Evaluation of the Kenyan Catch Assessment Survey

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Introduction to CAS and rationale for change: data collection for Kenya's coastal fisheries

Catch Assessment Surveys (CAS) are dedicated surveys targeting the capture fisheries to collect information on fish catches and fishing effort. Other sources of catch-effort data exist, including the post harvest sector and markets, although these sources tend to be less accurate, and with lower precision and cannot provide reliable data, especially on fishing effort. CAS designs typically require frame survey data to raise samples to total catch estimates. Catch-effort and frame survey data are important for supporting the management process. If catch data is combined with information on fish prices, it can be used to estimate the gross value of production (GVP). This provides an indication of the economic importance of the fishery relative to other fisheries or sectors. This is important for helping shape policy and for development planning purposes.

The State Department for Fisheries and Blue Economy (SDF&BE) in Kenya has operated a routine fisheries data collection system for coastal fisheries for a number of years, based on the principle of total enumeration whereby all fishing trips are recorded at all coastal landing sites. The approach has been questioned in recent years – mostly in terms of the cost and resources involved, but equally in terms of the limitations of the data being collected:

- From the perspective of the statistical validity of estimating catch and fishing effort data, full enumeration also offers relatively minor advantages over a sample based approach.
- Full enumeration, particularly at busy landing sites, is practically impossible to achieve and therefore raises questions as to the accuracy of the data that have been collected in recent years.
- Similarly, while the routine data collection aims for total enumeration, information is collected by enumerators only when they are physically present at the landing site. This means that early morning or late evening/night landings generally go unrecorded.
- In terms of reporting catches to the IOTC, and compliance with IOTC Resolution 15/02, the routine data collection is also limited in terms of reporting catches at individual species level – instead catches are reported as species aggregates (i.e., tropical tunas and neritic tunas).
- The current routine data collection system faces further additional challenges since the SDF&BE realizes that the actual information collected, i.e. total catch and value, is of relatively limited value for informing useful management decisions.
- Presently, there is also recognition of the need to steer the SDF&BE towards an ecosystem-based approach to resource management, including improving the understanding of the human dimension of the fisheries including social and economic issues.

Ultimately, due to staff shortages, and the costs involved, SDF&BE recognized that the system is no longer viable and that changes in the data collection of coastal fisheries were needed.

Catch Assessment Surveys (CAS) may also be used together with Frame Surveys (FS) to generate important information required both for fisheries management planning purposes. CAS and FS have also been used to provide the sampling framework for design of fishery assessment surveys. Frame surveys involve direct observation of all fish landing sites on a regular or *ad-hoc* basis to provide information on:

1. Important landing sites, their location and patterns of fish distribution.
2. Numbers and types of fishing vessels, including details of their size, propulsion, gear types.
3. Fishing activity and landing patterns of different fishing vessel-gear combinations, including seasonal, diurnal and geographical operations.
4. Supply centres, infrastructure and markets.
5. Fish distribution routes, utilization, processing centres and methods, etc.

Information recorded in the frame survey is used to identify primary and secondary sampling sites when devising appropriate sampling strata for the CAS. Information on the total numbers of sampling units (i.e., fishing vessels associated with each fishing vessel-gear type) is also used to raise sampled catch rates to estimates of total catch along the entire coast, or at different spatial scales.

The CAS is also used to provide important information for formulating management plans and for policy and development planning purposes. In common with management plans, CAS typically draw upon data collected and assembled from a variety of sources including population census, maps, rural appraisals, consultations with local resource users, or dedicated frame surveys.

OBJECTIVES OF KENYA CATCH ASSESSMENT SURVEY

General Objective

To collect of data for coastal fisheries so as to enable monitoring trends in fish catches, fishing effort, and economic value for use in fisheries management planning, policy formulation and decision making.

Specific Objectives

1. To estimate total annual catches (of coastal fisheries), by weight, for each fishing vessel-gear type.
2. To estimate spatial and temporal trends in overall catch rates (i.e., nominal catch per unit effort) by vessel-gear type, using gear specific units of fishing effort.
3. To estimate spatial and temporal trends in the species composition of catches by species and species family level, according to fishing vessel-gear type.
4. To determine the impact of different gears on the population structure of selected priority species.

