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DEVELOPMENT OF CENTRAL DATABASE FOR MARINE FISHERIES IN SRI LANKA

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ABSTRACT

Fisheries management cannot be undertaken efficiently unless the basic data is available. It is essential for the management agency that the most appropriate and accurate information for management of the fishery is continuously collected, processed and provided in a timely approach. Development and establishment of a robust fisheries information system is essential to Sri Lanka for sustainable management of the fishery sector. This study was carried out to implement improved fisheries data collection sampling system that is feasible for fisheries in Sri Lanka 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.

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TABLE OF CONTENTS

ABBREVIATION

CPUE	Catch per Unit Effort
CRMP	Coastal Resource Management Project
DFAR	Department of Fisheries & Aquatic Resources
EEZ	Exclusive Economic Zone
FAO	Food and Agriculture Organization of the United Nations
FRP	Fibre Reinforced Plastic
FWCR	Fishing without craft
ICEIDA	Icelandic International Development Agency
IDAY	Day boat with inboard engine
IMUL	Off-shore multi-day boat
IMULL	Off-shore multi-day boat (> 40ft)
IMULS	Off-shore multi-day boat (< 40ft)
MFAR	Ministry of Fisheries & Aquatic Resources
MTRB	Mechanised traditional craft
NBSB	Beach seine craft (Non-mechanized)
NTRB	Non-mechanized traditional craft
OFRP	FRP boat with outboard engine

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

1.1 Fisheries in Sri Lanka

Sri Lanka is an island state in the Indian Ocean, located southeast of the Indian sub-continent between latitudes 6-10°N and longitudes 80-82°E. The island is approximately 66,000 km^2 in area with an 1817 km long coastline. Sri Lanka claims sovereign rights over 517,000 km^2 of Exclusive Economic Zone (EEZ) of the Indian Ocean (Figure 1).

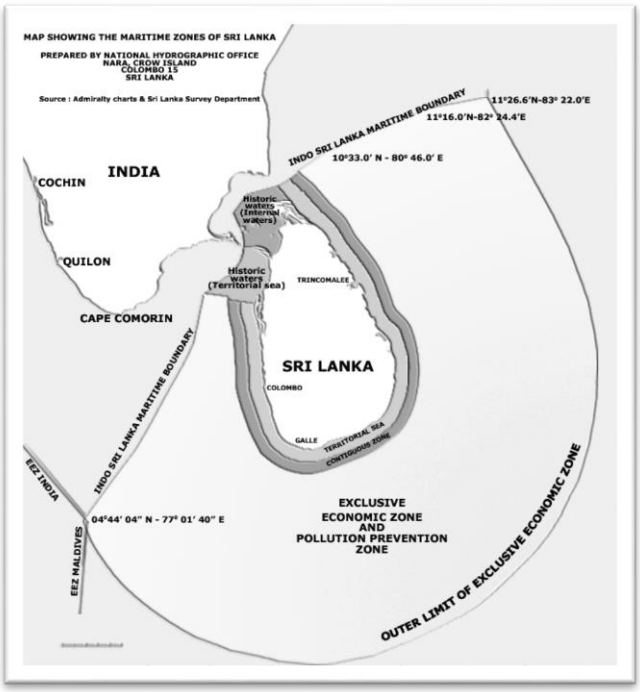


Figure 1: Sri Lanka Exclusive Economic Zone.

The fisheries sector plays a key role in Sri Lanka's social and economic life. Fish products provide over 65 percent of the animal protein for the population and the sector contributes approximately 1.2 percent to GDP (MFAR 2008).

Fisheries in Sri Lanka can be broadly categorized into marine and inland (fresh water) fisheries. The marine fisheries can be further divided into offshore (conducted by multi-day boats beyond the continental shelf), coastal (confined to waters of the relatively narrow continental shelf, operated by traditional vessels and vessels with outboard engines and inboard engines) and lagoon/brackish water (taking place in lagoons/estuaries by traditional vessels). The coastal fishing depends on monsoon climate patterns and fishers are used to migrating between the coastal to lagoon as seasons change within the same district. Except for a small number of large commercial operators with modern facilities, the fisheries sector in Sri Lanka comprises mostly small-scale operators (USAID 2008). Fisheries in Sri Lanka 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 offshore fisheries by introducing 80 9.8 meter long boats to conduct multi-day fishing operations in offshore waters. 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

gear made of synthetic material (Wijayaratne 2001, D.Bruin *et al.* 1995). Since then, offshore fishing has developed rapidly and this caused a substantial increase in marine fish production in Sri Lanka (Maldeniya and Amarasooriya 1998, Samaraweera and Amarasiri 2004).

