ENHANCING SMALL SCALE TUNA FISHERY CATCH ESTIMATION AND REPORTING IN KENYA

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Abstract

This paper looks at data collection approach adopted towards improving data collection and reporting and the status to date. The use of catch assessment survey (CAS) was piloted from 2016-2023 with aim to strengthen the monitoring plans for tuna species and improve Small Scale tuna data collection. Catch Assessment Survey was adopted as an approach to support improvement of data collection and monitoring and to strengthen co-management of nearshore fisheries. In 2022 CAS was conducted in thirty-three (36) landing sites by trained of data enumerators from different institutions and Beach Management Units (BMU). The CAS was implemented following the harmonized Standard Operating Procedures (SOPs) and CAS manual.

A total of 136 families were recorded during the CAS in 2022 with an estimated weight ≈35,596MT, against data reported at county levels of approximately 9000MT. Landings of tunas from Small Scale fishers were 6,160 tons in 2022 which is a sharp increase compared to 1,953 tons and 1,613 tons in 2020 and 2021.

The variations in monthly landings depicted normal seasonal trends with high catches recorded in November-March compared to that April to October predicting highly temporal variations in the fishing seasons along the coast.

The most dominant families were Scombridae (Tuna & tuna-like) and the highest length classes caught Thunnus albacores (80–100 cm, TL), T. obesus (75–85 cm, TL), E. affinis ranged (57.5–62.5, TL). The use of monofilament which also catch sharks and rays need further monitoring and regulation of gill net mesh size is key towards sustaining the fishery.

The sampling frame should be timely updated to reflects the reality on the ground; often there are changes in the number and distribution of fishing units per gear-type (movement/migration) in small-scale fisheries. Thus, need to monitor boats migration and changes in fishing gears/changes in the fishing pattern and the fishery structure. Strengthens and enforcement on logbook data collection for semi-industrial vessels has been planned to capture the individual fisher catch reports and reporting at species level.

In this paper we report on a fishery catch data collection program and key findings of the Catch assessment surveys (CAS) conducted in year 2022 and monitoring of small-scale data catch log sheets conducted by Kenya in the small- scale marine coastal fisheries. The objective is to

demonstrate the value and opportunities of a collaborative data collection and monitoring approach between managers, fishers and scientists.

INTRODUCTION

Kenya has a coastline of ≈640km (or ≈880km including estuaries, river mouths and embayments), stretching from the northern border with Somalia at Ishakani (1 o 30′ S) and to 5 o 25′S on the Vanga border with Tanzanian border. The continental shelf is narrow with fringing coral reefs extending ≈0.5-2.0 km and offshore to the 200nM Exclusive Economic Zone (EEZ). The marine fishery is predominantly small-scale and the annual fish landings account for only ≈19% of the national fisheries production. The small-scale or Small Scale Marine fisheries are an important source of livelihood with about 14,500 fishers directly employed in fishing.

Small-scale fisheries are important to humanity, contributing as much as half the global capture fisheries production and employing as many as 90 % of all fishers (FAO 2015). Despite their clear economic, nutritional and social importance many small-scale fisheries are poorly researched and poorly managed due to high cost of data collection. However, the benefits of involving designated trained data collectors and fishers in data collection and recognition of the role of fisher local knowledge has been gaining momentum globally (Hind 2014; Moller et al. 2004; Obura et al. 2002) and is one way of reducing cost barriers.

Participation by fishers in data collection can be a first step towards them having greater involvement in the fishery management decisions and thereby making them more likely to comply and ultimately leading to more sustainable livelihood practices (Almany et al. 2010; Ticheler et al. 1998). Generally, successful fisheries management occurs when fishers and managers work together to achieve a common goal (Gutiérrez et al. 2011).

The accuracy and adequacy of fisheries data needed for robust assessments of fisheries is frequently debated hence push for "fishery independent" data to overcome such issues such as hyper-stable catch-per-unit-effort due to the behavior of the target species or technological changes in the fishery (Erisman et al. 2011; Harley et al. 2001; Hilborn and Walters 1992).

Proper recording of the catch and effort in each of the specific fisheries is an important data set in the management of the fishery. This information on fish catches and effort in terms of crafts, number of fishers, gears with reference to a particular commercially important species or families is used to estimate the stock size of the fisheries and management measures to manage the fishery. Increased manpower and staff capacity in terms of skills and trained data collectors has been reported to improve coverage of most fish landing sites (Willemen et al., 2015).