5. To estimate the value of fisheries in terms of price/kg, total value for key species.

The Catch Assessment Survey Design

The CAS survey design employs a two-stage sampling design:

i. Within each County/District, Primary Sampling Units (PSU) (landing sites) are selected for sampling.
ii. Within each PSU selected, Secondary Sampling Units (SSU) (fishing vessel-gear type) are then selected for sampling, based on total number of fishing crafts per landing site, including landings from creeks and from the open sea

Definition of Sampling Units:

- Primary sampling units (PSU): Landing sites, where a landing site is defined as allocation where more than five fishing craft routinely land fish.
- Secondary Sampling Units (SSU): Fishing vessel-gear type (VG). The following VG categories (sampling strata) were proposed:

Table 1: Fishing vessel-gear types to be selected for Catch Assessment Survey sampling

		Main Gear Type															
Fishing craft Type	Code	BS	GN	LL	PS	RN	SN	CN	HL	MF	SG	HP	PT	HR	TR	TL	RS
Hori																	
Ngalawa																	
Mtori																	
Mashua																	
Mtumbwi																	
Foot-fisher																	
Dau																	

Selection of PSUs (Landings sites in each County/ administrative unit)

As a first iteration, 10% of all landing sites (PSUs) within a county should be selected for sampling. Landing sites should be selected randomly with probability proportional to their size (PPS) in terms of the total number of fishing crafts landing at the site. In practice, it was necessary to take into account other factors when selecting landing sites, e.g., whether the selected beach could be accessed throughout the year, the logistics of enumeration and the shoreline configuration. However, this should be avoided as much as possible in order to reduce bias.

A total of twenty two landing sites were chosen from the six Districts, of which five are currently Counties (Lamu, Tana River, Kilifi, Mombasa and Kwale). The sixth site, Malindi,

which is currently a district under Kilifi County (Table 2 & 3). From the four landing sites chosen to be sampled in Kilifi County, Kidundu was considered as an additional special site

Table 2: Distribution of selected landing sites and number of fishing crafts by County for Catch Assessment Survey

No of landing sites	County / District	Name of landing site	No. of fishing crafts
1	Kilifi	Mnarani	102
2	Kilifi	Uyombo	71
3	Kilifi	Mtwapa	29
4	Kilifi	Takaungu	21
1	Kwale	Mkunguni	88
2	Kwale	Vanga	77
3	Kwale	Shimoni	51
4	Kwale	Aleni	50
5	Kwale	Gazi	41
6	Kwale	Mwaepe	38
1	Lamu	Kizingitini	112
2	Lamu	Faza	79
3	Lamu	Kiunga	44
1	Malindi	Mbuyuni	118
2	Malindi	Ngomeni	115
3	Malindi	Mayungu	62
4	Malindi	Watamu	24
1	Mombasa	Kitanga Juu	60
2	Mombasa	Bamburi	29
3	Mombasa	Ferry ya zamani	25
4	Mombasa	Old town	7
1	Tana Delta	Kipini	159
22		**TOTALS**	**1402**

In Malindi the Mayungu area was noted to be worthy of sampling due to the migrant fisher population who are known to move from Vanga. Mijikenda in Malindi district, Kidundu in Kilifi, Mkupe and Matondoni in Mombasa county and Naghea in Tana delta- Kipini, were also chosen as a special cases for prawn fisheries. The sites were chosen from the raw data and considered sites with a representative gear fishing craft combinations. The sites also give a representative sample of the species caught in the coastal area

Table 3: Total number of landing sites per county / district and the 10% and 10%+ landing sites selected for CAS

County/District	Total number of landing sites	10% CAS landing sites	10% + CAS landing sites
Lamu	19	2	3
Tana River	4	1	1
Malindi	31	3	4
Kilifi	29	3	4
Mombasa	31	3	4
Kwale	46	5	6
Total	**160**	**17**	**22**

Important definitions concerning the sampling activity

Sampling day; 00:00-24:00 (midnight to midnight)

Sampling Period; 06:00- 18:00.hrs. However, enumerators were encouraged to make arrangements to ensure that most of the catch is sampled beyond these hours as influenced by the tidal cycles.