The marine fish production increased from 167,000 t in 1980 to 275,000 t in 2008. Number of fishers increased from 58,298 in 1972 to 17,1470 in 2008 and number of fishing households increased from 43,269 in 1972 to 146,940 in 2008. The total number of boats increased from 27,675 in 1990 to 41,733 in 2008 (MFAR 2008). Boats are categorized into six types accordingly to the Fisheries & Aquatic Resources Act No 2 of 1996 (Table 1). In 2008 there were 2,809 multi day boats (IMUL) in the offshore fishery. The coastal fishing fleet was made up of about 1940 in-board engine day boats (IDAY), 15,847 Out-board engine powered 6-7m FRP boats (OFRP), 2,959 motorized traditional crafts (MTRB) and 17,042 non-motorized traditional crafts (NTRB) including about 1,136 beach seine crafts (NBSB). The traditional crafts consist of dug-out canoes with or without outriggers and log rafts or *Teppams*. The beach seine fishery is conducted using large dug-out beach seine canoes which are exclusively used for this fishery. Some fishers engage in fishing without a craft in sallow coastal areas and lagoons (FWCR).

Table 1: Boat types involved in the Sri Lankan fisheries.

Description	Code	Fishery
Off-shore multi-day boat	IMUL	Off-shore
Day boat with inboard engine	IDAY	Coastal & Lagoon
FRP boat with outboard engine	OFRP	Coastal & Lagoon
Traditional boat with outboard engine	MTRB	Coastal & Lagoon
Beach seine boat (non motorized)	NBSB	Coastal
Traditional boat (non motorized)	NTRB	Coastal & Lagoon
Fishing without craft	FWCR	Coastal & Lagoon

Sri Lankan 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 and brackish water fisheries but not as much in offshore fisheries. 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. Longlines for tuna and sharks and troll lines are also used in offshore fisheries. Beside gillnets a number of other important gears includ troll lines, pole and line, ring nets, trammel nets, bottom long lines, bottom set gillnets, bottom trawls, beach seines and hand lines are used in coastal fisheries to catch both pelagic as well as demersal fish stocks. Brackish water fisheries in lagoons also use a wide variety of fishing gear including gillnets, bottom set nets, trammel nets, lagoon seines, drag nets, cast nets, scoop nets and fish traps.

All the types of fishing boats are used to operate more than one type of fishing gear. For example, an offshore multi-day boat 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. Fishermen in coastal fishing boats often change the gear according to seasons or availability of fish during the same season. For example, an OFRP boat may use gillnets targeting sardines during one week and may suddenly change over to using a different set of gillnets targeting anchovy. Therefore, the fishing

gear used in a large number of boats varies at different times. Fish landing sites can be classified into three main types (Table 2):

- Major fishery harbours (use to land Off-shore multi-day boats and Day boats).
- Anchorages (use to land all types of coastal fishery boats).
- Minor landing sites (Thotupola) or beach seine sites (use to land all types of coastal and lagoon fishery boats, except Day boat with inboard engine).

Table 2: Fish Landing Sites by Fisheries District - 2008 (Sources: Statistics Unit - Ministry of Fisheries and Aquatic Resources).

Fisheries District	Harbours	Anchorages	Thotupala	Total
Puttalam	1	4	61	66
Chilaw	-	1	59	60
Negombo	-	2	110	112
Colombo	2	-	24	26
Kalutara	1	-	37	38
Galle	2	2	90	94
Matara	2	4	23	29
Tangalle	3	2	39	44
Kalmunai	-	-	121	121
Batticaloa	1	-	187	188
Trincomalee	1	-	81	82
Kilinochchi**	-	-	17	17
Mullaitivu**	-	-	26	26
Jaffna**	-	-	128	128
Mannar	-	-	50	50
Total Ports	**13**	**15**	**1,053**	**1,081**

