DEVELOPMENT OF A CENTRAL DATABASE FOR ARTISANAL FISHERIES IN SOMALIA

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ABSTRACT

Fisheries management cannot be undertaken efficiently unless the basic data is available. However, Somalia was hindered by a lack of up-to-date scientific information on catch and fishing effort statistics, and other data relevant for the management and conservation of fish stock and marine mammals in Somali territorial waters. There is no reliable and timely statistics, vital for effective policy formulation, for measuring progress, and for accurate reporting on artisanal fisheries.

The statistical capacity building activities in the fisheries sector have until recently remained uncoordinated, incoherent, and incomplete. The physical infrastructure and equipment to facilitate production and dissemination of data by the federal Ministry of Fisheries remains inadequate. There are no statistical database, sampling frames and statistical classification, rendering survey undertakings in challenging Somalia fisheries. The capacity of statistical staff to collect and analyses data, develop manuals, design and conduct surveys and censuses is limited. However, the development of central database for artisanal fisheries in Somalia would have not been addressed in a comprehensive manner to take care of most aspects of Somali fisheries sector.

Therefore, the Ministry of Fisheries and Marine Resources in collaboration with local consultants has been engaged in the development of centralized and common fisheries database with all regions in Somalia. Development and establishment of a robust fisheries information system is essential to Somalia for sustainable management of the fishery sector. This study was carried out to implement and improved fisheries data collection sampling system that is feasible for fisheries in Somalia along with an improved fisheries database and database management system. The outcome of the study is five-fold: fisheries data collection system project report (this report), fisheries database and client application, database administration manual, client application user manual and fisheries data collection system guidelines for data collectors.

INTRODUCTION

Somali Fisheries

Somali has the longest coastline in Africa (3,330km) and an Economic Exclusive Zone of 1,165,500km^2, there is potential to sustainably increase employment, food security, nutrition and revenues from its fisheries but there is currently no active fisheries management. The fishery resources in Somali waters are said to be one of the richest in the African continent.

The fishing seasons of Somali waters is governed by the monsoon winds that occur in the calendar year between May and September. In this period, high waves and strong winds compel small and medium size commercial boats not to call at Somali ports. In this period, coastal fishing of the artisanal fishery is limited but it does not have much effect on the industrial fishery as it is engaged mainly on larger fishing vessels. The fishing days of the artisanal fishery varies between 220 to 240 days per year while the offshore fishing vessels were forced to change their fishing ground, gear or target species.

Large pelagic species including tuna and tuna-like species such as yellow fin, big-eye, skipjack, mackerel etc. are the most highly priced species locally. Although they are highly migratory, the traditional fishing grounds for these species are found along the Indian Ocean from latitude 05 to 100 N due to upwelling that occurs twice annually in the period of southwest monsoons. It is also known that there are good fishing opportunities in the Gulf of Aden and Indian Ocean for tuna during the Southwest monsoon in the deeper waters.

Fisheries in Somalia can be mostly classified into marine and inland (fresh water) fisheries. The marine fisheries can be further divided into offshore (conducted by foreign vessels), coastal or artisanal (limited to waters of the relatively narrow continental shelf, operated by traditional vessels and vessels with outboard and inboard engines) and Houri (taking place in bays/ by traditional boats). The artisanal fishing depends on monsoon climate patterns and fishers are used to migrating between the coastal to bays as seasons change within the same district.

Fisheries in Somalia have changed a lot and increased in complexity since the 1970s and the number of boats operated in the coastal waters has increased. The most effective phase of development began in the early 1980s partly due to government efforts to promote the coastal fisheries introducing the Ministry of Fisheries and Marine Transport organized fishing villages into approximately 21 cooperatives Haakonsen, J. M. (1983).

The cooperative structure provided fishing gear and set prices for fish, giving fishers a more stable and viable financial stake. In 1973–1975, a major drought caused widespread starvation and displacement. In response, the government resettled 15,000 nomads into four fishing cooperatives. Because the resettled peoples lacked fishing skills and associated knowledge, the four resettlements failed within five years Haakonsen, J. M. (1984). The highest recorded catch was in the 1980s, mainly due to motorization of crafts and the introduction of new crafts and engine spares and replacement engines became freely available due to lifting of import restriction and fishing boats.

During the last 25 years or so, civil war and anarchy caused the destruction of all fishery infrastructures through looting and destruction. To recover the fishery sector, there is a need to rehabilitate the sector by providing inputs and capacity building to the coastal communities. The sector currently contributes 2% national economy (GNP) but if fully developed it would contribute much more than that.

With the exception small artisanal fishing fleet, Somalia does not have any fishing vessels targeting tuna and tuna-like species in the Indian Ocean. There is no vessel of or above 24m, or less than 24m fishing outside of the Somali EEZ, targeting tuna and tuna-like species and flagged in Somalia, and therefore there is no Somali vessel on the IOTC Record of Authorized vessels. The Somali artisanal fleet does not specialized in targeting tuna and tuna-like species and catch IOTC species on an opportunistic basis like many other artisanal fisheries of the Indian Ocean.

Besides, there is no Monitoring, Control and Surveillance (MCS) of the marine resources and data collection system on marine products on both inshore and offshore fisheries. The sector has also experienced collapse of maritime and other technical educational institutes, hence, limiting attainment of knowledge to manage the activities in the fishing communities.

Significance of the study

Currently, there is a high demand and interest from new fisheries investors for artisanal and offshore fisheries in Somalia. In addition, fisheries experts and scientists in Somalia fisheries have been calling many years to deploy data collection system that is more extensive and reliable statistics in the sector. At the same time one of the Somali fisheries' main problems is a lack of reliable, accurate and timely information on artisanal fisheries statistics since 1980s. Fisheries statistics is the basis in policy making and fisheries management. Therefore, it is necessary for Somalia to improve artisanal fisheries statistics so as to strengthen management of the fishery resource.

Objective of the study

The main objective of the current study is to improve fisheries data collection system that is feasible for fisheries in Somalia along with an improved fisheries database and database management system. The ultimate purpose of this data is to place the foundation for proper management of the artisanal fisheries including the indorsed fisheries policy goal of promoting conservation, development and sustainable management of the fisheries resources for the benefit of present and future generations. The study will focus on artisanal fisheries as data recording will take place from 19 landing sites in all regional in Somalia along the coastal districts which will be used as strata method.

Fisheries production and fisheries resource status

The state of fish resources is not well known though the weak domestic purchasing power, poor market links and lack of export facilities suggest that many resources remain under-exploited. However, high value inshore stocks such as lobster and sea cucumber are known to be over-exploited, while prime finfish, such as red snapper, have always found a market in the Gulf States. Dried shark and ray have also been traditional products traded in the region.

A sustainable annual catch of 200,000 tons, **FAO, (2005)** of pelagic species has been suggested by FAO and an annual catch of 60,000 tons has been estimated (including foreign catches) **UNSC (2011)**. Coastal stocks are estimated at about 40,000 tons of demersal species, and 30,000 tons of sharks and rays. Sharks and rays can be as much as 40% of the catch of artisanal fisheries and are considered overexploited. Concentrations of pelagic species (scad, sardines, anchovy and other small Pelagics) show high seasonal variability and sustainable catches have been estimated at about 70,000-100,000 tons per year Glazer, et al. (2015). According to Glazer, et al. (2015) a recent estimate suggests considerable potential for pelagic (planktivore) species and overexploitation on some demersal species (see Appendix, Table ….).

All estimates need to be treated with caution. FAO reports around 30,000 tons of fish caught in the waters of Somalia since 2006 to 2012, Pauly D., & Zeller D., (2014). However, FAO data reflect the reported catches as provided by the national fisheries authorities. In addition to that, Pauly D., & Zeller D, editors (2014), indicates that The Sea Around Us Project estimates the catch from Somali waters to be in the order of 60,000 tons almost double as compared to the FAO's estimation (see **Table 1, Table 2, Table 3 and Table 17** in the appendix for a longer time series). However, these estimates include both the landings and the largely unreported catches landed outside Somalia (see following tables). The value of illegal catches taken out of Somali waters in 2005 was estimated as being at least US$300 million Lehr P., & Lehmann H. (2007). However, according to Glaser, et al. (2015) as already cautioned, all estimates and reported values must be treated with caution, particularly as up to 2014.