According to FAO 2022, there need for sustained monitoring of the fishery in terms of both statistics and biological information in order to inform effective management of the fishery, based on reliable and accurate information on the fish stocks and their exploitation trends. Catch Assessment Surveys (CAS) is dedicated exercise targeting the capture fisheries to generate information on catches and fishing effort. This provides a quick source of rich statistics about the fishery within short periods. The survey is guided by standardized data collection protocol/procedures that have been developed and updated since the pilot survey that was conducted between 2013-2016. Similarly, the data collection tools and approaches were updated from the pilot phase and currently, the use mobile application for collection and submission.

In this paper we report on a fishery catch data collection program and key findings of the Catch assessment surveys (CAS) conducted in year 2022 and monitoring of small-scale data catch log sheets conducted by Kenya in the small- scale marine coastal fisheries. The objective is to demonstrate the value and opportunities of a collaborative data collection and monitoring approach between managers, fishers and scientists.

2. METHODOLOGY

2.1 Data collection method

Kenya has implemented a collaborative and hybrid fishery data collection and monitoring system involving managers, scientists and fishers;

2.1.1 Catch Assessment Survey (CAS); it has two-stage sampling design. Within each county administrative unit, a sample of Primary Sampling Units (PSU), the landing sites is first selected, and then, at each PSU, samples of Secondary Sampling Units (SSU) (fishing craft gear) are selected based on total number of fishing crafts per landing site and the spatial distribution along the coastline in reference the frame survey findings. Ten sampling days every month are be allocated according to the moon phase and tidal cycles. The data items collected included catch weight, composition by species and size, fishing gears and methods, craft type and length and value of catch as well as fishing frequency.

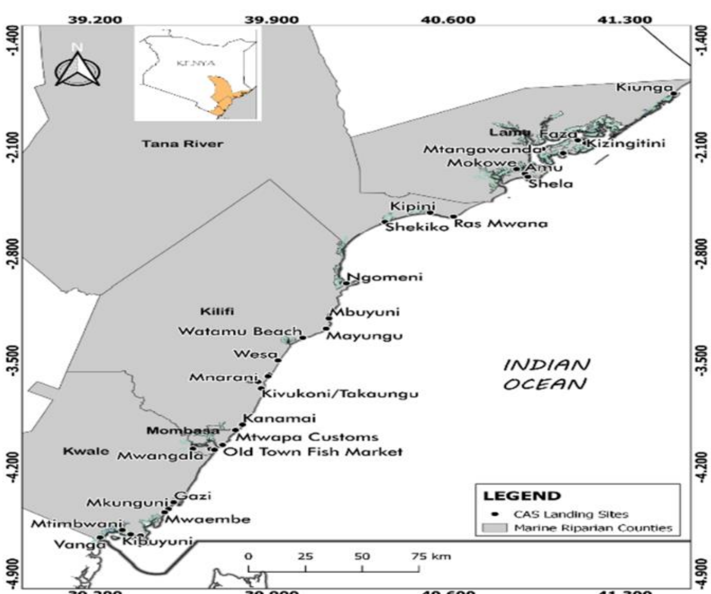

Table 2. 1 Fishing craft-gear types to be selected for Catch Assessment Survey sampling

Fishing craft Type	Main Gear Type															
	Code	**BS**	**GN**	**LL**	**PS**	**RN**	**SN**	**CN**	**HL**	**MF**	**SG**	**HP**	**PT**	**HR**	**TR**	**TL**	**RS**
	Code	BS	GN	LL	PS	RN	SN	CN	HL	MF	SG	PT	HR	TR	TL	RS	Code
Hori	HR	x	x	x	x		x	x	x	x	x			x		x	HR
Ngalawa	NG	x	x	x	x		x	x	x	x	x	x		x	x		NG
Mtori	MR	x	x	x			x		x	x	x	x		x	x		MR
Mashua	MS	x	x	x	x	x	x		x	x	x	x	x	x	x		MS
Dau	DA	x	x	x	x	x	x	x	x	x	x	x	x	x	x		DA
Mtumbwi	MT	x	x	x	x		x	x	x	x	x	x	x	x	x	x	MT
Foot-fisher	FF	x	x	x	x		x	x	x	x	x	x	x	x		x	FF

