation under the United Nations Convention on the Law of the Sea to prevent vessels carrying their flag to engage in Illegal, Unreported and Unregulated (IUU) activities. Without adequate monitoring tools, States cannot easily meet their obligations.

The IOTC categorises fishing vessels as industrial or artisanal, the latter defined as <24 m in total length, and which do not operate on the High Seas. All other fishing vessels are classified as industrial. Artisanal IOTC fisheries make up close to half the estimated tonnage caught under the ambit of the IOTC (IOTC 2020b). Annually, the Scientific Committee reports on the parlous state of data from artisanal fisheries under its purview (e.g. IOTC 2020b), despite considerable effort from the Secretariat and others to improve data collection and management capacity (IOTC 2020a).

The data challenges that are described regularly and in detail in papers to various IOTC working groups stem from multiple sources. For example, Res 11/04 sets out the Regional Observer Programme of the IOTC, but annual updates on ROS data provision by CPCs shows that only a small number of CPCs regularly meet the minimum coverage levels. The mandatory data schemes that the IOTC has in place, if reporting levels were high, would allow robust decision-making regarding a suite of fundamental issues, particularly stock assessments and evidence-based, scientific rationales for effort limitation and bycatch management. Improving performance in all arenas of data collection and reporting is amongst the highest priorities for strengthening the functioning of the IOTC. Indeed, port-based sampling is considered an observer activity, and thus falls under the IOTC's pilot ROS project. Specifically, ABALOBI requests advice from the Secretariat regarding reactivating the 5th aspect of its ROS project - Observations in Port - in collaboration with ABALOBI, noting that observing or monitoring landings cannot obviate the need for at-sea observations, particularly to verify discard data.

Challenges with paper-based systems

Logbooks and verification at landing are primary IOTC-codified Monitoring, Control and Surveillance (MCS) mechanisms that CPCs must use to gather and provide minimum types and amounts of data. The work required to manage catch and effort documentation (logbooks, landing declarations, etc.) and inspection schemes adequately are, unlike in the financial sector, by-and-large reliant on first-mile/pedigree data being captured on paper. Physical data sheets and books must be stored temporarily or submitted to an office, batched and stored again, then transferred to a data capture centre where humans spend inordinate hours, at great expense to the national fiscus, to convert analogue data into digital data. While the drawbacks for paper-based systems are manifold, the time-lag and inherent process errors from manual recording and data capture are arguably the most problematic. Consequently, these compounding issues erode the reliability and relevance of the data. Events from too long in the past and with often appreciable uncertainty from a legal perspective, are unlikely to be taken forward in a compliance process.

Last, but not least, tuna are typically caught, landed, moved, sold and consumed in timeframes that seldom match those for the arrival of paper-based data. Trade and food-quality imperatives cannot halt commerce while cumbersome systems take weeks or months to confirm the provenance and legality of products. Often, the required data have to be created at landing (e.g. buyers require a Captain's Statement before offloading catches) to facilitate trade, meaning that tuna may be traded without official verification of its traceability. For those governments that have not completed the adoption of electronic information systems, the costs are substantial. It is functionally impossible for paper-based systems operating at the scale of many artisanal IOTC fisheries to provide traceability data and documents *timeously*. Without robust traceability data, tuna cannot be legally exported to most international markets because those markets require increasingly robust traceability data. The impacts on the earning potential for artisanal fishers is obvious. However, this also negatively impacts the national economy, specifically the balance of trade and foreign currency earnings.

Currently, traceability in many tuna supply chains begins with generating catch and effort data at landing - contrary to Best Practice where fishing events are recorded by the fisher, daily, usually onboard. A second challenge is the availability of supporting documentation; responsible buyers must proactively secure copies of permits, Authorisations to Fish, etc. in an attempt to demonstrate the traceability and legality of the products. Typically these actions (generating data and accessing

documents) are the domain of well-resourced, industrial corporations trading in large volumes of tuna; this is beyond the capacity of artisanal fishers or most fishing cooperatives. Furthermore, industry-generated landing data are seldom if ever shared with authorities. Thus data from the same event are often generated multiple times - creating inefficiencies and potential discrepancies. Artisanal fishers usually lack the coordination, resources and market pressure to collect, manage and share landing data. Limited market access severely constrains many artisanal fishers' livelihoods and resilience. For the purposes of this paper, these challenges are termed 'market barriers'.