Table 1. Somalia reported and estimated catches in 2010

Year	Industrial	Artisanal	Subsistence	Discards	Total catch
FAO reported catch	(46% of UBC estimate)			29,800	
UBC/ Sea Around Us estimate	14,540	32,730	8,120	9,530	64,900
% (UBC)	22%	50%	13%	15%	100%

Source: Persson et al. (2014)

Table 2. Composition of estimated annual catch in Somali waters (averages 1997-2006)

Species	Value per ton (US$)	Annual landings (tons)	Estimated annual value (US$ million)	% by value
Yellowfin Tuna	$2,333	2,168	5.71	12%
Bigeye	$2,913	1,485	5.04	11%
Skipjack	$1,035	1,417	1.47	3%
Albacore	$2,516	90	0.26	1%
Spiny lobster	$9,959	453	4.39	10%
Swordfish	$2,639	393	1.25	3%
Species nei	$1,051	26,413	27.77	61%
Total	$1,416	32,419	45.89	100%

Source: Persson et al. (2014). nei: not elsewhere included

Table 3. Small-scale catches reported and estimated for 2005 for Somalia (tons)

Region	Fish	Shark	Total	Shark	Source
Somaliland	6,030	2,486b	8,516	29%	Gulaid (2004)
Puntland	2,144a	8,990	11,134	81%	Mohamed & Herzi (2005)
Galmud, Hirshabelle, South-west & Jubaland	14,825	6,113	20,938	29%	Sabriye (2005)
Total Somalia	22,999	17,589	40,588	43%	

Source: Persson et al. (2014). A substantial part of the finfish catches from Puntland are sold to Yemen and not included in the reported catches for Puntland.

For the artisanal fleet, the number of fishermen and fishing vessels is largely unknown, however, through an FAO project, Somalia has started to registered fishermen and so far a total of 65,144 fishermen have been registered. More than half are reported to own their fishing boats and 50% are members of fishing cooperatives was estimated at about 3,464 motorized fiberglass vessels (6-10 meters), 110 sail boats and 726 houris (5-meter canoes), suggesting that there may currently be in the order of 4,300 vessels of all types (Table 5.). Boats are categorized into four types accordingly to the Local Boat Name (See Figure 2.).

The boats used in most sites is fiberglass skiffs with an outboard engine. For landing sites along an open coastline, fiberglass skiffs allow easy beaching and landing from a sandy beach. Boats with inboard engines often moor at sea and therefore usually require protected harbors. Dhows and sail vessels are found only in the south while houri, a rowing boat, is the most commonly used boat in Somalia. (See Table 4.)

Table 4. Distribution of boat types

Local Boat Name	Definition
Saxiimad/Baaraforde/Faara boota	Fiberglass skiff with outboard
Volvo/Laash	Fiberglass with inboard
Houri	Wooden boat without engine
Dhow	Dhow Motorized
Sambuk	Wooden boat with inboard engine

Table 5. Numbers of boats by type counted during 2015

Boat Type	Total
Motor boats (inboard and outboard engine	3,464
Houris	836
Totals	**4,300**

Sources: Statistics Unit - Ministry of Fisheries and Marine Resources

Figure 1. Distribution of common fishing boat

Fiberglass skiff with inboard

Fiberglass skiff with inboard

Wooden without engine (Houri)

Wooden skiff with outboard engine

Fishing Gear

Somali fisheries are characterized by its multi-gear and multi-species nature. A wide variety of fishing gear is employed to catch a large number of species, particularly in coastal water fisheries. The most common gears are handlines, troll-lines and mesh nets; while traps are also used. Gillnet is the most widely used gear, targeting large Pelagics such as Skipjack, Yellowfin in offshore fisheries, small Pelagics such as smaller tuna species, mackerels, sardines and anchovy in coastal fisheries. Glazer, et al. (2015), stated that artisanal fishers in northern (Somaliland) target finfish (pelagic and demersal), sharks, lobster, prawns, crabs, and sea cucumber. However, the main gears used by this sector include gillnets, hooks (for large fish and sharks), hand lines, and some traps and seine nets Glazer, et al. (2015).

Fishery communities' structure

The main fishery areas are divided into thirteen main zones, based on major cities and towns: Kismaayo (Jubbaland), Mark and Barawe (Southwest) Mogadishu (Benadir), Warsheekh and Adale (Hirshabelle), Hobyo (Galmudug), Garacad, Eyl, Bargaal, Boosaaso, Lasqoray, (Puntland), Maydh, and Berbera (Somaliland). (See Figure 3.) Fishermen communities are largely made up of traditional fishermen, living in about 250 fishing villages and towns all along the coast from the Kenyan border to Djibouti.

However, the largest concentrations are found along the southeast coast (Mogadishu and Lower Shabelle areas), where population density is highest. Fishermen fully engaged (primary sector) in

artisanal and industrial fisheries are estimated at about 30, 000. In addition, part-time fishermen seasonally engaged in the fishery sector are estimated at about 60, 000. Fishing is based from some 65 landing sites scattered along the north and east coasts. Between the landings sites the population densities are very low, hence, these grounds are only lightly fished.

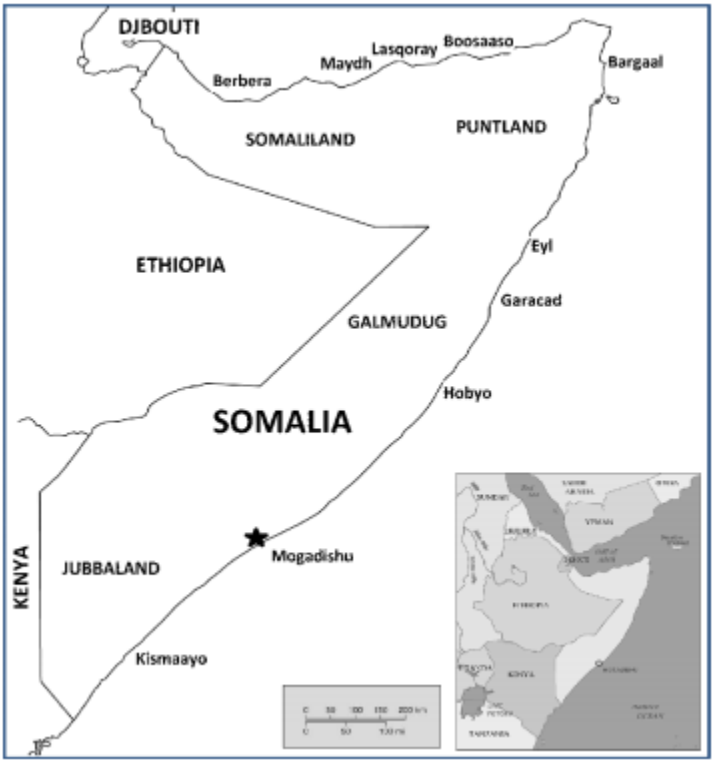


Figure 2 Map of Major Fishing Landing Sites

Institutional Framework

The Federal Ministry of Fisheries and Marine Resources (MFMR) is the country's premier fisheries management agency. In coordination/cooperation with other National Government Agency, MFMR has jurisdiction over management, conservation, development, protection, utilization and disposition of all fisheries and aquatic resources of the country, except those within Federal Member States (FMSs) waters wherein MFMR is tasked to coordinate with and assist FMSs. The overall monitoring of the survey is done by the Ministry of Fisheries and Marine Resources and actions are taken to further improvements of the survey considering the practical situation in the field.

FISHERIES DATA COLLECTION IN SOMALIA

Previous data collection system

Fisheries statistical collection in Somalia began in 1970s, using a team of trained fishery inspectors, adopting the two-stage stratified sampling technique. The Fisheries Planning and Statistics under the Ministry of Fisheries and Marine Transport was responsible for fisheries statistics in Somalia. The department was responsible for collection, analysis and dissemination of national fisheries information. During the centralized administration system (1980s), there was a strong formal link between the Fisheries Planning and Statistics and regional/district administrations. Regional/district fisheries officers and their coordinators were responsible to the Fisheries Statistics. Consequently in every landing site, fishery inspectors were employed at the district level (during that time) as data enumerators. Apart from other fishery related activities, data collection was the main/core activity of the fishery inspector.

Current status of data collection

Structure of the existing data collection

The fisheries statistics data collection system is currently operated by several agencies, but the Statistical Unit of Ministry of Fisheries is responsible for the collection and reporting of fisheries statistical information in Somalia. It receives fisheries data reports from various sources, and engaged in collection of some limited raw data. At present, collection of fisheries statistics by Department of Marine Policy Planning and Statistics is relatively simple, aimed primarily at estimating total fish production.

All field Fisheries Inspectors under MFMR generally work one day per week, collect catch and effort data from beach landing sites primarily Benadir region. These data cannot be used for regular stock assessment or management of fisheries, which is a primary requirement of MFMR. This work is carried out by Fisheries Inspectors under the overall supervision of the statistical Unit in the Ministry of Fisheries and Marine Resources, but there is no description or written guidelines available for the implementation of the system.

The formal links between the Fisheries Policy Planning and Statistics department and the regional governments administrations has never became fully operational due to financial constraints since following the implementation of a decentralized administration system, whereby regional government fisheries inspectors are no longer exist to federal member states. As a result, since this date a limited amount of data (from sampling sites) has been collected. In the sampling sites where data enumerators have been unwaged the data is simply not collected.

