

## **Title: Reconstruct Catch Data of Artisanal Fisheries in Tanzania for Improved Fisheries Resources Management**

*Mathew O. Silas<sup>1</sup>, Ranwel N. Mbukwah<sup>1</sup>, Owen M. Kibona<sup>2</sup>, Masumbuko L. Semba<sup>3</sup>, Saleh A. Yahya<sup>1</sup>, Zahor M. El Kharousy<sup>4</sup>, Ismael A. Kimirei<sup>5</sup>, Emmanuel A. Sweke<sup>1</sup>*

<sup>1</sup>Deep Sea Fishing Authority (DSFA), Zanzibar, Tanzania

<sup>2</sup>Ministry of Livestock and Fisheries, Dodoma, Tanzania

<sup>3</sup>Nelson Mandela African Institution of Science and Technology (NM-AIST), Arusha, Tanzania

<sup>4</sup>Ministry of Blue Economy and Fisheries, Zanzibar, Tanzania

<sup>5</sup>Tanzania Fisheries Research Institute (TAFIRI), Dar es Salaam, Tanzania

Corresponding Author: mathew.silas@dsfa.go.tz

### **Abstract**

Artisanal fisheries continue to be vital for food security and sustainability, employment, and economic well-being in Tanzania's coastal communities. However, underreporting has plagued these fisheries for decades, stemming from fragmented data collection systems, geographic challenges, reporting species to family level (not species level) and inadequate inclusion of all fishing methods, including spot fishing targeting tuna species. This paper explores the necessity of reconstructing the missing catch data from artisanal fisheries in Tanzania, underscoring historical and structural factors that have led to consistent underreporting. We stress the importance of comprehensive and harmonised data collection and management for adherence to national, regional and international obligations and regional conservation and management efforts. The paper highlights the implications of improved data reporting to the Indian Ocean Tuna Commission (IOTC) and the Food and Agriculture Organization of the United Nations (FAO) and the benefits of addressing data gaps for sustainable fisheries management in Tanzania.

**Keywords:** artisanal fisheries, fish catch, underreporting, missing data

## **Introduction**

Artisanal fisheries are a key economic activity for the livelihoods of coastal communities in Tanzania, offering both sustenance and economic support. The sector has over 103,253 fishers and more than 509 landing sites (Jiddawi and Öhman 2002; Silas 2022; MLF 2020; DFD 2020), reflecting its diversity and significance. However, underreporting of catch data in this fishery obscures proper planning and effective fisheries management, a tendency that renders non-compliance for international reporting, which is a requirement for regional organisations like the Indian Ocean Tuna Commission (IOTC) and the Food and Agricultural Organisation of the United Nations (FAO) (Jacquet et al. 2010).

Recognising these challenges, Tanzania has undertaken several initiatives to address the under-reporting of catch data in the artisanal fishery. These initiatives include training on proper data collection practices, focusing on catch records and standardisation of data collection protocols. The country has also developed digital data infrastructures for storing and retrieving fish catch data. Three databases have been established, including eCAS for mainland Tanzania, SAMAKI for Zanzibar, and FIS for the Deep Sea Fishing Authority (DSFA).

Despite having a database and trained enumerators responsible for recording daily catch data at the fish landing sites, access to clean and tidy fisheries' catch data is still challenging. Some major issues in the existing database include poor representation, as only a few landing sites were strategically selected for data recording. Only 106 landing sites out of over 500 are reported in the eCAS. Given the challenges of geographical location and remoteness of some landing sites, accessibility of all the landing sites along the coastal waters of Tanzania becomes impossible. These few landing sites record catch data based on the specified sampling period of 10 days per month. The ten-days sampling represent only 30 percent of the fishing time in a month, which means only one-third of the catch is recorded in the respective digital infrastructure. Another issue facing the fish catch data quality in Tanzania is the inconsistent data collection techniques and methods across Mainland Tanzania and Zanzibar (Jacquet et al. 2010; Bultel et al. 2015).