Figure 2.1 Map showing distribution of selected coastal CAS landing sites

2.1.1 Daily catch collections; this is undertaken Beach management units (Fishers) on daily basis using catch log sheets. The data items collected included fishing area, fishing gears and methods, mode of propulsion and species catch weight and value,

2.1.1 Length-Frequency assessment

During the Catch Assessment Survey (CAS) recorded in 2022, a total of 9,453 specimens of both finfish and shellfish were sampled for length-frequency analysis from the selected landing sites in the five (5) counties: Lamu (11 sites), Tana River (2 sites), Kilifi (11 sites), Mombasa (6 sites) and Kwale (6 sites).

2.2 Data recording and transmission

A hybrid method of physical and electronic data collection forms is used in collecting data at the selected landing sites. The catch weight was measured using weighing scales while tapes used in measuring craft lengths. All Survey data collected trained enumerators, data captured and transmitted real-time electronically using mobile application.

2.3 Data analysis and estimation

To estimate the total fish catches landed during the year 2022, data from CAS, Daily catch data and Frame survey report was utilized. Computation guided by the below formulae;

Total catch = Total fishing effort * Catch per Unit of effort

Fishing effort = F*BAC *A

where,
F= no of boats from frame survey
BAC= average no of active boats/no of boats from frame survey,
A=no of fishing days

Catch per Unit Effort (CPUE)

CPUE when calculated = Total catches /Total units of effort
or
CPUE when collected = Average catch of a fishing unit by unit of time

3.0 RESULTS AND DISCUSSION

3.1 Overall catches

A total of 136 families were recorded during the CAS in 2022 with an estimated weight ≈35,596,357 Kgs, against administrative data reported at county levels of approximately 9,000MT.

Landings of *Scombridae* from Small Scale fishers were 6,160 tons in 2022 which is a sharp increase compared to 1,953 tons and 1,613 tons in 2020 and 2021. During the year 875 tons, 989 tons and 388 tons of Sphyrnidae *Carcharinidae* and Istiophoridae respectively were landed by small scale fishers

This is attributed to improved data collection methods. The higher percentage of Scombridae, comprising 17% of the total catch weight and suggests its prominence in the fishery. *Siganidae* closely follows with a percentage of 10% in catch weight.

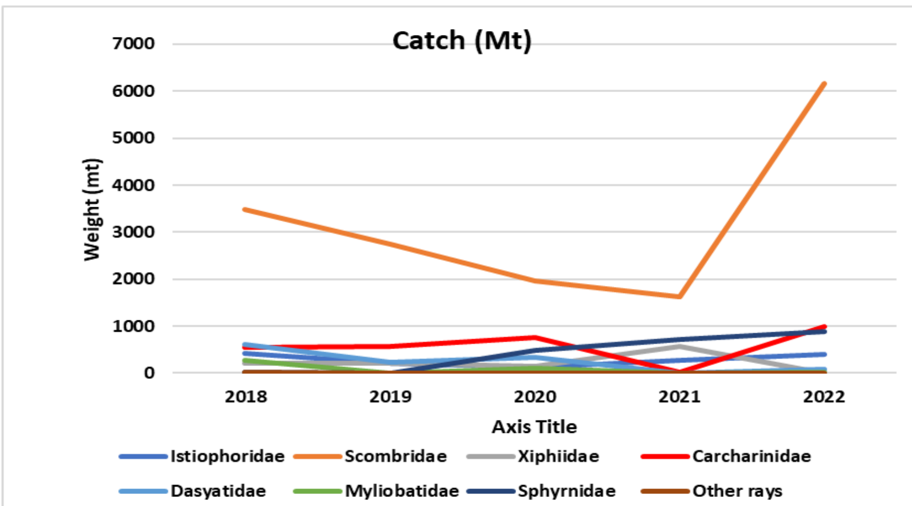

Figure 3.1 Annual catch Iotc families

3.1.1 Catch rates

From the result Hori-Handline had the highest estimates catch rate at 19.24 Kg/Fisher/day, Dau-handline at 13.46Kg/Fisher/day, Mashua-Ringnet at 10.46Kg/Fisher/day and Mashua-handline at 10.26Kg/Fisher/day. The spatial representation of the catch by species and the fishing fleet dynamics is not possible primarily because the entire catch is caught by Small Scale operators' vessels have no GPS recording devices.