A CPC that wishes to meet its data submission and reporting obligations from artisanal fisheries to IOTC requires both logbooks and MCS data to be robust. Logbook data, because it is self-reported with minimal verification systems, becomes less trustworthy when MCS effort is weak or inadequate. An electronic system for monitoring data (which collects much of the same data that are collected in logbooks) can become a powerful tool for CPCs to meet IOTC requirements while simultaneously strengthening aspects of data derived from national logbook systems.

Digital Monitor data

The digital revolution, and especially smartphone applications (apps) with cloud-based storage and processing capacity, can overcome some of the market barriers, even for very small operations. Electronic Fisheries Information Systems (eFIS) allow CPCs to increase the scope and improve the quantity and quality of fisheries data. The many benefits of electronic solutions extend to the realm of MCS.

This paper presents a privately developed, smartphone app-based system for monitoring artisanal fisheries landings and related data. It holds the potential to transform data recording, management, analysis and sharing/reporting. ABALOBI (which means "fisher" in the isiXhosa language) is a South African-registered public benefit organisation and social enterprise working with artisanal fishers. ABALOBI's suite of electronic tools includes the FISHER app which collects e-logbook-type data and the MARKETPLACE app, which connects buyers with fishers (inter alia through utilising the FISHER app data). The MONITOR app is of most relevance for the IOTC's artisanal fisheries. It is already used in private shore- and port-based MCS schemes in several jurisdictions. While our vision is for a modern, paperless, fully integrated, electronic fisheries information system, our platform allows for physical paper forms to be maintained, as de facto physical backup, for as long as needed. Pilots of ABALOBI MONITOR conducted in non-tuna fisheries demonstrated proof of concept successfully.

Data security and, critically for the IOTC setting, data sovereignty, are of significant concern to ABALOBI. The ABALOBI Monitor Platform is hosted on AWS secured infrastructure, which ensures a necessary level of access security, failover coverage and disaster mitigation. Data integrity cannot be compromised by users once data are in the warehouse. While data are often imperfect, a system becomes open to abuse if data can be changed without a record of that. ABALOBI systems do not allow any user to make any changes to any data directly. A third party technical support company must grant access to the raw data that needs editing. That process is managed through a support ticket system which provides a permanent record of what was changed, why, and by whom. ABALOBI utilises the AWS Ireland cluster for all hosting needs and if required could look to host tenant infrastructure & data in-country, should the necessary local AWS cluster exist. However, readers are encouraged to read the AWS explanation of their services in relation to residency/jurisdictional location of data storage, which confirms there are zero pragmatic concerns (AWS 2020); privacy and confidentiality with AWS servers are as robust and guaranteed as is possible currently. Confidentiality and non-disclosure agreements prevent ABALOBI from disclosing any information to third parties without consent. Further, our robust access-control systems ensure that only personnel authorised by a given CPC can access their data.

Overview of the ABALOBI MONITOR platform

The ABALOBI MONITOR platform incorporates data collection, storage, analysis and real-time data visualisations as a complete end-to-end electronic catch reporting system. The app populates a secure data warehouse, while user management and data visualisation interfaces are accessed through ABALOBI's admin console. App functionality and development are considerably more complex than using typical data forms utilised in many mainstream operations reliant on off-the-shelf products. For situations where the app isn't suited or available ABALOBI makes use of electronic forms built in the Open Development Kit (ODK) standard, to which ABALOBI has contributed open-source code in the past. All data and administration tools rely on cloud storage, while data can be collected offline - i.e. both ABALOBI MONITOR and mobile forms can be configured to function without an internet connection (batching and storing data on the local device and uploading when an internet connection is established). Further, they are designed to function on Android and Apple smartphones from entry-level devices up. ABALOBI MONITOR was co-designed with fishers and monitors specifically to ensure intuitive, easy-to-use interfaces requiring minimal training to achieve proficiency, and with field types defined to minimise incorrect data entry.