Historical catch data gaps persist, particularly in FAO records for Zanzibar from 1950 to 1999 (Zeller and Pauly 2015). This is because the catch data in the FAO database reflects only data for the United Republic of Tanzania, which combines fish catch information for mainland

Tanzania and Zanzibar. Therefore, this study aims to reconstruct long-term time series catch data for artisanal fisheries in Tanzania mainland and Zanzibar and to align this information with recent data. We hope that compiling fish catch data since 1950 onward and integrating them into the developed database will improve access to fish catch data that can be used to inform on the trends and patterns of the artisanal fishery. This information is needed to properly manage the fisheries sector and make management decisions compliant to regional and international fisheries agreements.

### ***Challenges in Data Collection and Reporting***

Several historical and structural issues affect the management of artisanal fisheries in Tanzania, thus affecting data accuracy. For instance, longlines have targeted tuna and billfish since the early 1990s; however, data on the catch for these species is often limited, and those available are always incomplete and inconsistent along the coastal waters of Tanzania (Jacquet et al. 2010). These discrepancies are caused by different approaches used to collect, record and report catch data in different landing sites along the 1,424 km stretch of the coastline (Malleret-King et al. 2003; Jacquet et al. 2010). Despite the fishing activities in Mainland Tanzania and Zanzibar being done within the same coastal waters, the separate reporting by respective authorities creates yet another factor contributing to inconsistent data collection and, hence, difficulty in integrating the collected data (Jacquet et al. 2010).

Several initiatives, to reconstruct missing catch data and fill gaps for Zanzibar from 1950 to 1999 (see Jacquet et al. 2010). However, the accuracy of the data, including recreational fishing and discards—not included in the reconstruction, is still needed. For instance, a landing data gap for Pemba Island for 1980 and 1981 obscured accurate estimates of artisanal catches (Jacquet et al. 2010). Nonetheless, the reconstructed data have never been updated in the FAO and IOTC database.

Another challenge leading to underreporting of catch data is the fact that the official reports only cover the catch sold at the mark while excluding a portion of landed fish that was not sold at the market or separated by fishers for their families. This is particularly evident with smaller catches, as historical data collection has been driven by tax estimation rather than a focus on comprehensive data reporting for stock assessments or conservation purposes

(Malleret-King et al. 2003; Jiddawi and Öhman 2002; Silas 2022). Consequently, the available data does not adequately support essential monitoring and reporting efforts.

### **Proposed methodology for data reconstruction**

To reconstruct reliable and realistic artisanal fisheries catch data in Tanzania from 1950 to 2023, this study proposes a comprehensive approach that will involve the review of published articles in grey literature and gathering existing fish catch data from artisanal fisheries in coastal waters. The key step in this approach is gathering published reports from multiple sources, including IOTC, FAO, government archives, historical publications, and previous reconstructions. These reports will be reviewed to identify reported catch data or computed statistical metrics reported in respective sources and documents.

The extracted information will serve as a benchmark for reconstructing time series and align with time to identify the missing years. An appropriate statistical technique will be deployed to fill the missing years. Based on the assumptions (regional fishing efforts, species availability, and ecological dynamics), the study will use either surrogate, interpolation or extrapolation statistical techniques to fill gaps of missing data in space and time and scientifically approved statistical metrics (e.g., Jacquet et al. 2010). This structured approach addresses historical reporting inconsistencies and generates an accurate and reliable dataset that supports sustainable fisheries management.

This study will include an important but often-overlooked recreational fishing and subsistence catches. Integrating data from these underreported categories, the assessment will provide more realistic catch statistics for artisanal fisheries along the coastal waters of Tanzania and align it fishing pressures. The information is important in understanding trends of fish stocks over time, which is required for sustainable management strategies.