3.1.2 Total Estimated Landings by Craft Types

The results indicates that the dominant craft Mashua landing 41%, followed by Dau at 27% of the total marine Small Scale catch. The lowest recorded in Ngalawa at 1% and shown in figure 3.5.

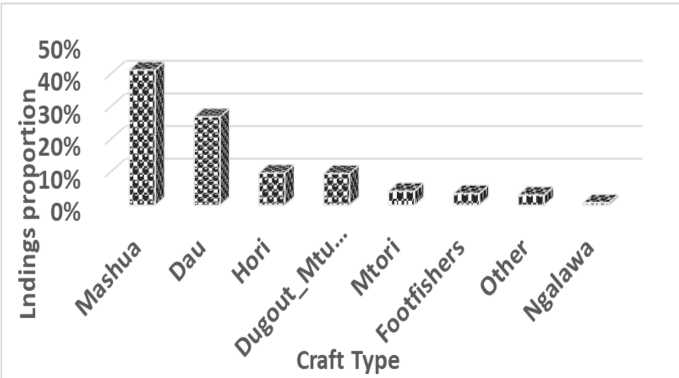

Figure 3. 2 Proportion of fish catches by craft type in 2022

3.1.3 Catch proportions by gear type

The overall percentage proportion by gear type is shown in figure 3.6. Most of the catch proportion was from Monofilament at 23% of the total catch. Ringnet, handline, gillnet, beach seine and basket trap had estimates of 21%, 16%, 12%, and 9% of the total catch respectively.

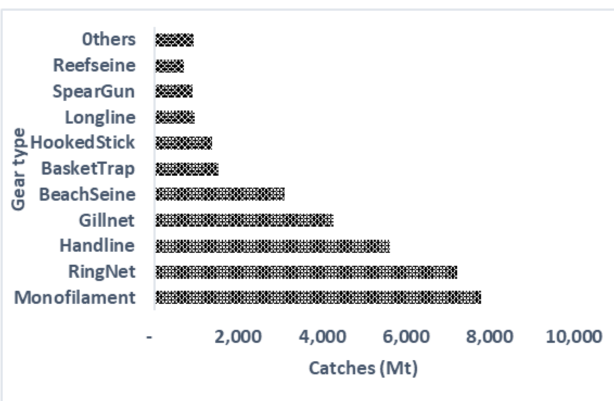

Figure 3. 3 Proportion of fish catches by gear type in 2022

3.2 Seasonal catch Variations

The variations in monthly landings depicted normal seasonal trends with high catches recorded in November-March compared to that April to October. Highest landings were recorded in; December ≈4,055 Mt; November ≈3,859 Mt and least in June and July ≈ 2,021 Mt and ≈ 1,849 Mt; indicating highly temporal variations in the fishing seasons along the coast. These variations in monthly landings depicts normal seasonal trends with high catches recorded in November-March compared to that April to October.

Generally fishing for tuna species is highly seasonal activity where Small Scale vessels in July-November target migratory tuna which occur in the coastal waters. The peak season for sailfish landings is during the November to March in coastal waters. Species landed are tuna yellowfin tuna, Skipjack tuna, Kawakawa, sailfish and Spanish mackerel.

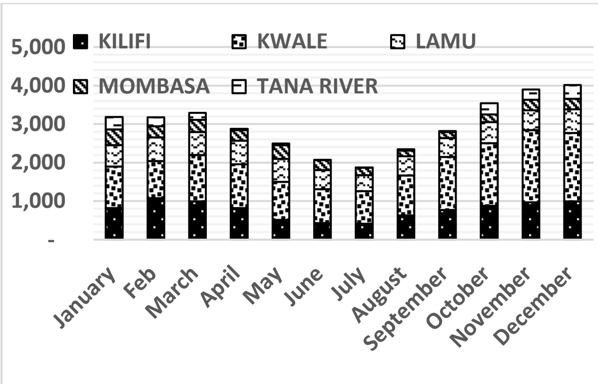

Figure 3. 4 Monthly Landings in the Small Scale Marine Fisheries of Kenya from Catch Assessment Surveys (CAS – January -December, 2022)