The Federal Government and the regional states do not have reliable and timely statistics, vital for effective policy formulation, for measuring progress, and for accurate reporting on development outcomes at local, national and international levels. Lack of reliable data/information has been recognized as one of the major constraints in sustainable fisheries development/management in Somalia.

Improved interest in this sector could weaken if additional steps are not taken to better manage Somali fisheries. In addition, coordination between regional governments and federal authorities, greater data collection and analyses, and a comprehensive approach to fisheries regulation are

critical. Several attempts has already been tried out for improvement of artisanal data collection system in Somalia but it never became fully operational due to financial constraints.

Main challenge

Since 1980s, national annual fisheries statistics reports, specifically for the artisanal sector, have not been produced. There has not been a systematic effort to collect scientifically rigorous data on Somali fisheries. Unfortunately, the civil war in Somalia in the 1990s destroyed the Somalia statistical systems specifically fisheries sector. The statistical infrastructure and systems were left in serious state of disorder, which constrained the collection, compilation and dissemination of statistics in the country. Basic statistics—the amount and composition of catch, prices obtained for catch, biological information about target species— were not available. Consequently, the types of analysis needed to inform fisheries regulations were severely constrained. Thus, updated information is profoundly needed.

Since before 2013, the Fisheries Planning and Statistics department had been looking for means to improve the consistency of artisanal fisheries statistics. The shift to a decentralized administration structure in 2000 has made this work very difficult. At present, no data collection or sampling system is set up in the different States of Somalia, and very few fisheries data is currently being collected on the Somali artisanal fleet. The collected data has not yet been analyzed as the database is incomplete and the Fisheries planning and statistics staff working in the statistics unit does not have the capacity to finish the work.

Moreover, at the regional governments the collection of fisheries data is mostly stated to be very low in the order of priorities and may therefore be neglected. Thus, the rationalization of data enumerators in some landing sites has not been apparent as poorly affecting district activities. For instance, more than 99% of Somali fisheries capture in the Indian Ocean comes from artisanal fleets. This creates significant data challenges across the nation. Small, artisanal fleets have characteristics that complicate fisheries data collection and hence management: many small boats, low governance capacity, dispersed and numerous landing sites, diverse market chains, multi-species and multi-gear fleets, and no clear distinction between target and bycatch species. Consequently, data quality varies widely, underreporting is widespread, and catch is rarely documented at the species level.

Existing vessel registry Database

Under the Fisheries and Marine Resources requires logbooks in order for domestic or foreign fishers to receive a fishing license,[1] there is currently no uniform or coordinated way for data to be collected from small-scale fishers, either through sampling schemes or through direct catch reporting. Onboard observers are not feasible on small vessels. Data collection at landing sites would generate needed information on the status of fisheries and ensure fishers are following regulations.

[1] Article 12 & 6

Prior to 2013 the boat register contained a number of vessels that were out of operation and substantial number of vessels, possibly between 20-30%; did not appear to be registered. Therefore the boat registry has been introduced at MFMR with the financial and technical support of FAO. Boat registry database is the end product of the computerization of fishing boat registrations. This was established in July 2016 and has been modified and expanded in several stages in line with the newly introduced boat registration. Reliable data on fishing vessels were not available prior to the boat registry. One of the roles of the boat registry database is to provide information for various reports needed by the Ministry of Fisheries and Marine Resources and other agencies, especially the Somalia Coast Guard.

For instance, in 2015 and 2016, there were an estimated 3080 and 4,300[2] artisanal vessels respectively and 30,650 fishers in Somalia (see Table 6) including motorized fiberglass, sailboats, and canoes MFMR, (2016). About 80% of the fishing vessels are GRP 6-10-meter outboard and inboard powered open vessels.

The fishing vessel registry database is not comprehensive data/information on fishing vessels, fishing gear and target species are not available through vessel registration and issuing of Fishing Operations Licenses, information are mostly required for fisheries management. This database therefore needs to be seen as part of a long and continuous effort on the part of MFMR to establish a fisheries statistical system helpful for sound fisheries management as it will serve as a frame for the total catch raising factor (total number of vessels by boat type and federal member state) for the new fishery database (initially for coastal fisheries see Table 6).

Table 6: Fishing Boats by regional government – 2015 and 2016

-District	**MDAY/ SDAY/ TRB**
Somaliland	594
Puntland	1,697
Galmudug	565
Hirshabelle	320
South-west	386
Jubaland	495
Benadir (Mogadishu)	243
Total Boats	4,300

Source: Statistics Unit - Ministry of Fisheries and Marine Resources) & FAO-Info graphics-Somalia Fisheries-en

[2] FAO-Info graphics-Somalia Fisheries-en

OVERVIEW OF DATA COLLECTION AND DATABASE MANAGEMENT

SUGGESTED IMPROVEMENTS

In this paper, the previous system, current status and main challenge for the overall artisanal fisheries statistics in Somalia have been detailed. Substantial effort must be taken in order to get reliable artisanal fisheries statistics. In summary, unreliable statistics confound fisheries management on three fronts. Biologically, they bring greater uncertainty into the biomass estimation process by reducing confidence in the accuracy of fisheries management advice. Politically, they reduce the public's confidence in the ability of fisheries managers to monitor and manage the resource on their behalf. Economically, they limit the economic and social understanding of the position and viability of the fisheries sector. Therefore, this section will provide broad discussion on sampling procedure, community participation in data collection and the type of data to be collected in marine waters of Somalia so as to improve artisanal fisheries statistics.

Objectives of data collection

Various industries and professions in a country require access to accurate fisheries data. These can be fisheries biologists, economists, sociologists, managers, politicians and different industries in need of different information with varying interests. However there is a common demand for some basic fisheries data FAO (2000) and Per Johan S. (2000). Generally the common objectives of data collection are to prepare regular publication of a yearbook or Annual Fisheries Statistics. Additionally, some estimation like production by different fish landings is vital for a wide range of stakeholders. Data collection is needed for the scientific analysis of fisheries resources; total landings are often required by species and needed for use in fish stock assessment.

Sampling

Sampling is very important in fisheries data collection. A sample is a collection of parts of the elements of a set FAO (2005). The elements will be the sampling units, part of the elements will form the sample and the full set is the population. The main objective of sampling is to estimate parameters of population from a small fraction of the total population.

It is noticeable that perceiving all the elements of a population is not a practical approach considering the cost, time and management factors FAO (2005). In contrast sampling has some principal advantages as it is less expensive, faster and better focused Banerjee M., (2012). Additionally when samples are selected with an adequate criterion, it is possible to measure the precision of the conclusions or implications about that population FAO (2005).

According to Wikipedia, the definitions of the most important terms used in sampling can be listed as follows.

> **Sample:** A subset of individuals (a sample) chosen from a larger set (a population)
> **Target population:** The complete collection of observations we want to study.

Sampled population: The collection of all possible observation units that might have been in a sample or the population from which the sample was taken.
Observation unit: An object on which a measurement is taken. This is the basic unit of observation, sometimes called an element.

Sampling procedure

The proposed improvements in the artisanal fisheries statistics system will involve sampling in time and space. The primary sampling unit is the landing site. A few landing sites will be selected from a list obtained during the latest fisheries frame survey. The sampling method will be stratified random sampling. The following are few of the reasons for using stratified sampling:

- In marine areas there are 19 administrative districts which can be used as strata.
- Estimates of the fish production are always needed for each district (stratum).
- Every regional government in regards to the population density will be included in the sample;
- Adequate representation of specific groups of the target population in the sample will be ensured; and
- Efficiency of the sample design will be improved, thus making the survey estimate more reliable.

In the sampling procedure, each fishing district is regarded as a stratum. This means that they are all represented in the data. In stratified sampling, every element in each stratum has an equal probability of being sampled. In each stratum (fishing district) a random sample of landing sites will be applied. For instance, from a cluster of 20 major landing sites in Puntland five will be sampled i.e. two small and three large landing site (Table 7). Unfortunately, in some districts the selection of landing sites is not completely random due to difficulty in accessibility, conditions of the landing sites (either permanent or temporary sites); and size and type of fishing activities. For that reason only 19 landing sites will be selected where data recording will take place (Table 7). The 19 landing sites will act as representatives of the 65 major landing sites in all the over the country. The sample size of 19 is very satisfactory. However, the justification for this is: (i) limited resources in terms of manpower; and (ii) the belief that there is little variation between landing sites in terms of the relevant variables under study. (iii) The sample size is remarkably higher the rage. Temporary landing sites are not included in the sample, because they are very small and mostly used by very few people. Landing sites vary in terms of size and type of fishing activities. Some are small, with few types of fishing activity while others are large with many types of fishing activity.

The accessibility to the landing sites from the fishing communities is also considered in the sampling process. Some landing sites are very remote and hard to reach as some are still inaccessible while few are still insecure to undertake data collection activities. The representation of type of fishing vessels and gears in landing site are also taken into consideration in this sampling procedure, as this will determine the type of species caught. The types of fishing vessels and gears are distributed throughout the 19 districts. Since the country has taken new federal system but in Somalia there is no regulation which limits fishers to move from one landing site to another in any district.