Sampling days; sampling days were to be determined every beginning of the month according to the moon phase and tidal cycles. Ten sampling days were allocated every month for the selected sites.

Selection of Secondary Sampling Units at each PSU (landing site)

At each landing site during the sampling period, the enumerators identified (with the help of fishers and/or Beach Management Unit (BMU) leader) the number of fishing vessel-gear types that landed during the sampling day, which are then summarized in the following tabular format that is included on the data recording form (Table 4).

Table 4: Number of enumerators by institutions required for CAS

District	Landing sites	Enumerators		
		KMFRI	FiD	BMU
Lamu	19		3	3
Tana river	4		1	1
Malindi	31		4	4
Kilifi	29		4	4
Mombasa	31	2	3	3
Kwale	46	4	4	4
Total	**160**	**6**	**19**	**19**

Time frame for implementation of the CAS

The Catch Assessment Survey was undertaken between May 2013 and March 2016. Sampling at each selected landing site was conducted for 10 days per month - excluding Fridays and Sundays which are the worship days for Muslims and Christians, and which correspond to relatively little fishing activity during these two days.

Provisional CAS results

Based on the sampled catches observed by enumerators, raised to total catches, the total estimated landings for the period was 66,438 tons. The monthly distribution of catches by County is shown in Figure 1 below.

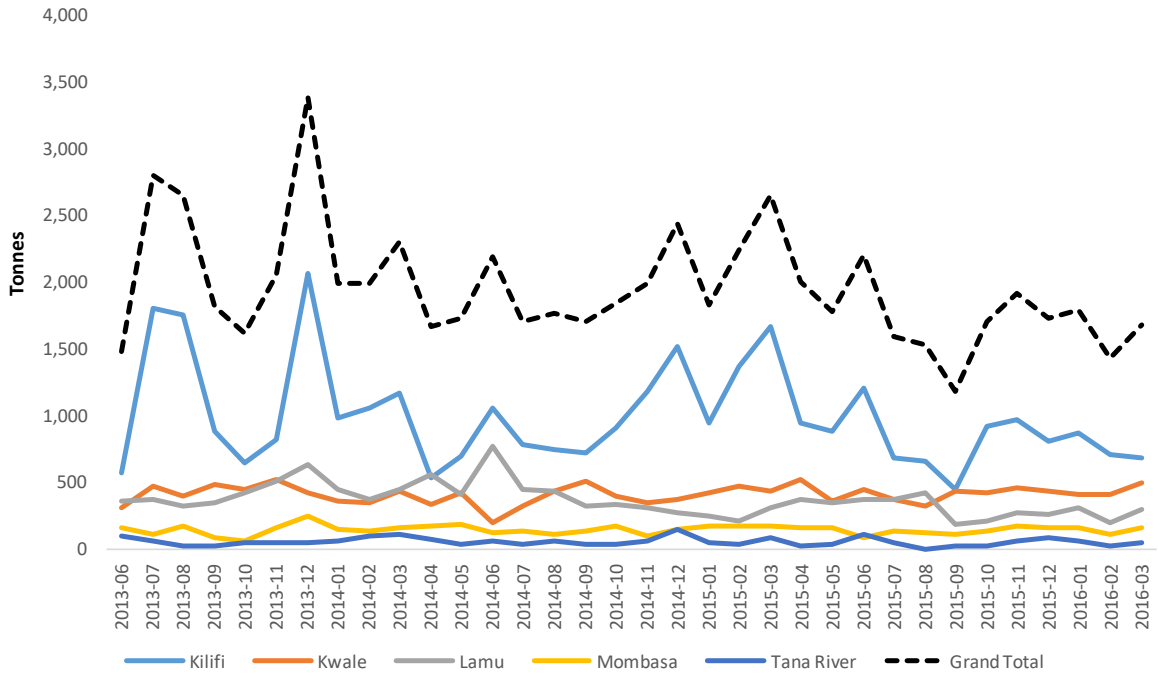

Fig. 1: Temporal distribution of catches by Counties

<u>Comparisons between the routine data collection and Catch Assessment Survey</u>

In both the routine data collection and Catch Assessment Survey, total catches and numbers of landings are highest in Kilifi County, followed by Kwale, Lamu, Mombasa and Tana River Counties (Figures 2).