3.3 Temporal Distribution of Catches by Family Groups

The most dominant families were *Scombridae* (Tuna & tuna-like), *Siganidae* (Rabbitfish), *Lethrinidae* (Scavengers), *Octopodidae* (Octopuses) and *Scaridae* (Parrot fish). The families with highest catch during the NEM were *Engraulidae, Callinymidae, Chanidae, platycephalidae, aulostomidae, caesionidae* and *sparidae* while those with least catch per craft are *Soleidae, ginglyomostomatidae* and *kyphosidae* respectively. The SEM high catches included *engraulidae, apogonidae, caesionidae, terapontidae, Soleidae, Atherinidae* and *chanidae* respectively while the least catch included *scorpaenidae, pemphridae, plesiopidae* and *acropomatidae.*

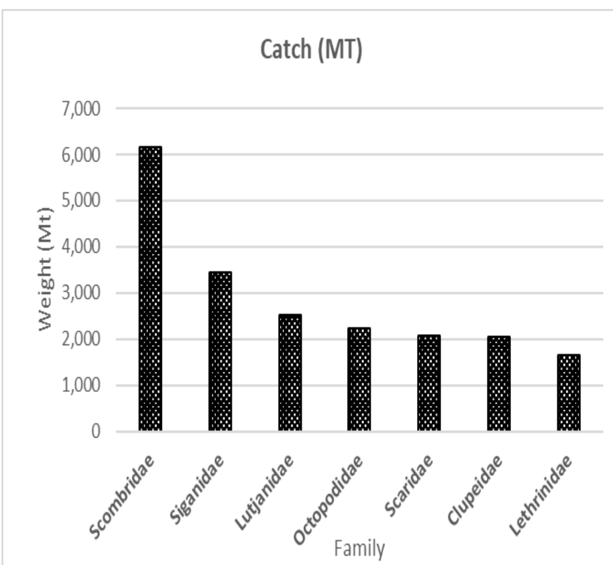

Figure 3. 5 Overall weight (MT) and value (Million) of major fish families caught along 5 riparian Counties along the Indian Ocean in 2022

3.4 Size Composition Tuna and Tuna-like species

From the species sampled for length- frequency, *Thunnus albacares* had size length ranges from 25 to 150 cm (TL) with higher catch at 80–100 cm (TL). About 39.6% of *Thunnus albacares* the landed species were above the maturity length while 60.4% were immature while *Thunnus Obesus* had size length ranges from between 28.5 and 135 cm (TL), with higher catch at 75–85 cm (TL), 53.6% of the *Thunnus Obesus* landed species were above the maturity length while 46.4% were immature.

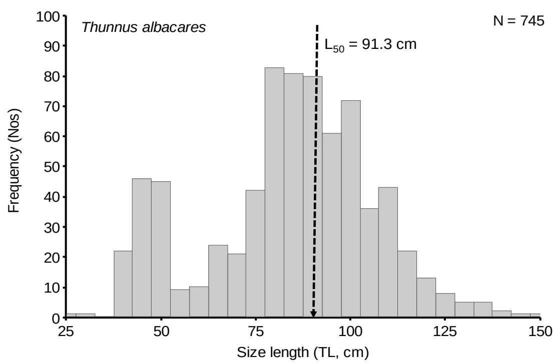

Figure 3. 6 Length-frequency distribution for Thunnus albacares in the coastal and marine fisheries of Kenya.

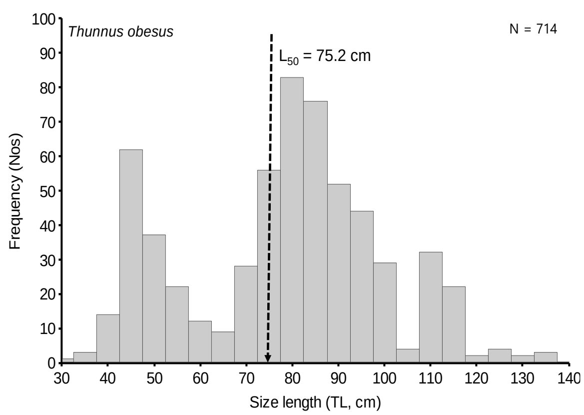

Figure 3. 7 Length-frequency distribution for Thunnus obesus in the coastal and marine fisheries of Kenya.