Sampling strategy

In small-scale fishery like Somalia, the amount of information regarding total landings, species composition, prices etc. is so large that the use of a census approach (total enumeration) is impracticable FAO (2004). Collecting fisheries data in all landing sites and from all vessels is impossible and not viable. Lack of manpower, limited finance and limited transportation also affect in this regard. Therefore, to minimize the operational costs, time and logistics, most effective way to collect fisheries data is through stratified sampling FAO (2002).

The sampling strategy can be developed using stratification at various levels. The primary sampling unit is the landing site. Landing sites can be selected from the latest fishery survey (Fishing boat census 2015) and also from the Vessel Registry database. Geographical stratification or stratification by area is on the basis of the coastal administrative districts (Figure 2).

Regional government based fisheries data becomes important for regional based fisheries administration, development and management. Stratification by time is on a monthly basis. However, sampling strategy, particularly in sampling the coastal fisheries need to change according to the monsoons as some fisheries become inactive during the monsoon periods.

Stratification by fishery
Marine fisheries are classified

Vessels can be classified as follows and table 5 shows the vessel numbers (see Table 7.)

- Offshore fishery, which is conducted by Multi-Day Boats (MDAY)
- Coastal fishery, which conducted by Sing-Day Boat (SDAY) which is confined to waters of the relatively narrow Continental Shelf, operated by traditional vessels and vessels with outboard engines and inboard engines.

Table 7. Boat types involved in the Somalia fisheries

Description	Code	Fishery
Multi-day boat with inboard engine (Volvo)	M(IFRB)	Off-shore
Day boat day with inboard engine (Volvo)	S(IFRB)	Coastal (Artisanal)
FRB boat with outboard engine	S(OFRB)	Coastal (Artisanal)
Traditional outboard engine	S(OTRB)	Coastal (Artisanal)
Traditional boat without engine	S(NTRB)	Coastal (Artisanal)

Sources: Statistics Unit - Ministry of Fisheries and Marine Resources

Stratification by landing sites
All major landing sites should be sampled while anchorages and minor landing sites in each district (stratum) where possible a random selection should be applied. Fish landing sites within a district can be classified under three sections, Major harbors, Anchorages and Minor landing sites. All boat types should be included at the sites sampled each time. The sampling strategy should to cover all major fisheries conducted in a district. It may need to be revised during the monsoon seasons because some fishing methods.

Stratification by craft type

The number and types of boats vary from site to site. Therefore, the number and types of boats to be sampled should be determined for each selected landing site, based on the number of boats operating from each landing site. Stamatopoulos, in FAO (2002), denoted the required number of samples to get an accurate estimate of CPUE (Table 8). Some methodology can be applied to selection of the number and types of boats to be sampled. Data Collector should do this in advance, in consultation with the head of statistics division under MFMR of the relevant fishing district.

Stratification cannot be done by fishing gear, since several different types of fishing gear may be used by the same boat. In the offshore fishery, multi-day boats may operate gillnets as well as troll lines, hand lines and long lines (Shark/Tuna) during a single fishing trip. The catch is put together in the fish hold and it would not be possible to separate the catch by gear when the fish is landed at the landing site. Fishermen in coastal fishing boats often change the gear according to seasons or availability of fish during the same season. After implementing the new system for few years (2/3 years) there may be a possibility to stratify by gear type, analyzing the fishing gear details in the database.

In each month, the selection of the 10 days for field visits to sample fish catch should be done in advance. If the days are not selected randomly due to any unavoidable circumstances, the 10 days should be spread evenly over the month. Every attempt should be made to achieve the required total number of sampling days assigned to each data collector.

Table 8. Distribution of sample landing site

Region	Sampled Districts	Total	Landing site size		Sampled landing sites
			Big/Large	Small	
Jubaland	Kismaayo	13	4	9	2 (1B &IS)
	Badhaadhe,	8	2	6	1B
Southwest	Baraawe	2	1	1	1B
	Marka	4	1	3	1B
Hirshabelle	Warsheekh	3	1	2	1B
	Ceel Cabdi	8	1	7	1S
Galmudug	Hobyo	5	1	4	1B
	Ceel huur	4	1	3	1S
Puntland	Eyl	13	1	12	2 (1B&1S)
	Baargaale	5	2	3	1S
	Boosaaso	5	1	4	1B
	Garacad	2	0	2	1S
	Alula	2	1	1	1B
Somaliland	Barbara	3	1	2	1B
	Lughaye	1	0	1	1S
Benadir	Urubo	1	1	0	1B
	Liido	1	1	0	1B

Where:

B means big landing sites which have > 25 boats
S means small landing sites which have < 25 boats

That is to say, each sample from any landing site will contain all variables which will represent that a certain species was caught from a certain type of vessel using a specific type of gear in a particular time (See Appendix).

A standard error of the mean has been calculated by making use of the following formula:

$$SE = \frac{SD}{\sqrt{n}}$$

Where *n* is the number of observations and the Standard Deviation is calculated by using the Standard Deviation formula:

$$SD = \sqrt{\sum \frac{(x - \bar{x})^2}{n-1}}$$

With data from Table 3 (last column) the obtained sample standard error is 0.022; this measures the variability of the sample means. Statistically, accuracy and precision in sampling is measured by statistical indicators called Coefficient of Variation (CV). CV is a relative index of variability that utilizes the sample variance and the sample mean. CV is the most commonly used relative index of variability, it measures how each sample deviates from the mean and is usually expressed as a percentage.

$$CV = 100 \times \left(\frac{SD}{mean} \right)$$

Experience indicates that CVs below 15% are indicators of acceptable variability in data samples (Stamatopoulos 2002). According to the data in this study, the obtained CV is 6% which is obtained by making use of the sample mean and standard deviation (Table 9). In this case, the CV is acceptable for the smaller sample size with low scores (one or two per district) obtained from the whole population of landing sites.

Table 9 provides information on calculated standard deviation and standard error of the mean as well as the coefficient of variation of the sampling landing sites. In calculating data for (Table 8) the variables used were: n = 19 (i.e. sample size), number of observations is 13, mean = 1.461 and square root of n = 4.358899, while *n*-1 = 18.

Table 9. Statistical parameters for the selected sampling landing sites

E	x-mean	x-mean squared	Sum of x-mean/n-1	SD	SE	CV
2	0.538461538	0.015260044				
2	0.538461538	0.015260044				
2	0.538461538	0.015260044				
1	-0.461538462	0.011211461				
2	0.538461538	0.015260044				
1	-0.461538462	0.011211461				
1	-0.461538462	0.011211461				
1	-0.461538462	0.011211461				
1	-0.461538462	0.011211461				
1	-0.461538462	0.011211461				
1	-0.461538462	0.011211461				
1	-0.461538462	0.011211461				
2	0.538461538	0.015260044				
2	0.538461538	0.015260044				
19	1.11022E-15	0.170040486	0.009446694	0.097	0.022	6.650

Note: Calculated using Excel

The secondary sampling unit is the day. The data will be collected for 10 days per month. These 10 days will be selected with the help of a random table. This will give 10 days in each month where enumerators go to the landing site for sampling. For constancy of recording and data analysis in the computer, one district fisheries inspector will select the days for at least six months at a specific time and notify all landing sites through their respective fisheries inspectors. That means, during recording days, each of the selected landing sites (19 randomly selected from the sampling procedure) will be sampled to represent the entire marine landing sites. The recent guidelines on how many samples are required for each type of vessel using particular gear to get an accurate estimate of CPUE is given by Stamatopoulos, in FAO Fisheries Technical paper No. 425, 2002 (Table 9). A key point with sample data is that the more you collect, the smaller the additional increase in accuracy (Table 10).

During the recording days (sampling days), enumerators will record all vessels landing at that particular landing site. The recorded information will include the type of fishing vessel, number of crew members, species composition, type and size of fishing gear, fish catch and catch value (See Appendix). The recorded information (variables) for each vessel will include.

It is expected that every fishing vessel operating from the landing site on the particular day will be recorded since the enumerators are part of the local community in which they live and they are familiar with the fishery. With 10 recording days per month, the expectation of getting enough data from the sampled landing sites to represent the total population of boats in all 65 landing site is high. By limiting the recording to only 10 days, data enumerators should have sufficient time to perform their other duties.

Simple random sampling

Simple random sampling is the most basic form of probability sampling and provides the theoretical basis for the more complicated forms Lan, et, al. (2009). Simple random sampling is the simplest way to sample a population. Its simplicity arises from the way that the sample is selected. In this design, all possible samples have the same probability of being chosen FAO (2005).