Once the trend catch data is reconstructed, it will undergo rigorous quality assurance and quality check to validate its reliability. Uncertainty analysis will be carried out of the constructed trend catch data and compared against socio-economic indicators, such as population growth and economic activities in fishing-dependent regions. This comparison will provide additional confidence in the accuracy of reconstructed trend data. Also, interviews

with experienced fishers of different ages will be conducted as an additional approach to validate the estimated catch.

### Preliminary results based on reviewed information (data)

Several studies that reconstructed catch data indicated a significant underreporting in Tanzania's artisanal fisheries from the 1950s to the present (Heidrich et al. 2023; Bultel et al. 2015; Jacquet et al. 2010). For example, Jacquet et al. 2010 revealed that official data submitted to the FAO were lower than actual catch volumes, particularly in records from Zanzibar, including Pemba Island, and in Tanzania's recreational and subsistence fishing activities (Figure 1).

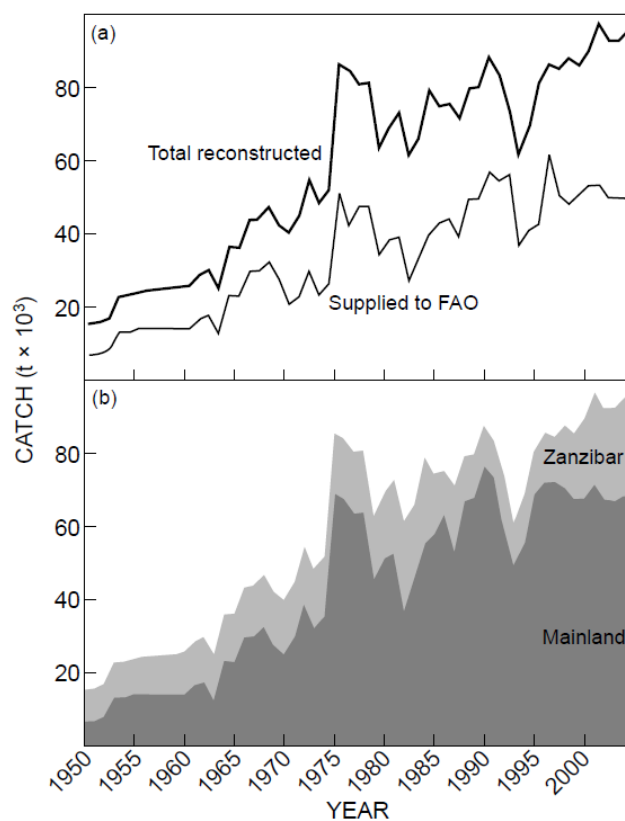


Figure 1: Tanzania's marine fisheries catches, 1950–2005, showing (a) total reconstructed catches compared to data supplied to FAO and (b) reconstructed catches separated by Zanzibar and the mainland (source Jacquet et al. 2010)

Integrating missing data in reconstructing time series catch data will improve estimates. Historically, artisanal fisheries have contributed substantially to tuna and billfish catches through longlining and encircling nets since the 1990s, indicating that the total catch from the

artisanal fisheries is significantly higher than currently reported. This discrepancy carries important implications for resource management and stock assessments. The proposed reconstruction aims to uncover the actual volume contributed by artisanal fisheries in Tanzania, which is currently not counted.

The reconstructed time series data stresses the necessity of including artisanal catches in regional fish stock assessments and conservation planning, as they provide crucial information necessary for sustainable management practices, including total allowable catch (TAC). The findings reveal a pivotal role of artisanal fishing activities along Tanzania's coastline and reinforce the call for enhanced data reporting frameworks that align with IOTC and FAO requirements.

## **Discussion**

This paper proposes reconstructing Tanzania's artisanal fisheries data to build a comprehensive and accurate dataset that includes important but ignored fisheries catch data of artisanal fishing activity. A review of the previous reconstructed data revealed a significant underreporting of official catch records to FAO. Notable gaps in catch data from Unguja and Pemba Island of Zanzibar and the exclusion of unsold catch used for subsistence and recreational fishing are major contributors to underreporting. Therefore, this study aims to fill the gaps and improve catch trend data for artisanal fishery, providing a more precise understanding of total artisanal catches.