** Fish landing sites for the districts in Northern Province have been estimated

Lack of proper harbour facilities at some locations, longer time taken for landings, difficulty in separating catch by gear etc. were some of the issues identified in relation to the sampling of the offshore fishery. Some boats do not land all the catch in one day. Landings are spread over 2-3 days as boat owners seek maximum profits. Very often, the catch is immediately disposed (auctioned or transported) after landing. Compared to harbours and anchorages, minor landing centres accommodating FRP crafts and traditional crafts show greater heterogeneity in terms of crafts and fisheries. Some landing centres have only one type of craft (e.g. FRP crafts, orus, beach seine craft) while others have a mix of craft types. Similarly, while crafts in some landing sites are engaged in one fishery (e.g. beach seine fishery), similar type of crafts at two other landing centres may be engaged in different fisheries (e.g. FRP boats engaged in gillnet fishery and hand line fishery) (Joseph *et al.* 2005).

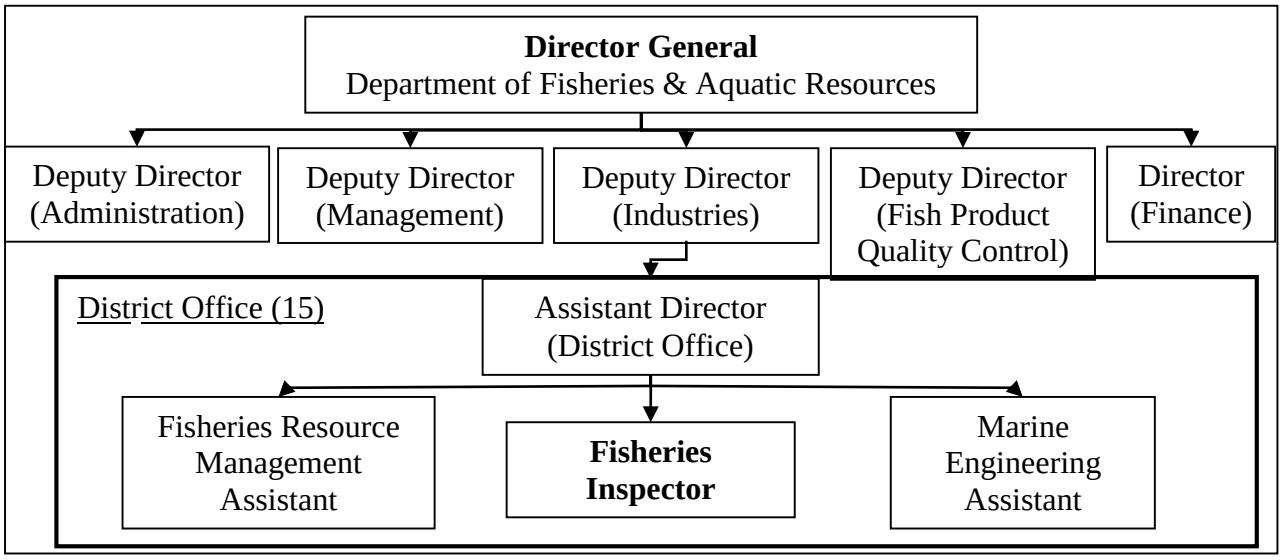
The December 2004, tsunami had a devastating impact on Sri Lanka's fisheries sector and post tsunami aid has been a major contributor to the rapid development of the sector during the past few years. Numerous governments, NGOs (local and international) and other projects have helped rehabilitate the sector during this period. However, the excessive amounts of uncoordinated assistance during the post-tsunami period appears to have resulted in an oversupply of boats (Table 3), which may have exacerbated the over-exploitation of coastal fisheries (USAID 2008).

Table 3: Fishing boats (Sources: Statistics Unit - Ministry of Fisheries and Aquatic Resources).