Stratified random sampling

"Stratification is the process of partitioning a target data population (e.g. all fishing vessels) into a number of more homogeneous sub sets based on their characteristics" FAO (2002). The statisticians use the term "stratification/n" when the landing places are categorized, and represented for each category of landing place selected. This is the usual practice to utilize minimum resources (manpower and funds) by bypassing the requirement to cover all major landing places in any division (regions or group of provinces) of a country. When there are a number of distinct categories (homogeneous), the frame can be organized by these categories into separate "strata".

Stratification may reduce cost and improve precisions Lan, et, al. (2009). However and Lohr, S. (2010), reasons that resources (manpower and funds) for sampling are almost always limited. Therefore it may not be possible to cover all major landing places in any division (province or group of provinces) of a country. Instead, the landing places are usually categorized and represent above landing sites for each category selected FAO (2000).

Where the population holds a number of distinct categories (homogeneous), the frame can be organized by these categories into separate "strata." Each stratum is then sampled as an independent sub-population, out of which individual elements can be randomly selected. A homogeneous population is treated such that, the frame is organized by the different categories of the population into separate strata. Each stratum is sampled as an independent sub-population and individual elements are randomly selected.

Frame survey

Fixed sampling sites should provide a satisfactory geographical coverage of the statistical area FAO (2002). Frame surveys assisted with existing geographical information are required for prior selection of fixed sampling sites. In terms of potential fishing effort, the number of boats by site and boat/gear type is also relatively important and a complete census or count of the main units (ports, boats, and fishermen) is mandatory.

Estimation process

In sample-based approach, total catch is based on the mean catch per fishing day from a landings sample and the mean number of fishing days per vessel from a vessel sample, which multiplied together, give the mean catch per vessel. The total catch can then be obtained by multiplying this by the total number of vessels (a raising factor) obtained from a frame survey or vessel register FAO (1998).

The common formula to estimate the catch is as follows FAO (2002):

Catch = Catch per unit effort (CPUE) x Effort

Where:

Catch (total), refers to all species taken together and is usually computed within the logical context of:

- A limited geographical area or stratum.
- A given reference period (i.e. a calendar month).
- A specific boat/gear category.

Catch per unit effort represent the average catch by active boats during the reference period.

Effort represents the vessel activity during the period. The common formula to estimate the effort can be express as follows:

Effort = Boat Activity Coefficient (BAC) x F x A

Where, BAC is expressing the probability that any boat will be active on any day; F is a raising factor expressing the total number of fishing units that are potentially operating at all fishing sites; A is a raising factor expressing total number of days with fishing activities during the month. Stamatopoulos FAO (2002), has computed and suggested the minimum sampling size to get reliable estimates on the production in different accuracy level (Table 9).

The calculations below apply to each boat type M(IFRB), S(IFRB), S(OFRB), S(OTRB), S(NTRB) in each fishery (CF, OF).

Total number of boats in all landing sites sampled during each month A is calculated as,

$$A = \sum_{i=1}^{n} A_i$$

Total number of boats operated in landing sites during each month B is calculated as,

$$B = \sum_{i=1}^{n} B_I$$

Then the boat activity factor, Z is;

$$Z = \frac{B}{A}$$

Total number of boats sampled in a district on a given month N is calculated as, N

$$N = \sum_{i=1}^{n} N_i$$

To calculate total catch the total number of boats raising the figures to include all active boats during the month in each district, total catch of all boats sampled in a district during a month is calculated as,

$$C = \sum_{i=1}^{n} C_I$$

$\bar{C}$, Average catch per boat per day, is calculated as,

$$\bar{c} = \frac{C}{N}$$

To calculate the number of active boats M in a district, the total number of boats is multiplied by the boat activity factor

$$M = Z \times D$$

Where, D = total number of boats in a district

To calculate the total monthly landings per district, we use number of fishing days from the PR1 form.

$$\text{Monthly production } P_m = \bar{C}.M.Y$$

Where;

$\bar{C}$ = average catch per boat per day

M = number of active boats in the district per month
Y = number of fishing days

Table 10: Recommended sample sizes for landings (boats) at a desired level of accuracy and as a function of data population size FAO (2002)

Accuracy (%)	90	91	92	93	94	95	96	97	98	99
Data population size	Safe sample size for vessel landings									
400	30	36	44	56	73	97	133	188	267	356
500	30	37	45	58	75	102	143	208	308	432
600	30	37	46	59	77	106	150	223	343	505
700	31	37	47	60	79	108	156	236	373	574
800	31	38	47	60	80	110	160	246	400	640
900	31	38	47	61	81	112	164	255	424	703
1000	31	38	48	61	82	114	167	262	445	762
2000	32	39	49	63	85	120	182	302	572	1231
3000	32	39	49	64	86	123	188	318	632	1549
4000	32	39	49	64	87	124	191	327	667	1778
5000	32	39	50	64	87	125	192	332	690	1952

For a population size of 400 boats, 30 samples are needed for 90% accuracy, 97 samples for 95% accuracy and 356 samples for 99% accuracy (Table 9).

Need for a database management system

This study is concerned with an improvement of routine artisanal fisheries data collection and management in Somalia. In order to obtain reliable and updated information, the following steps should be followed (Table 10). After collection, the data must be stored, and made easily available for analysis and interpretation for management of the fishery resources. Fisheries policy makers, planners and managers rely mostly on processed information and not raw data. This is due to the fact that, the primary data is often very detailed and difficult to interpret. However, for the purpose of scientific analysis, raw data is often preferable. Therefore the data is usually stored in a database. A database is a computer program which can store, edit and find data.

A database system is basically a computerized record keeping system. It is a system whose overall purpose is to maintain data or information and to make information available on request. Data are the values physically recorded in the database (raw data) and information is the values that could be understood by user. A collection of database systems refers to a Database Management system Date C.J. (2004). A Database Management System (DMS) is a computer program designed to manage a database and run operations on the data as requested by users. A good DMS allows a high level of flexibility in filtering, aggregating and transforming the data. It also contains data checks to avoid data entry mistakes and to increase the accuracy of the stored data.

The main functionalities of database are:

- Adding new (empty) files to the database.
- inserting new data into existing files.
- Retrieving data from existing files.
- Updating data in existing files.
- Deleting data from existing files.
- removing existing files permanently from the database.

Table 11. Steps to take to obtain reliable and updated information

Steps	Information
Step 1	Who are the main stakeholders in fisheries, what are their management roles and responsibilities, their main objectives for data needs etc
Step 2	Identify the information requirements of each stakeholder to support their roles in fisheries management
Step 3	Identify manpower and other resources for obtaining required data from the collection to analysis.
Step 4	Design a simple sampling procedure for data collection with respect to potential sources, tools and appropriate stratification to meet requirements mentioned in step 2
Step 5	Determine the analysis process
Step 6	Design databases and other systems to support the storage, processing and sharing of data and information
Step 7	Disseminate the information

THE PURPOSE OF A NEW FISHERY DATA COLLECTION SYSTEM

Development and establishment of a robust fisheries information system is essential to Somalia for sustainable management of the fishery sector. An information management system for the fishing vessels, known as "Vessel Registry", has already been developed and is currently up and running and the quality of fishing craft information recorded improving on a daily basis. The proposed fishery database with its role to store fisheries data, when linked to the vessel registry will enable MFMR to generate fisheries statistics for monitoring the fishery resources (initially the coastal/lagoon fleet). Thus the new system will provide information necessary to facilitate decision making for sustainable use of the marine resource. Fisheries management cannot be undertaken efficiently unless the basic data is available. This data consists of total catch, fishing effort, catch per unit effort, size and age structure of the catches and thus will be the essential raw material needed to assess the fish stocks and their behavior to fishing.

Proposed Fishery Data Collection System
Significance and outcomes

The Department of Fisheries and Marine Resources (MFMR) needs to have reliable statistics on fisheries, beginning with accurate catch statistics as the basic information. At present there is, within the Ministry of Fisheries and Marine Resources, a considerable effort extended towards collecting basic data on catches, which does not produce reliable estimates. The MFMR needs to concentrate on analyzing this information to facilitate sustainable use of marine resources both in biological and economical terms.

The fishery data collection system will be based on the methodology that will be introduced in the Coastal Resources Management Plan to improve the fisheries data collection system. MFMR is equipped with the manpower and know-how as well as the technology to manage and maintain such a database. (Figure 4) shows the data collection and database management process.

Resources used

This new and improved fisheries data collection system will be developed, implemented and deployed using Microsoft SQL Server 2016 as the database storage for the sampled data and Microsoft Access 2016 Project and Visual Basic for Application, for data entry, maintenance and overall interaction with the fisheries data collection database.

A stratified sampling procedure will be introduced through enhanced sampling strategy that is ideal and practicable for fisheries in Somalia. A set of improved data collection forms will also be introduced, including FAO specie codes, boat type codes as well as fishery type codes.

Field data collection system of MFMR

Field level data collection on catch and effort of marine fisheries is made by all Fisheries Inspectors (FIs) attached to each coastal district. There will be 41 FIs engaged in data collection from the entire 19 beach landing sites and fishing harbors. These data are used to make monthly estimates of fish production by species and type of fishing craft by district level.