The catch of *E. affinis* ranged from 21 to 98.5 cm (TL), with the most dominant size class at 57.5–62.5 cm (TL) with higher catch dominating sizes between 60 and 75 (TL, cm). 90% of E.affinis caught were more than the L50

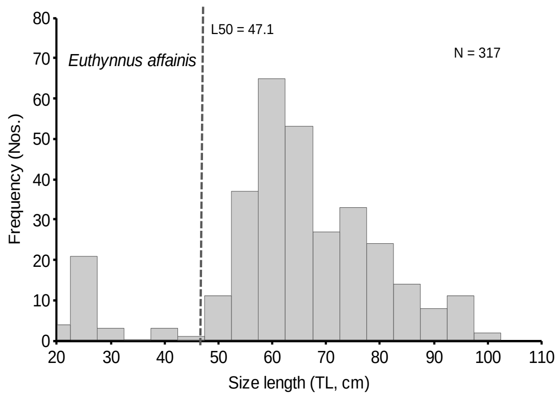

Figure 3. 8 Length-frequency distribution for Euthynnus affinis in the coastal and marine fisheries of Kenya, 2022 CAS survey period.

4.0 Conclusions and recommendations

Fisheries dependent surveys have the advantage of capitalizing on the skills fishers bring to the surveys such as excellent powers of observation or the amount of survey effort (many fishers/much efforts versus few researchers) which may be of greater importance when densities of fishes are very low because of overfishing.

From a technical perspective collecting data throughout the fishing season as opposed to one off costly surveys can be advantageous. For example, changes in catchability caused by tidal and lunar effects may be important aspects of the fishery which are only revealed when data collection spans one or more of these cycles and may be similarly important for a host of other variables.

Data generated from a large proportion of fishers in a fishery can also prevent biases that may be present when a small number of fishers are "observed", another common approach to data collection.

Precise estimation of the various fishing units operating from a PSU in a stratum minimizes errors in final overall estimates. The number and distribution of units are used to calculate the raising factors which result in the estimation of total catch and effort for the strata. An error in the number of boats per stratum or in the gear distribution would affects the estimates.

The sampling frame should be timely updated to reflects the reality on the ground; often there are changes in the number and distribution of fishing units per gear-type (movement/migration) in small-scale fisheries. Thus, need to monitor boats migration and changes in fishing gears/changes in the fishing pattern and the fishery structure.

In order to improve on fisheries data management, storage, and sharing, the finalization of the Fisheries Information Management System (FIMS) is a priority. For long-term sustainability of CAS data collection, adequate capacity is required in sampling and species identification. Strengthens and enforcement on logbook data collection for semi-industrial vessels has been planned to capture the individual fisher catch reports and reporting at species level.

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References

Almany GR, Hamilton RJ, Williamson DH, Evans R, Jones GP, Matawai M, Potuku T, Rhodes KL, Russ GR, Sawynok B (2010) Research partnerships with local communities: two case studies from Papua New Guinea and Australia. Coral Reefs 29:567–576.

Erisman BE, Allen LG, Claisse JT, Pondella DJ II, Miller EF, Murray JH (2011) The illusion of plenty: hyperstability masks collapses in two recreational fisheries that target fish spawning aggregations. Can J Fish Aquat Sci 68(10):1705–1716

FAO (2015) Voluntary guidelines for securing sustainable small-scale fisheries in the context of food security and poverty eradication. FAO, Rome

Gutiérrez NL, Hilborn R, Defeo O (2011) Leadership, social capital and incentives promote successful fisheries. Nature 470:386–389

Harley SJ, Myers RA, Dunn A (2001) Is catch-per-unit-effort proportional to abundance? Can J Fish Aquat Sci 58:1760–1772

Hilborn R, Walters CJ (1992) Quantitative fisheries stock assessment. Chapman & Hall, New York

Hind EJ (2014) A review of the past, the present, and the future of fishers' knowledge research: a challenge to established fisheries science. ICES J Mar Sci 72(2):341–358.

Moller H, Berkes F, Lyver POB, Kislalioglu M (2004) Combining science and ecological knowledge: monitoring populations for co-management. Ecol Sci 9(3):2

Obura DO, Wells S, Church J, Horrill C (2002) Monitoring of fish and fish catches by local fishermen in Kenya and Tanzania. Mar Freshw Res 53(2):215–222

Ticheler HJ, Kolding J, Chanda B (1998) Participation of local fishermen in scientific fisheries data collection: a case study from the Bangweulu Swamps, Zambia. Fish Manage Ecol 5:81–92