Year	Boat type						
	IMUL	IDAY	OFRP	MTRB	NTRB	NBSB	Total Boats
2004 (Pre Tsunami)	1,581	1,493	11,559	674	15,260	1,052	31,619
2007	2,460	1,060	5,200	1,680	16,640	1,008	38,048
2008	2,809	1,940	15,847	2,959	7,042	1,136	41,733

Ministry of Fisheries and Aquatic Resources (MFAR) is the line ministry in the central government in-charge of the development and management of fisheries and aquatic resources in the country. Ministry mainly involves with policy and project formulation, control of budget and planning and monitoring of the fisheries sector activities. Two departments, Department of Fisheries and Aquatic Resources (DFAR) and Coast Conservation Department (CCD), five statutory bodies and one state owned company are positioned under the ministry. Department of Fisheries & Aquatic Resources (DFAR) is mandated to implement the Fisheries & Aquatic Resources Act No 2 of 1996. For the easy implementation of its functions, DFAR administration has been decentralized to 15 Coastal Fisheries Districts (Figure 3) and each district is divided into number of fisheries inspectors (FI) division. An Assistant Director heads each district fisheries office (Figure 2). There are Fisheries Inspectors, Fisheries Resource Management Assistants and a Marine Engineering Assistant attached to each district office.

Figure 2: Organization Structure of the Ministry of Fisheries and Aquatic Resources (MFAR), Sri Lanka.



1.2 Objective of the study

The main objective of the current study was to implement improved fisheries data collection system that is feasible for fisheries in Sri Lanka along with an improved fisheries database and database management system.

1.3 Fisheries data collection in Sri Lanka

1.3.1 Derivation

Fisheries statistical collection in Sri Lanka began about 40 years ago, using a team of trained Statistical Collectors, adopting the two-stage stratified sampling technique. Catch data were collected from a fixed number of 10 boats using 13 different sampling forms (Bernacsek G and Joseph 2002).

In 1978, the carder of Statistical Collectors was abolished and all Fisheries Inspectors in a district were required to collect fisheries statistics. Saddled with many functions within their respective Fisheries Inspector division including enforcement of regulations, welfare work, etc., collection of fisheries statistics became a low priority activity of the FIs. The responsibility of processing and coordination of fisheries statistics has been taken by Planning Division of the Ministry of Fisheries.

In 1991, the responsibility was transferred to the Department of Fisheries but the data collection process remained among the Fisheries Inspectors. In early 1990s the statistical officer who has been appointed by the Department of Census Statistics to the Department of Fisheries, simplified and reduced the whole fisheries data collection system. In 1998 only the responsibility was shifted back to the Planning and Monitoring Division in the Ministry of Fisheries.

1.3.2 Current status

A large number of individuals, agencies and government departments collect or generate marine fisheries related data. The nature of the data collected, scope and details as well as level of analysis and usage depends on the objective of the collection along with various other constraints (Benediktsdottir and Tomasson 2006).

Lack of reliable data/information has been recognized as one of the major constraints in sustainable fisheries development/management in Sri Lanka. Several attempts have been made to study specific fisheries, particularly marine fisheries. Recent improvement of current fishery data collection system was suggested by Coastal Resources Management Project (CRMP) and funded by Asian Development Bank in 2002-2005. The objectives of the project were to develop and implement a new data collection system. Many consider the system developed under CRMP to be the ideal base unit for the improvements (Benediktsdottir and Tomasson 2006). As such, transfer of this system (which runs in Excel) into MS Access in a MS SQL Server would allow any statistical system developed under the CRMP format. This CRMP data collection system at DFAR has already been tried out for 2 years (2004-2005) but it never became fully operational due to project closure in 2005 with the tsunami disaster.

1.3.3 Structure of the existing data collection programme

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 Sri Lanka. It receives fisheries data reports from various sources, and engaged in collection of some limited raw data. These data are used to make monthly estimates of fish production by species or species groups and by the number of various types of fishing crafts for each division and district. At present, collection of fisheries statistics by Department of Fisheries and Aquatic Resources (DFAR) is relatively simple, aimed primarily at estimating total fish production. All field Fisheries Inspectors attached to the District Fisheries Offices along

the coast generally work one day per week, collect catch and effort data from beach landing sites and fishing harbours. These data cannot be used for regular stock assessment or management of fisheries, which is a primary requirement of DFAR (Joseph *et.al.*, 2005). This work is carried out by Fisheries Inspectors under the overall supervision of the statistical Unit in the Ministry Of Fisheries and Aquatic Resources, but there is no description or written guidelines available for the implementation of the system (Benediktsdottir and Tomasson 2006).