Generally, there will set schedule or a standardized sampling system to be followed by FIs within their administrative area and sampling is done 10 days a month. They make an assessments of production at landing sites they visit and provide monthly estimates of production on standard forms, including information on fish prices and operating fishing crafts. Estimation of production made on the basis of limited number of species or species groups. Apart from the catch data various other types of data; boat registration, fish price etc., are also collected by FIs. The boat registry will be developed based on this information. A new database on vessel registry will be develop by MFMR with the assistance of FAO.

The composition and complexity of Somali fisheries

In Somalia, the marine fisheries are based on multi species, multi gear fishery using 5 types of fishing vessels (Table 7). There were 4,300 fishing boats operated in marine waters in 2016, out of which 5% were multiday boats operating in offshore waters, 25% Day boats with inboard engines, 40% boats with outboard engines, 9 % traditional boats with outboard engines and the remaining 21% were traditional boats operating in coastal waters. Generally there is a wide distribution of fishing vessel type and gear in all 250 coastal districts and Somalia has a total of 65 landing sites along the coast (MFAR 2015).

Frame survey and vessel registry

In 2015 and 2016, the Ministry of Fisheries & Marine Resources (MFMR) conducted a fishing boat census and their results include total landing sites as well as the total number of boat/type by landing site. These findings can be used as the frame on the number of boats by type as this information is currently available from the vessel registry database for coastal fishery. For offshore fishery total number of boats by each regional government can be obtain from the vessel registry but due to the migration of multi-day boats to various landing site the total number of multi-day boats operated/landed, need to be obtained through a monthly frame survey by using form PR1. Due to some migration of boats from coastal to coastal, owing to weather and/or seasons, the total number of boats in coastal fishery need to be obtained through a monthly frame survey by using same form PR1 (Appendix 1 Data forms).

However, Sparre, P.J., (2000), the frame survey should be updated every fishing season or within some other time unit which forms the basis for raising samples to total landings. A full frame survey will be repeated less often, about every five years. The fisheries authorities will coordinate the sampling program with the counting of vessels in each landing site. Thus, a well-managed vessel register is much more useful than a frame survey Sparre, P.J., (2000). Frame surveys will be used as an interim solution until a continuously updated vessel register will be established.

Data collection forms

Fishing effort (number of active boats) and catch per unit effort (catch per boat) are the basic parameters determined from sampling the fishery. These are the parameters required to estimate total fish production as well as parameters required for basic stock assessment models FAO Stamatopoulos (2002).

Standard data forms should be prepared to obtain fish catch data separately for coastal fisheries, and offshore fisheries. Data forms should be made as simple as possible for easy filling and computerization. Codes should be given for craft types, fishing gear and species/species groups. Those codes given for fishing gear and species/species groups (species names identified as in "Marine Fishery and Marine Resources of Somalia Species" are in conformity with international codes (FAO 2 alpha coding).

For each fishery (coastal and offshore), there are two forms that have to be completed on each sampling day. CF1, OF1 are used to record fishing activity or effort. CF2, OF2 are used to record catch data from individual boats. The identity of the sampled boats, the amount of fishing gear used, fishing ground, departure and arrival time and the total catch by species have to be recorded. (Appendix 1, Data forms: CF1, OF1, CF2, and OF2).

There is a separate form (PR1) to monitor the number of samples and landing sites which have been observed by data collectors and also to get information regarding number of fishing days (active fishing days) by boat type during the month in a particular fishing landing center. And also to get the total number of multi-day boats operated/landed (Appendix 1 Data forms).

Data collectors and data entry operators

For this system it is needed to allocate 3-5 Data collectors for each big landing site and 1-2 data collectors for the small landing sites in every coastal district depending on the extensiveness of the coast and the number of landing sites of the district. They need to send the data sheets to MFMR head office through the supervision of FMS-MFMR in the particular regional government administrations. It is needed to allocate 5-6 data entry operators in the MFMR head office to enter the data into the database. Training will be given to both staff together with field familiarity (fish identification and estimating of sampled catch) to minimize the errors in data collecting and entering process.

C**ommunity participation in data collection**

The collection of data requires enough manpower at the source where the data is recorded. The FAO (1997) requested that states should ensure that timely, complete and reliable statistics on catch and fishing efforts are collected and maintained in accordance with applicable international standards and practices and in sufficient detail to allow sound statistical analysis. In developing nations, fishery-dependent monitoring can be extremely useful for generating both biological data and fisheries input (fishing effort) and output (catch). This information is highly needed in fisheries management for decision making. In the absence of fisheries staff (data enumerators) to record the data, fishing community members can be used. A few members of the fishery community could be trained and given mandates to collect fisheries data.

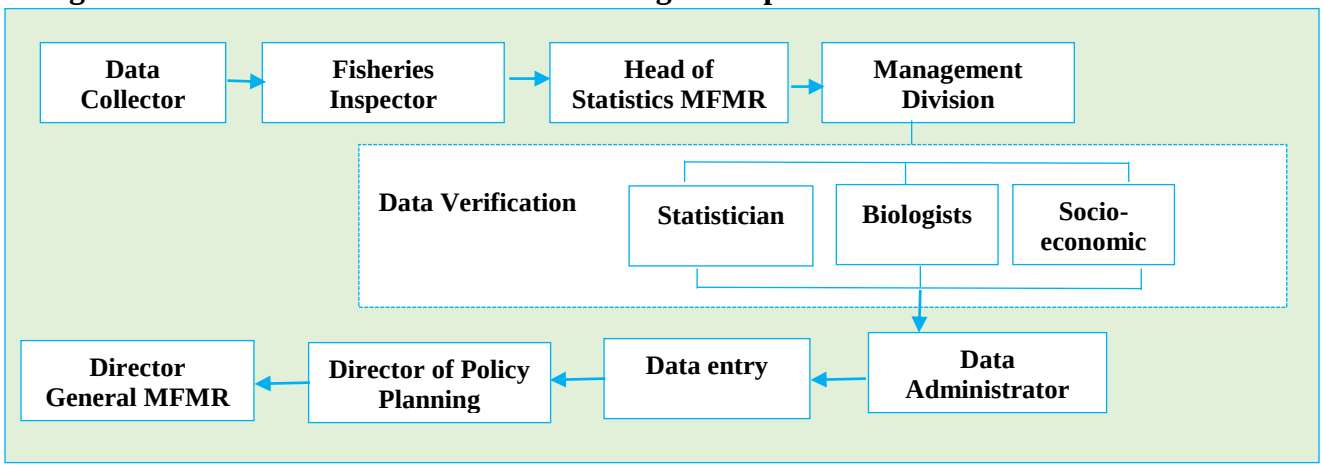
The community members will represent data enumerators at those landing sites where there are no data enumerators to collect data. Though the data gathering by local people may not always be of the highest quality, their involvement can result in gathering large quantities of reasonably reliable data and perhaps more importantly, enhance a feeling of "ownership" among the community members and motivate them to implement conservation measures Richard G., et el (2005). Richard G., et el (2005) argued that it is possible to obtain large quantities of reliable

data relatively inexpensively through the use of local fishermen. This may be seen as the first step in preparing the communities to take up their role in a community–based approach in the management of fish resources.

However, data entry personnel have to spend some time on checking the quality of the data recorded by community members before entering it. Jennifer G., et al., (2006) suggested that the systematic application of effort towards developing sources of information outside the Fisheries Department, especially with cooperation of fishermen and industry, will ensure that the Fisheries Department does not depend exclusively on first-hand collection of information, but they have to check the data before processing, presenting and interoperating the results for government policy-making.

In order for the community to perform a better job in data collection, community members who are responsible for the statistical collection should be motivated. Somas (2003) recommended that when the community participates in any fisheries information collection they should be assisted or receive assistance to compensate the time lost to their daily activities

Figure 3. Data collection and data base management process



PROPOSED DATABASE

Introduction

In order to obtain reliable and updated information, the data must be stored, and made easily available for analysis and interpretation for those who manage and develop the fisheries. Therefore the data must be stored in a database. This proposed data collection system is concerned with an improvement of marine fisheries data collection and management in Somalia. The proposed fishery database system is composed of a relational database for data storage and manipulation and client software for data entry, maintenance and reporting. It is specially designed to manage and reflect the type of Somali fisheries.

Methodology

The proposed fishery database is a Client/Server application, developed using Microsoft SQL Server 2016 (for data storage) and MS Access Project 2016 (for data input/output and processing). Excel workbooks and sheets from the data collection Excel system will be used as the building blocks to define and build the new fisheries statistics database and the data collection input forms will be used as prototypes for the new MS Access client input forms. The client contains all the entry forms, lists and reports available to the users of the system while the actual data is stored on the server.

The database stores the entered data separately for each type of fishery, district, landing site, boat type, gear type right down to sampling day, within year and month. It calculates the catch estimates and prepares the data for various lists and reports available for users at all times. A more detailed information and description of functionality of the database is given in the administration and user manuals.