However differences can be noted in terms of the following:

1. <u>Estimates of total catches, and catches at landing site/County level</u>

The total estimates catches over the sampling period was 66,438 tons for the CAS, compared to 26,629 tons from the routine data collection – around 40% of the catch levels estimated by the CAS.

Also worthy of note is the increase in total catches between 2014 and 2015 estimated by the CAS, compared to a reduction in catches as reported by the routine data collection.

2. Share of total catches between Counties

Differences were also noted between the overall contribution of total catches between Counties, estimated by the CAS and routine data collection. The contribution of Kilifi being 51% of the total catches in CAS, while in the routine data collection the contribution was 35%. The other counties contributed 21%, 19%, 7% and 3% respectively in CAS but had a contribution of 26%, 25%, 105 and 4% respectively in the routine data.

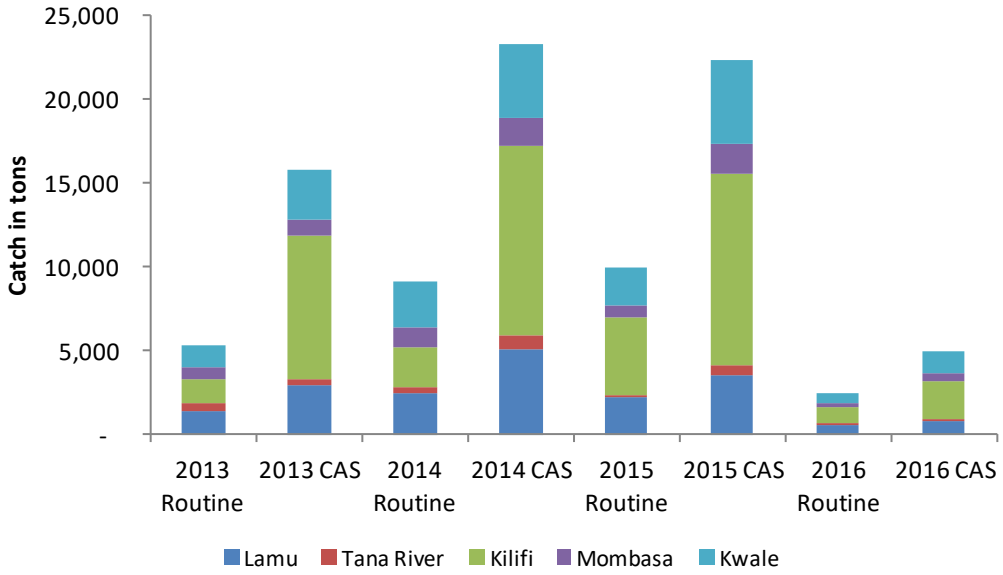

Figure 2: CAS and Routine data estimates of annual catches by County.
Notes: 2013 includes catches between June-December only; 2005 refers to catches between January-March only.

Temporal distribution of catches

The monthly catches from both CAS and routine data collection are shown in figure 3. Comparing the two systems, the routine catches look generally constant with catches ranging pikes between 580 and 1,000 tons per month. The average catch over the whole sampling period was around 775 tons per month.

In comparison, catches estimated by the CAS fluctuate significantly between months – with the highest catches each year occurring between January to March when fishing for deep water snappers takes place. Total monthly catches range from 1,200 tons to 3,400 tons, with an average catch of 2,000 tons per month over the period of sampling.