It is envisioned that refining data accuracy will support sustainable fisheries management in several ways. First, a more detailed dataset allowing for realistic stock assessments and the establishment of quotas that reflect actual fishing pressures on vital species. Secondly, accurate data is required to meet Tanzania's reporting commitments to the FAO and IOTC, reinforcing the country's commitment to the sustainable management of pelagic species such as tuna and billfish. This alignment with international standards also strengthens Tanzania's position and role in regional efforts to curb illegal, unreported, and unregulated (IUU) fishing, promoting transparency and consistency in data reporting.

Finally, the reconstructed data will have significant socio-economic benefits to the multitude of Tanzania's coastal communities, especially the artisanal fishers who are depend on the fish

stocks for their livelihoods and sustenance. Furthermore, accurate data will likely ensure sustainability through science-based decision-making. Moreover, understanding the actual contribution of artisanal fisheries helps policymakers allocate enough resources to facilitate consistent and persistent management important for long-term sustainability of the fisheries sector. The reconstruction of catch data is therefore important to illuminate the significance and contribution of the fisheries sector in general to the national GDP and supports the socio-economic development of the Tanzania's coastal fisher communities and the regions at large.

## **Conclusion**

Reconstructing artisanal catch data in Tanzania is essential for more effective fisheries management. This paper establishes a baseline from which efforts can be directed to improve data accuracy, fulfil national, regional, and international reporting obligations, and support the livelihoods of coastal communities. Future initiatives are needed to harmonise data collection methods between Mainland Tanzania and Zanzibar, expand monitoring to encompass currently unreported data and continue integrating artisanal fisheries into national and regional fisheries management frameworks. By addressing these needs, Tanzania can achieve sustainable fisheries management that safeguards marine resources, stimulates economic development and meets its commitments to regional and international organisations, including the IOTC.

## **References**

- Bultel E, Doherty B, Herman A, Le Manach F, Zeller D (2015) An update of the reconstructed marine fisheries catches of Tanzania with taxonomic breakdown. *Fisheries catch reconstructions in the Western Indian Ocean* 2010:151-161
- DFD (2020) Marine Fisheries Frame Survey 2020, Zanzibar. Ministry of Blue economy and Fisheries Zanzibar. SWIOFish Project/World Bank. pp52. Department of Fisheries Development,
- Heidrich KN, Meeuwig JJ, Zeller D (2023) Reconstructing past fisheries catches for large pelagic species in the Indian Ocean. *Frontiers in Marine Science* 10:1177872
- Jacquet J, Fox H, Motta H, Ngusaru A, Zeller D (2010) Few data but many fish: marine small-scale fisheries catches for Mozambique and Tanzania. *African Journal of Marine Science* 32 (2):197-206
- Jiddawi NS, Öhman MC (2002) Marine fisheries in Tanzania. *AMBIO: A Journal of the Human Environment* 31 (7):518-527. doi:<https://doi.org/10.1579/0044-7447-31.7.518>

- Malleret-King D, King A, Manghubhai S, Tunje J, Muturi J, Mueni E, Ong'ada HJFP (2003) Understanding fisheries associated livelihoods and the constraints to their development in Kenya and Tanzania. 8196
- MLF (2020) Fisheries Annual Statistics Report, Ministry of Livestock and Fisheries, Tanzania. <https://www.mifugouvuvuvi.go.tz/>.
- Silas MO (2022) Patterns of small-scale coastal fisheries and local fisheries management in Tanzania : adaptation to a changing climate. Doctoral thesis, comprehensive summary, Department of Ecology, Environment and Plant Sciences, Stockholm University, Stockholm
- Zeller D, Pauly D (2015) Reconstructing marine fisheries catch data. Catch reconstruction: concepts, methods data sources Online Publication Sea Around Us University of British Columbia