The platform incorporates gear- or fishery-specific catch recording using scientifically robust, standardised approaches and definitions whenever possible. The platform collects Key Data Elements (KDE) following the alignment standards of the industry-led Global Dialogue on Seafood Traceability (GDST). This ensures interoperability between ABALOBI MONITOR and other platforms, allowing data exports to other databases. This is particularly valuable for meeting CPCs reporting obligations to the IOTC.

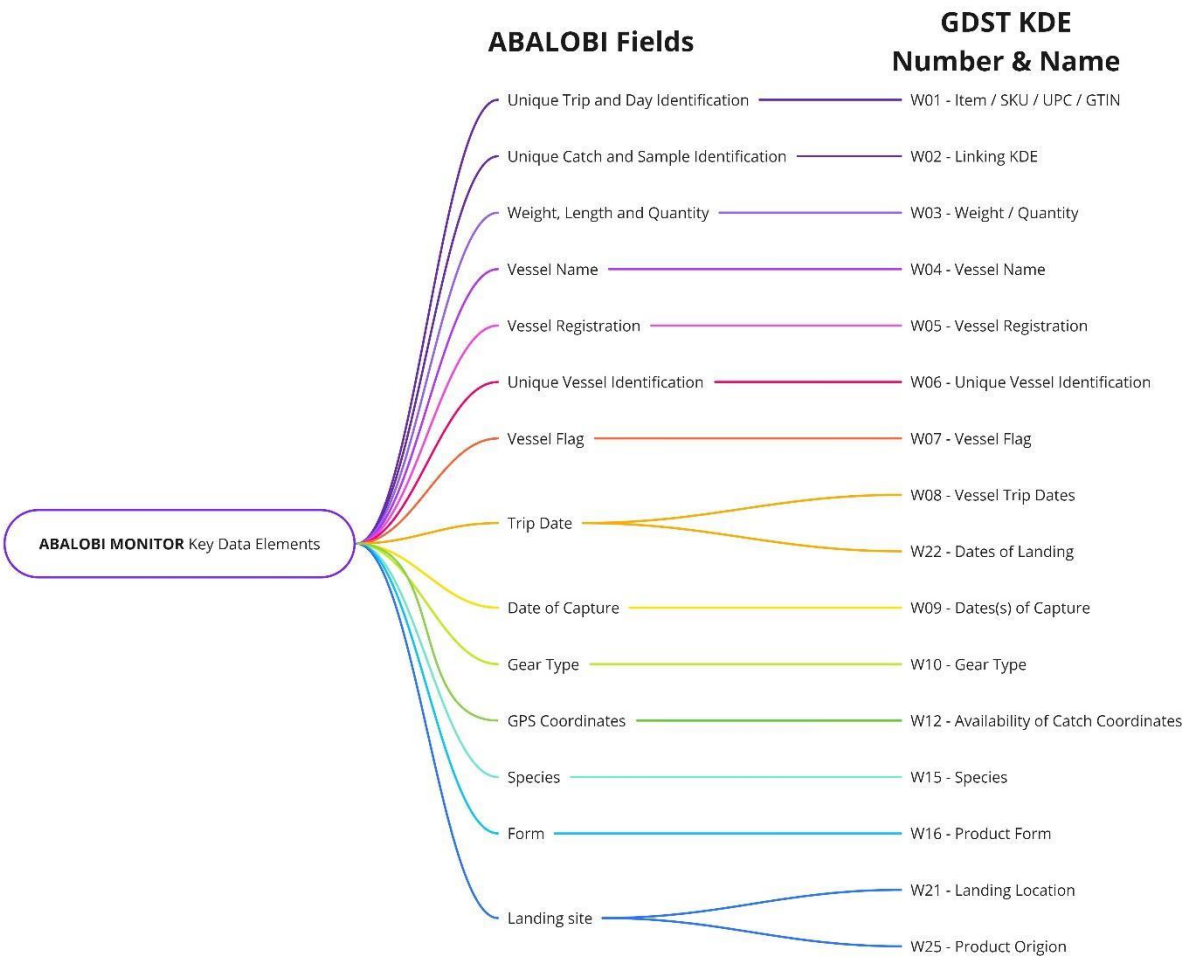

Figure 1. Comparison of ABALOBI data fields with the Key Data Elements defined by the Global Dialogue on Seafood Traceability.