1.4 Existing vessel registry Database

Under the Fisheries and Aquatic Resources Act No 2 of 1996 the DFAR should keep track of the total fishing fleet. Prior to 2007 the vessel 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 (Benediktsdottir and Tomasson 2006). Therefore the vessel Registry has been introduced at DFAR with the financial and technical support of Icelandic International Development Agency (ICEIDA). Vessel registry database is the end product of the computerization of fishing boat registrations and their operation licenses. This was established in October 2007 and has been modified and expanded in several stages in line with the newly introduced boat registration and operation licensing procedure. Reliable data on fishing vessels were not available prior to the vessel registry. One of the roles of the vessel registry database is to provide information for various reports needed by the DFAR, Ministry of Fisheries and Aquatic Resources and other agencies, especially the Sri Lanka Navy.

The fishing vessel registry database contains comprehensive data/information on fishing vessels, fishing gear and target species 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 DFAR 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 district) for the new fishery database (initially for coastal and lagoon fisheries).

The Vessel Registry database is a Microsoft SQL Server 2005 database and the user interface is a MS Access Project 2007 application. The District offices are equipped with an application with limited functionalities, which is a MS Access 2007 based database system. Programming language used is Visual Basic for Applications together with macros and SQL (standalone queries as well as stored procedures). In order to carry out data processing SQL is used together with visual basic, macros and facilities in MS Excel. The database has several standard reports and the staff using SQL and facilities in MS Excel creates any other reports required in ad hoc manner.

2 OVERVIEW OF DATA COLLECTION AND DATABASE MANAGEMENT

2.1 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).

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.

2.2 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 obvious that observing 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 (Cochran 1977). Additionally when samples are selected with an adequate criterion, it is possible to measure the precision of the conclusions or inferences about that population (FAO 2005).

According to Lohr (1999), the definitions of the most important terms used in sampling can be listed as follows.

Sample: A subset of 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.

2.2.1 Simple random sampling

Simple random sampling is the most basic form of probability sampling and provides the theoretical basis for the more complicated forms (Lohr 1999). 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).

2.2.2 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" when the landing places are categorised, 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 (province 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 (Lohr 1999). 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 categorised 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.

2.2.3 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.

2.2.4 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 4).

Table 4: 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 4).

2.3 Database management

A database system is basically a computerised 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 1987). 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.

3 THE PURPOSE OF A NEW FISHERY DATA COLLECTION SYSTEM

Development and establishment of a robust fisheries information system is essential to Sri Lanka 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 DFAR 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 behaviour to fishing.

4 PROPOSED FISHERY DATA COLLECTION SYSTEM

4.1 Significance and outcomes

The Department of Fisheries & Aquatic Resources (DFAR) 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 Aquatic Resources, a considerable effort extended towards collecting basic data on catches, which does not produce reliable estimates. The DFAR needs to concentrate on analysing this information to facilitate sustainable use of marine resources both in biological and economical terms.

The new fishery data collection system will be based on the same methodology as the recently improved fishery data collection system of the Coastal Resources Management Project (CRMP) already mentioned in section 1.3.2. DFAR 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.

4.2 Resources used

This new and improved fisheries data collection system will be developed, implemented and deployed using Microsoft SQL Server 2005 as the database storage for the sampled data and Microsoft Access 2007 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 Sri Lanka. A set of improved data collection forms will also be introduced, including FAO specie codes, boat type codes as well as fishery type codes.

4.3 Data collection procedure

Data collection procedure must be adapted to the situation. As same appropriate stratification meet target for accuracy and precision and take into consideration financial and other constraints (FAO 2000).

4.3.1 The composition and complexity of Sri Lanka fisheries

In Sri Lanka, the marine fisheries are based on multi species, multi gear fishery using 6 types of fishing vessels (Table 1) and some even engage in fishing without a craft. There were 41,733 fishing boats operated in marine waters in 2008, out of which 7% were multiday boats operating in offshore waters, 5% Day boats with inboard engines, 38% boats with outboard engines, 7% traditional boats with outboard engines and the remaining 43% were traditional boats operating

in coastal waters. Generally there is a wide distribution of fishing vessel type and gear in all 15 coastal districts and Sri Lanka has a total of 1,081 landing sites including 13 fishery harbours, 15 anchorages and 1,053 minor landing sites along the coast (MFAR 2008).