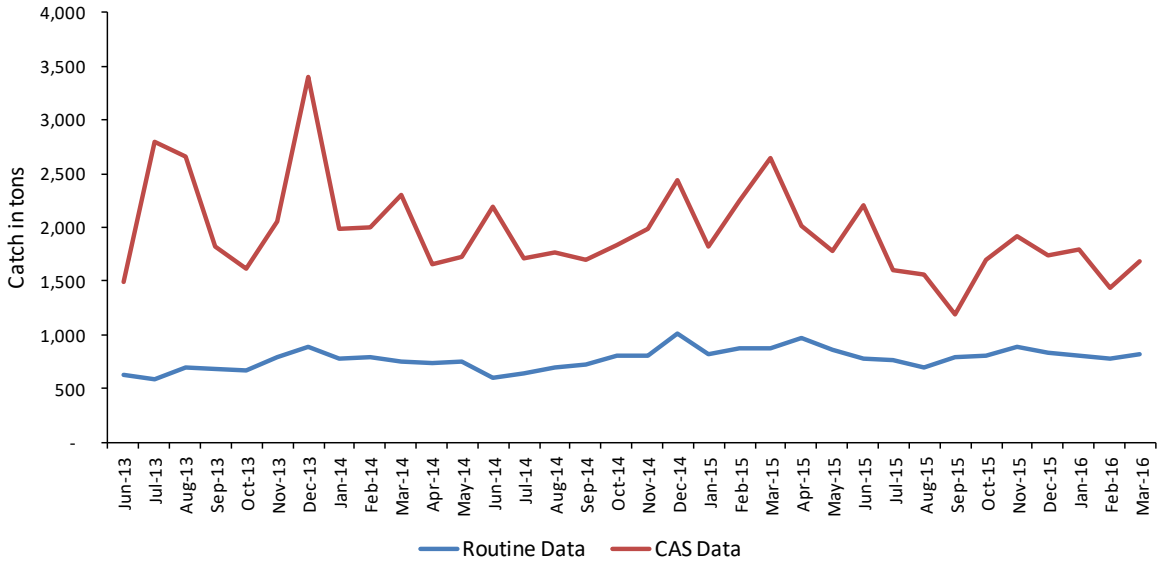

Figure 3: Monthly catches recorded from CAS and Routine data systems

Monthly catches over the entire sampling period (June 2013 – March 2016) were also combined (Fig.4), to examine possible seasonal trends in the data.

The results of the CAS data appear to show evidence of seasonality in catches, to a much greater extent than the routine data collection, and which confirms the commonly held knowledge of the fisheries and changes in catch rates and fishing activity affected by the rough monsoon season.

The catches were lowest in September after which the landings increase reaching a peak in December. Another peak is also realised in March after which a decline is observed, which is to be expected as sea conditions starts getting rough in April while the calm sea condition begins in October.

The lack of seasonality in the routine data collection appear to indicate issues with the reliability of the catch estimates – and the possibility of underreporting of catches, although the exact reasons are unclear and require further investigation.