Analytics and data visualisations include multiple, dynamic dashboards, per monitor, gear, species or by landing site. Standard tables or visualisations include metrics for catch per unit effort, gear type, length-frequency data, spatial effort, target species, mapping capabilities (if spatial management of fishing effort is of interest) and many more. An essential component of the platform is accessibility, through managed user accounts that provide varying levels of access. Data export is currently handled on a per request basis, and additional data export functionality will be offered as the needed. As part of the user management component, partners will soon be able to update lookup fields (fisher names, monitor names, species, gear types, communities, etc.) that surface in the app interface - subject to controls and verification protocols. ABALOBI follows strict, secure and standardised data protocols and data warehouse management. This includes the registration and verification of users, compliance with privacy laws, and best practice security protocols and encryption for apps and servers.

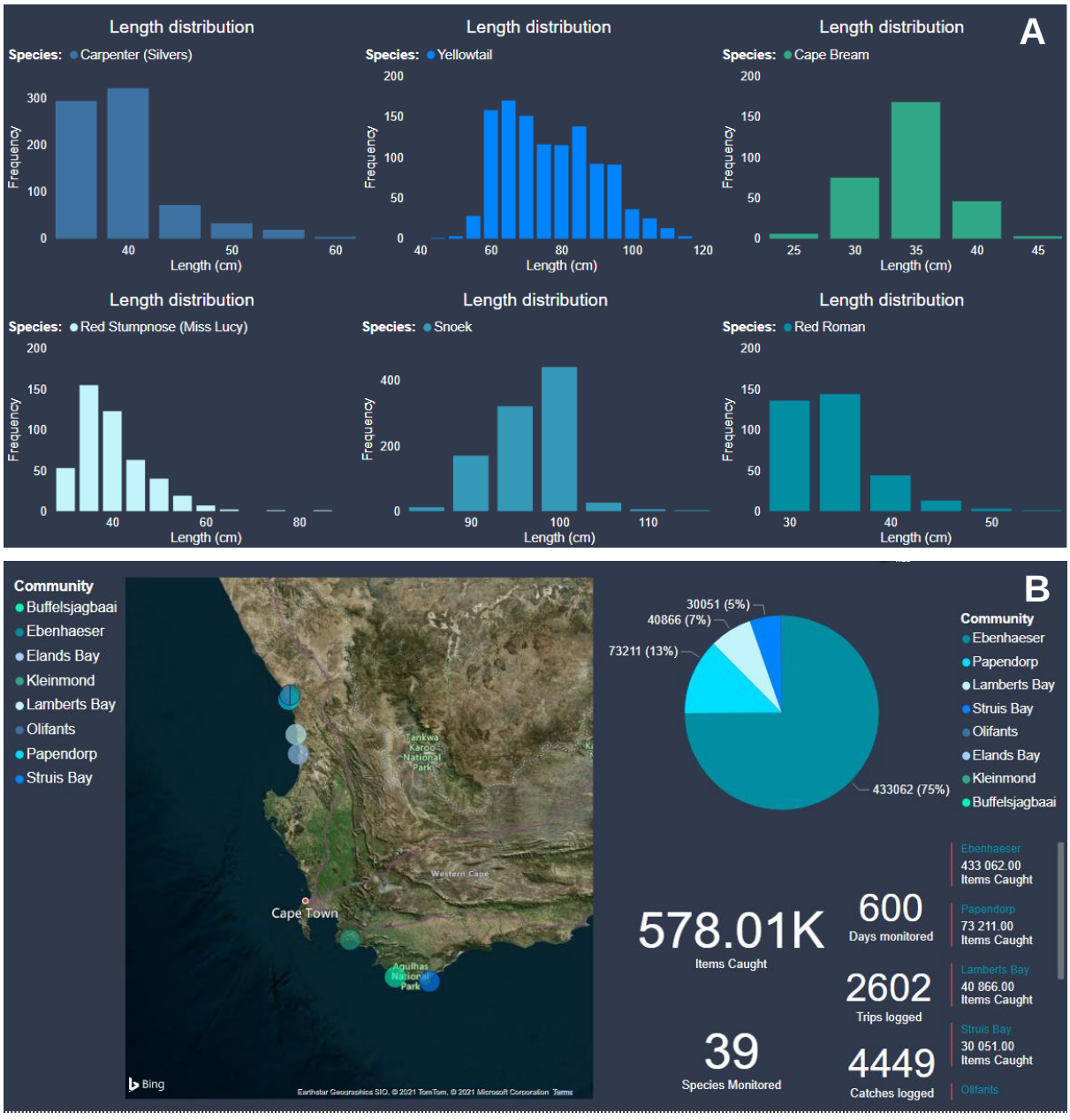

Figure 2. Examples of data visualisations of data collected through ABALOBI MONITOR. Panel A shows frequency histograms from length data on multiple species. Panel B shows fine-scale summary data of catch by region and aggregate catch totals. The dashboard can surface any number of datasets with a wide range of customisable visualisation formats.

ABALOBI MONITOR platform incorporates the following fishery-specific catch reporting and data visualisations using mobile, web- and cloud-based technology:

1. **Catch reporting** - Standardised and scientific methodology implemented for catch monitoring at landing sites or along the shore - rendering a robust and efficient service for analysis and reporting. Meeting the required level of coverage can be achieved if the requisite human resources are in place - the platform is not a limiting factor.
2. **Data and analytics** - Dynamic dashboards allow users to summarise data by fisher or landing site, and to tabulate and analyse CPUE metrics, length frequency, gear type and community breakdowns, species-specific metrics, spatial effort and more.
3. **Data export** - Manual and automated downloads of data tables (in csv and other formats).
4. **Alignment** - with GDST's KDEs.