Structure of the database

The structure of the database mainly consists of tables, views, stored procedures and the basic database objects and properties that are unique to this database. Tables can be further divided into, Code tables containing already defined underlying basic information and their codes like boat type codes, species codes, district codes etc., and Data tables, that contain the data entered based on the collected information as a result of sampling. See the Table 6 for table list, description and code type. A more in depth description of code tables and data tables is given below.

Code tables

Code tables consist of Fishery type, Fishery areas (to identify the common fishery types for species and fishing gear types), Fishing grounds, Boat types, Gear types, Species, Ports (landing sites) and their codes. Through the maintain section in the user client main menu the user (data entry operator/data base administrator) will be able to maintain the code tables (add or delete gear types, landing sites, species, and Data Collectors details etc.).

Data tables

Data tables (data entry) can be described as fishing activity/effort (number of boats at landing site, number of operated boats and number of sampled boats), number of fishing days in the respective month (coastal fishery), data collectors, boat details, fishing gear details and fish catch by species type. A user interface will provide the choice of selecting the type of fishery, fishery district and harbor landing site or anchorage. Through the user client main menu the user (data entry operator) will be able to input the data through data entry forms.

Forms

Although forms are not physically located in the database server, they are part of the database system. Forms can be described as the means by which the user interacts with the database. (E.g. data entry forms). Refer to the User manual for more detailed information and description of the functionality of forms.

Database objects

Database objects in this database are: tables, views, roles, stored procedures, triggers, Indexes, dependencies, foreign keys and relationship diagrams. A more detailed information and description of the database objects is given in the administration manual.

Data management

A data filtering method for listing data by date of recording, district, landing site, anchorage or harbor and based on other useful criteria can be developed. This will assist with data supervision and management.

Table 12: List of Database generated tables

Table name	Description	Table type
tblArea	Table to identify the common fishery types for species and fishing gear types	Code table
tblBoats	Boat types and codes table	Code table
tblCatchWeight	Table to record the catch weight by specie type	Data table
tblDataCollectors	Table to record Data Collectors details	Code table
tblFishery	Fishery type and code table	Code table
tblFishingGrounds	Table to select fishing grounds and codes	Code table
tblGear	Fishing gear and codes table	Code table
tblHeader	Table to record main details regards to sampling day	Data table
tblOperationDays	Table to record boat activity	Data table
tblPorts	Table to select the landing site	Code table
tblPR1	Table to record sampling district year and month	Data table
tblSampleCatchDetails	Table to record Sampled catch details	Data table
tblSampleGearDetails	Table to record boat details on sampling day	Data table
tblSampleMain	Table to record boat details on sampling day	Data table
tblSpecies	Species and codes table	Code table

tblSumTotalCatchMonth	Table to store calculated estimates by month / year	Data table
tblSumTotalCatchBoattype	Table to store calculated estimates by boat type/district	Data table
tblSumCatchMonthSpc	Table to store monthly estimated catch by species or specie group	Data table
tblSumCatchBoattypeSpc	Table to store estimated catch by boat type / species	Data table

Output (reports)

Various reports will be accessible through the user client main menu and any other reports required in ad hoc manner can be created by using tables in the Access client and facilities in MS Excel. The reliable information (reports) can be generated in terms of weight (Kg/tons) and the species composition (including English or scientific names) and these reports can be submitted to the any organization when required. For example reports listing:

- Estimated catch by fishery / district / boat type.
- Estimated catch by district / month.
- Estimated catch by boat type/Species. Estimated monthly catch by species or specie group.
- Boat count by type / district.

A more detailed information and description of the reports is given in the User manual.

Required data for fisheries management

To manage fisheries for the public good, the relevant biological and economic data has to be collected. The decisive biological data relates to the fish stock growth function and its response to the harvesting activity. This involves a relationship such as natural mortality, weight gain by age, recruitment and fishing mortality functions. The economic information relates to the harvesting production function, the harvesting cost function and prices of inputs and outputs.

In addition, the cost of management, data collection and research should be taken into consideration. For proper management of the fishery, economical and biological monitoring should be gathered together. Economic data will give a clear picture of the fishery industry while biological data is useful in estimating specific biological parameters that are useful in fish stock estimation. Together, they both provide a basis for suggesting fisheries management strategies.

Table 13. Basic data requirements for proper fisheries management.

Biological	Landings by species per fishing fleet and even per gear, length, weight, maturity, sex and age of each individual fish, natural and fishing mortality per species and intrinsic growth rate biomass
Ecological	Impact of fishing gear on physical habitat, changes of physical habitat brought by non-fishing activities, indicator species and biological carrying capacity of the environment
Economical	Number of operating vessels in the fishery, fixed cost per fishing unit, variable cost per fishing unit (cost of manpower, cost of fuel, cost of labour, depreciation

	cost), revenue (income per fishing unit), profitability of each fleet, financial discount rate, destination of landings, dependence on fishery of other sectors of the community (processors, wholesalers etc), infrastructure cost and enforcement cost.
Social	Number of fishers employed within the fishery, number of people employed in shore based activities – by gender, by age group etc, and dependence of fishers and shore based workers on the fisheries for their livelihood

IMPROVED SYSTEM, COSTS AND BENEFITS

Cost of good data collection Implementation of the improved system for data collection, analysis and management requires financial cost. These costs can be categorized into two main categories: investment costs (Table 10) and running costs (Table 11). The criteria used to estimate these costs are based on the current market price and civil service policy of the country. The running cost estimation was done for one year. However, the implementation of the system is not an end program because data collection and management is a continuous process.

Investment costs

This is the cost which will be incurred during the introduction of the new system to marine districts. The introduction of the system requires transport facilities to go to districts and verify the existence and capacity of the landing sites. It will involve a lot of communication between the Fisheries Division and district authorities. This will be the preparatory phase of the system. Also, awareness creation to village environmental committees and district personnel must be conducted in this phase. The district personnel and village leaders have to understand why the system has been changed and for what purpose. Then data entry personnel, data enumerators and community members who will be selected to record data will be trained. The training will include a theory and practical stage. Fisheries experts responsible for the database should go around the district to install the completed database. After the training, data will be collected and entered in the computer.

Table 14. Investment cost for the improved system of data collection, analysis and management

Activity	**Time scale**	**Responsibility**	**Cost in USD**
Introduction of the system	2 months	Fisheries Planning and Statistics (FPS)	10,000
Consultation to Regional Authority Offices	2 months	Fisheries Planning and Statistics (FPS)	15,000
Awareness creation	1 months	FPS, Regional government authority	25,000
Training (theory and practical)	2 months	FPS, Regional government authority	40,000
New hardware	1 months	FPS, RGA	50,000
Database installation to the district	2 months	FPS	15,000
Sub total	**6 months**	**FPS, RGA**	**155,000**

Annual Running costs

The running costs of the improved system will include the salary for the personnel who will be responsible for data collection and data entry. It will also include the cost of printing data collection forms and the contract for maintenance of the computers. Monitoring and evaluation will be done by Fisheries Division staff to make sure that data is recorded and entered in the required manner. The district authorities will also be required to take part in monitoring.

Table 15. Running cost for the improved system of data collection, analysis and management per year

Activity	Time scale	Responsibility	Cost in USD
Salary for data collectors and data entry personnel	1 year	FPS, RGA	**120,000**
Computer contract for maintenance	1 year	FPS	**10,000**
Printing of data collection form	1 year	FPS	**12,000**
Monitoring and evaluation	1 year	FPS, RGA	**25,000**
Sub total	**1 year**	**FPS, RGA**	**167,000**

Potential gains through better data collection

As outlined in Tables 14 and 15 above, the total cost of establishing an improved data collection system is about 322,000 USD. The estimated cost here does not cover physical facilities like office space etc. The current value of Somali domestic fisheries was estimated US$135 million each year Table 18). Thus, the total revenue for marine artisanal fishery based on available data is represented in according to provisional data for 2005–2009, an average of 40,833mt of fish were landed each year by the small-scale fleet: 32,310mt from the artisanal sector and 8,523mt from the subsistence sector.

The estimation that the annual landed value for the artisanal and subsistence sectors was between US$23.8 and US$104.2 million (average US$58.3 million. To this, the artisanal sector contributed between US$20.4 and US$84.5 million annually and the subsistence sector contributed between US$3.4 and US$19.7 million (Appendix Table 19). To manage the fishery in a sustainable manner, fisheries data is needed. If the data collection effort described in this paper contributes to this objective, the amount of 322,000 USD per year appears to be a very good investment.