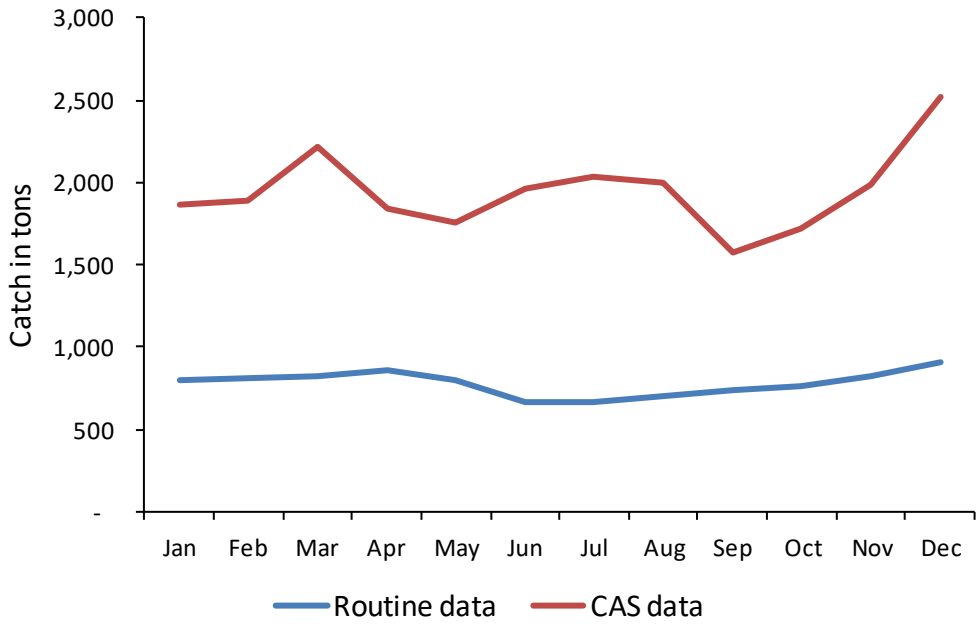

Figure 4: Average monthly catches recorded from CAS and Routine data system

Evaluation of the CAS methodology

The provisional results of the CAS are encouraging which, if taken forward, represent substantial savings in terms of costs and resources required for data collection of Kenya's coastal fisheries.

The data collected by the CAS are also a significant improvement over the former routine data collection, in terms of the spatial and temporal resolution of information collected on catches and fishing effort, and compliance with IOTC mandatory data reporting requirement (e.g., submission of total catches, catch-and-effort, and size data), including:

- Catch and fishing effort, by month and vessel-gear type.
- Catches by individual species, including IOTC species, which should enable improved compliance with IOTC mandatory data reporting requirements.
- Collection of size frequency data from sampled landings, previously not included in the routine data collection, which will ensure greater compliance with IOTC Resolution 15/02.
- Additional information on vessel activity, including information of vessel-gear type landings, including size of vessels.
- Evidence of seasonality in catches, and changes in targeting and fishing activity through the year, which appear to confirm commonly held knowledge of the fisheries.

However, given the scale of differences in total catches estimated by the routine data collection and Catch Assessment Survey, further work is required in order to validate the results of sampling and data collection system. Specifically:

i. Comparison of landing site level data (or even vessel level information, if available) between the routine data collection and CAS to better understand of the reasons for differences in estimation of total catches for each method.

ii. Similarly, further exploration of the CAS and routine data collection is needed to understand the differences in total number of landings recorded between the two data collection systems.

iii. Automation of the catch raising estimation procedure. The provisional estimates of the CAS presented in the paper have been calculated by Kenya SDF&BE, with the assistance of the IOTC Secretariat. However the lack of an integrated database for processing and validation the CAS means that all data checking and computations of the data – including raising to total catches – were semi-automated using Excel, which proved cumbersome and easily susceptible to errors.

iv. Improvements in the validation of the sampling data. During the quality assurance of the CAS by the IOTC Secretariat, a number of issues were discovered, including inconsistencies in the format and structure of the data entered, data errors allocating of incorrect species code, incomplete data for some records (e.g., no recoding of total catches for sampled vessels, just the sampled catches), in addition to errors in the original procedures applied when raising of data.

Challenges were also encountered during data collection; for example some data was lost, while there was also late submission of data forms, in addition to a lack of personnel to digitise the data. As a result the SDF&BE has embarked on a trial of electronic data collection, using an open source mobile technology to facilitate improvements in the timeliness and validation of data collected at the landing sites.

Recommendations

Further appraisal of the results of the CAS by Kenya and evaluation of the new data collection system is required, with the assistance of the IOTC Secretariat as necessary, before a final decision can be made in the transition from the routine data collection system to CAS methodology.

Assistance from the IOTC Secretariat has also been requested by Kenya to provide a technical appraisal of the new integrated fisheries database, and support for developments in electronic data collection by enumerators (e.g., use of mobile technology for data entry). A visit by the IOTC Data Coordinator has been scheduled for December 2017, with further updates to be provided at future IOTC Working Party meetings.