5. **Admin console** - User (fisher & monitor) management, data management (species & gear types), access to data analytics and visualisations. Easy and flexible upload/update of fisher, monitor, gear type and species look-ups.
6. Standardised and secure data protocols and data warehouse management.
7. Online/offline use and capability.

Data sovereignty, access management, integrity and security

ABALOBI Monitor is a cloud-based platform; this enables remote management of the codebase of the ABALOBI Monitor app. A key advantage is this allows update pushes to users, requiring no action from users.

Access

It is critical to the consistent functioning of the ABALOBI platform and the ABALOBI multi-tenant approach that the primary databases are hosted on secure ABALOBI cloud-based servers. All tenants' data are also ring fenced, so tenants can only access their data, with zero possibility of unauthorised viewing, use or modification. Furthermore, data are encrypted and subject to regular back-up routines.

Integrity

Data integrity cannot be compromised by users once data have been uploaded to the data warehouse. In fact, data entries can only be edited in the app before being saved, but not thereafter (i.e. edits are not possible between saving and submitting data). And while we recognise that data are often imperfect, a system becomes open to abuse, and data become less trustworthy if post hoc changes be made in non-transparent or untraceable ways. Users, including ABALOBI personnel, cannot access the raw data. A third party technical support company can respond to requests to edit raw data and must undertake those edits., managed through a support ticket system. This ensures a permanent record of what was changed, when, why, and by whom; it also places distance between owners of data and the ability to change it - a key feature for data integrity.

Ownership

ABALOBI does not assume any form of ownership of the data generated by partners utilising the ABALOBI Monitor platform and fully respects the confidentiality and sovereignty of the data it curates on behalf of clients. Data ownership rests solely with partners, who have control over:

1. their data
2. defining access (by their own users and by third-parties)

3. data sharing arrangements
4. and data utilisation arrangements

Control over data sharing and access could, under the right project setup, allow a CPC to grant the IOTC Secretariat access to certain raw or processed data.