Table 16. Economic value of Somali fisheries. Industrial catches are primarily landed outside Somalia and therefore value does not enter the Somali economy

Fleet Average	Average landed value (US$)	Value chain Multiplier	Total value to Somali economy
Artisanal	$48,500,000	2.59	$125,500,000
Subsistence	$9,900,000	1.00	$9,900,000
Industrial	$20,500,000	Not applicable	None
Total	**$78,900,000**	**-**	**$135,400,000**

Source: Glazer, et al. (2015)

DISCUSSIONS AND CONCLUSION

This study evaluates the trends and potential developments of fisheries data collection in Somalia. The development of an improved data collection system has to satisfactorily meet the reliable data/information requirements for sound fisheries management in Somalia. The accessibility of accurate and reliable output can be achieved only if the whole system is operational.

Data collectors play the key role in the implementation of the collected raw data. Therefore it is important to emphasize the requirements of training for the data collecting staff (fish identification and estimating of sampled catch) as well as data entry staff.

It is recommended to improve system, which is based on sampling and community participation in data collection, appears possible to create more benefits than costs. It also reduces the workload of data enumerators and data entry personnel. As the number of sampling days has made only ten days per month, data enumerators will have more time for other activities for the remaining twenty days.

The output data is going to be used in the management of the fishery. If the exact catch trends, sustainable revenue, yield per recruitment of a commercial important species and cost of the fishery are known policy makers will be able to infer the appropriate fisheries policy and consequently devise management measures to be used for the artisanal fisheries in Somalia.

Concerning data management, Ministry of Fisheries and Marine Resources should make sure that MS SQL Server 2016 database is working properly to enable the Fisheries Planning and Statistics to analyze the data. To maintain and develop the database and to support the long term data management system in Somalia there is a need for a long term commitment from IOTC and FAO.

New database developed with the technical assistance of IOTC is quite comprehensive; data are entered, edited, and compiled to fulfill various domestic and international reporting obligations. Ensuring staff know how to use the database; this comes down to documentation and training. It is better that IOTC and FAO could work with the staff of MFMR and regional governments to create the documentation and training and that will be useful of handling the database.

Capacity building should be considered not only for the routine operation of the system but also for modification of the system as the need arises. The two sides should collaborate to establish a new database to have clear information in all fisheries statistics in Somalia. An overall database could be established to input all fisheries statistics data such as frame surveys, catch assessment surveys and export fishery data.

Further studies are needed to test the accuracy of the sampling strategy, estimation method and the database management system. Finally, it is also recommend to include a later stage the biological information such as length and stratification by gear.

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Appendix 1

Table 17. Reconstructed Somalia catches 1950-2010

Year/ tons	FAO landings	Total reconstructed catch (UBC)	Industrial	Artisanal	Subsistence	Discards
1950	6,000	18,300	1,480	9,900	6,600	272
1960	4,500	18,000	1,110	10,600	6,050	195
1970	5,600	19,900	1,380	12,200	5,870	494
1980	14,330	29,900	9,760	12,650	5,180	2,285
1990	22,295	28,900	10,880	10,970	3,890	3,178
1995	23,851	27,800	15,690	6,180	1,980	3,900
2000	23,950	42,200	11,690	18,800	5,660	6,009
2005	24,800	61,800	12,100	32,000	8,790	8,947
2010	29,800	64,900	14,540	32,730	8,120	9,530

Source: The Sea Around Us/ UBC, 2010.

Table 18. Estimated potential of Somali EEZ fisheries ('000 tons)

Large Marine Ecosystem				**Somali EEZ**			
Somali Current (SC)	**Arabian Sea (AS)**		**Weighted SC**	**Weighted AS**	**Total Somali**	**Somali catch**	**Potential**
Piscivores	215	323	119	17	136	139	-3
Planktivores	542	646	301	34	335	26	309
Benthivores	597	633	331	33	364	28	336
Total			751	84	835	193	642

Source: Glazer et al. 2015.

Appendix 2

Table 19. Range of prices for fish products caught by Somali domestic sectors, and the estimated value (first point of sale) of those products based on landed weight

Sector	Fish Grouping	Catch (kg)	Low Price (US$/kg)	High Price (US$/kg)	Avg. Price (US$/kg)	1st Point of Sale - Low	1st Point of Sale - High	1st POS - Average
Industrial	All Emperors	3,925,269	$0.50	$2.30	$1.35	$1,962,634	$9,028,118	$5,310,658
	All Groupers	1,796,778	$0.25	$2.50	$1.22	$449,194	$4,491,945	$2,194,636
	All Snappers	1,409,780	$0.20	$2.50	$0.86	$281,956	$3,524,449	$1,214,579
	Indian Goatfish	1,299,209	$0.30	$2.30	$1.08	$389,763	$2,988,180	$1,401,289
	Painted Sweetlips	2,626,060	$0.40	$2.30	$1.04	$1,050,424	$6,039,938	$2,721,553
	All Mackerel	110,571	$1.00	$5.00	$1.93	$110,571	$552,855	$213,450
	All Clupeids	373,177	$0.20	$2.30	$0.70	$74,635	$858,307	$261,224
	All Billfish	207,321	$0.40	$2.00	$1.20	$82,928	$414,641	$248,785
	Yellowfin Tuna	1,064,245	$0.80	$4.00	$2.40	$851,396	$4,256,982	$2,554,189
	All other Tuna	815,461	$0.40	$3.00	$1.44	$326,184	$2,446,382	$1,174,868
	Misc. Scads	41,464	$0.15	$2.30	$0.84	$6,220	$95,367	$34,926
	Misc. Marine Fish	152,035	$0.98	$0.98	$0.98	$149,564	$149,564	$149,564
	Spiny Lobsters	234,260	$5.00	$20.57	$12.92	$1,171,302	$4,819,073	$3,026,701
Subsistence	All Emperors	3,422,961	$0.50	$2.30	$1.35	$1,711,480	$7,872,810	$4,631,065
	All Groupers	855,740	$0.25	$2.50	$1.22	$213,935	$2,139,351	$1,045,226
	All Snappers	513,444	$0.20	$2.50	$0.86	$102,689	$1,283,610	$442,352
	Misc. Goatfish	427,870	$0.30	$2.30	$1.08	$128,361	$984,101	$461,488
	All Clupeids	855,740	$0.20	$2.30	$0.70	$171,148	$1,968,203	$599,018
	Misc. Tunas	840,181	$0.40	$3.00	$1.44	$336,073	$2,520,544	$1,210,483
	All Jacks & Scads	855,740	$0.15	$2.30	$0.84	$128,361	$1,968,203	$720,797
	Misc. Marine fish	630,136	$0.98	$0.98	$0.98	$619,896	$619,896	$619,896
	Misc. Cuttlefish	121,667	$0.25	$3.00	$1.06	$30,417	$365,000	$128,779
Artisanal	All Emperors	3,636,117	$0.50	$2.30	$1.35	$1,818,058	$8,363,068	$4,919,452
	All Groupers	909,029	$0.25	$2.50	$1.22	$227,257	$2,272,573	$1,110,314
	All Snappers	909,029	$0.20	$2.50	$0.86	$181,806	$2,272,573	$783,164
	Misc. Goatfish	454,515	$0.30	$2.30	$1.08	$136,354	$1,045,384	$490,226
	Common Dolphinfish	909,029	$0.98	$0.98	$0.98	$890,849	$890,849	$890,849
	All Mackerel	1,818,058	$1.00	$5.00	$1.93	$1,818,058	$9,090,291	$3,509,643
	All Clupeids	909,029	$0.20	$2.30	$0.70	$181,806	$2,090,767	$636,320
	All Billfish	909,029	$0.40	$2.00	$1.20	$363,612	$1,818,058	$1,090,835
	Yellowfin Tuna	2,727,087	$0.80	$4.00	$2.40	$2,181,670	$10,908,350	$6,545,010
	All other Tuna	2,727,087	$0.40	$3.00	$1.44	$1,090,835	$8,181,262	$3,929,026
	All Jacks & Scads	909,029	$0.15	$2.30	$0.84	$136,354	$2,090,767	$765,682
	All Rays and Mantas	3,470,984	$1.50	$1.50	$1.50	$5,206,476	$5,206,476	$5,206,476
	Shark fins (black)	36,663	$51.00	$55.60	$53.66	$1,869,801	$2,038,449	$1,967,219
	Shark fins (white)	4,999	$87.00	$100.00	$91.43	$434,954	$499,947	$457,094
	Sharks (meat)	8,165,796	$0.20	$2.50	$1.42	$1,633,159	$20,414,490	$11,603,282
	Misc. Marine Fish	905,210	$0.98	$0.98	$0.98	$890,501	$890,501	$890,501
	All Cuttlefish	458,333	$0.25	$3.00	$1.06	$114,583	$1,375,000	$485,128
	Spiny Lobsters	245,740	$5.00	$20.57	$12.92	$1,228,698	$5,055,213	$3,175,013

Source: Glazer et al. 2015

Appendix 3 - Data forms
Appendix 4 - Fisheries Database – Administration manual
Appendix 5 - Fisheries Database – User manual
Appendix 6 - Guide lines for data collectors