Proposal

We propose to pilot the implementation of the ABALOBI MONITOR platform for artisanal tuna landings. ABALOBI's experience has shown that customising ABALOBI MONITOR is necessary to ensure reliable data recording and efficient reporting. Co-configuration with the IOTC Secretariat and one or more coastal CPCs should be a simple and efficient process, since most of the fields in use are standard. The proposed pilot(s) could evaluate efficiencies and synergies (e.g. with business-friendly access to verified documentation for exports, or with compliance sections for follow-up on flagged events) from adopting electronic tools. Pilots could also facilitate development of lessons and principles that would allow IOTC to develop Standard Operating Procedures, or minimum standards, for electronic systems. A standards-based approach encourages innovation and cost-effectiveness by removing many barriers to new entrants to the sector; new entrants potentially provide new tools and services to under-served artisanal tuna fishers. A second valuable aspect of collaboration with IOTC Secretariat personnel and subsidiary bodies such WPDDCS, would be to establish how electronic tools such as ABALOBI MONITOR can be used to meet observer coverage requirements under Res 11/04 for artisanal fleets, and which data fields should be utilised for which reporting and submission processes, including for potentially meeting some aspects of CPCs' ROS obligations.

Benefits from adopting electronic information systems

There are multiple benefits from eFIS, of which some of the biggest are listed below (in no particular order).

1) The *timeous* provision of large volumes of reliable data, including length-frequencies and other fundamental data for stock assessments (if CPCs mandate those data to be collected)
2) Related to 1) is more robust and efficient stock assessments (and thus management advice). Electronic data can
    a. obviate much of the current, periodic revisiting of stock assessment models to update with historical data
    b. allow assessments to be conducted with better *a priori* model selection and parameterisation
3) Establishing a robust pathway for artisanal fisheries to achieve ecolabel certification
4) Real-time, integrated eFIS allows new approaches to address IUU, including building novel compliance tools around digital monitoring data
5) A single, reliable source of shareable digital monitoring data will create substantial efficiencies across the supply chain. ABALOBI specifically allows multiple users to access the information it curates. Thus tuna traders obtain data required for onward sales of tuna directly, unlike the current situation where they must either create their own catch and provenance data (e.g. requiring a Captain's Declaration or similar) or attempt to trade without them.

The sustainability of tuna fisheries is of interest to many parties besides the IOTC and its CPCs. In particular, developed markets are increasingly attuned to environmental impacts and sustainability of seafood products. As a result, it is widespread practice in developed markets to procure tuna exclusively or preferentially from fisheries that are publicly listed by Fishery Progress as being in a credible Fisheries Improvement Project (FIP), or with Marine Stewardship Council (MSC) certification. Adoption of Abalobi's electronic tools could be catalytic in moving groups or

communities of artisanal tuna fishers into FIPs and thus on a well-trodden and supported path towards sustainability.

Recommendations

The full benefits of electronic approaches are only experienced when the conversion from paper is complete – partial solutions are ineffective against IUU, don't reduce effort or costs substantially and cannot consistently deliver timeous and reliable data. ABALOBI's experience suggests that the management and sustainability of many artisanal IOTC fisheries will not improve until the transition from paper-based to electronic data collection occurs. Electronic systems such as those developed by ABALOBI have clear potential in transforming important aspects of IOTC's data environment.

ABALOBI agrees with the findings of the Second Performance Review (PRIOTC02) regarding the need to improve data collecting systems for IOTC fisheries, including electronic systems (IOTC 2017). The first topic in the WPDCS' DRAFT Program of Work (2021-2025) refers to supporting "... the implementation of data collection and sampling activities of coastal fisheries …" (IOTC 2020a). To give additional, and very tangible effect to a specific recommendation from the PRIOTC02 regarding electronic data systems ("innovative and/or alternative means of data collection [systems]... and [to] move towards electronic data collection and reporting for all fleets" (IOTC 2017)), ABALOBI requests that the WPDCS consider including supporting a pilot(s) of ABALOBI MONITOR under the WPDCS Work Plan. In addition, such an action would substantively address the eighth recommendation in PRIOTC02: "... continue efforts to adopt adequate fisheries management arrangements and to assist developing coastal States…" (IOTC 2017, p. 15).

We are cognisant that great caution is needed when changing data collection and management systems. However, given the challenges with the status quo, we believe that piloting ABALOBI MONITOR will not cause bigger problems than currently experienced. Further, such a pilot will burnish a CPC's environmental and sustainability credentials, directly address IUU, facilitate development of additional compliance-related tools, and create the potential for premium markets to access artisanal fishers catches.

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