4.3.2 Frame survey and vessel registry

In 2006 Ministry of Fisheries & Aquatic Resources (MFAR) 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 and up to date statistics on the number of boats by type as this information is currently available from the vessel registry database for coastal and lagoon fishery. For offshore fishery total number of boats by district can be obtain from the vessel registry but due to the migration of multi-day boats to various ports 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 lagoon, owing to weather and/or seasons, the total no of boats in lagoon fishery need to be obtained through a monthly frame survey by using same form PR1 (Appendix 1 Data forms).

4.3.3 Sampling strategy

In small-scale fishery like in Sri Lanka, 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 2006) and also from the Vessel Registry database.

Geographical stratification or stratification by area is on the basis of the coastal administrative districts (Figure 3). District based fisheries data becomes important for district 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 as:

- Offshore fishery, which is conducted by multi-day boats.
- Coastal fishery, which is confined to waters of the relatively narrow continental shelf, operated by traditional vessels and vessels with outboard engines and inboard engines.
- Brackish water fishery, which takes place in lagoons/estuaries by traditional vessels and vessels with outboard engines or fishing without a vessel.

Stratification by landing sites

All major harbours 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 strata, Major harbours, Anchorages and Minor landing sites (Thotupola) or beach seine 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 (e.g. beach seine operations) are not in operation during the season.

Stratification by craft type

Vessels can be classified as follows and table 5 shows the vessel numbers by types in the 15 fisheries districts:

- Fishing without craft **(FWCR).**
- Traditional non-motorized crafts **(NTRB).**
- Traditional motorized crafts (traditional crafts powered by outboard engines) **(MTRB).**
- Beach seine crafts **(NBSB).**
- Fibreglass crafts (6-7m powered by outboard engines) **(OFRP).**
- Day boats (powered by inboard engines) **(IDAY).**
- Multi-day boats **(IMUL)** are further subdivided in to two categories large (> 40ft) **(IMULL)** and small (< 40ft) **(IMULS)** depending on the fishing capacity/effort**.**

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 5). Same 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 Assistant Director of Fisheries of the relevant district.

Table 5: Fishing Boats by District – 2008 (Sources: Statistics Unit - Ministry of Fisheries and Aquatic Resources).

District	IMUl	IDAY	OFRP	MTRB	NTRB	NBSB	Total Boats
Puttalam	108	40	2,503	174	1,209	150	**4,184**
Chilaw	111	253	1,873	394	1,226	59	**3,916**
Negombo	248	122	1,795	449	1,855	31	**4,500**
Colombo	18	28	238	-	246	20	**550**
Kalutara	250	17	330	-	244	22	**863**
Galle	236	44	639	216	374	56	**1,565**
Matàra	509	105	795	276	377	6	**2,068**
Tangalla	326	31	880	165	790	71	**2,263**
Kalmunai	13	453	1,138	258	1,042	121	**3,025**
Batticaloa	308	324	1,274	-	3,678	171	**5,755**
Trincomalee	680	14	1,891	528	2,202	157	**5,472**
Mullaithivu	-	-	200	80	240	10	**530**
Kilinochchi	-	-	266	70	202	20	**558**
Jaffna	-	-	436	153	2,888	208	**3,685**
Mannar	2	509	1,589	196	469	34	**2,799**
Total 2008	**2,809**	**1,940**	**15,847**	**2,959**	**17,042**	**1,136**	**41,733**

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, analysing the fishing gear details in the database.

In each month, the selection of the 14 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 14 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.

4.3.4 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 (Joseph *et al.* 2005).

Standard data forms should be prepared to obtain fish catch data separately for costal fisheries, offshore fisheries and lagoons. 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 Resources of Sri Lanka Species" (FAO 1994) are in conformity with international codes (FAO 3 alpha coding).

For each fishery (coastal, offshore and brackish water), there are two forms that have to be completed on each sampling day. CF1, OF1 and BW1 are used to record fishing activity or effort. CF2, OF2 and BW2 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, BW1, CF2, OF2 and BW2).

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 district. And also to get the total number of multi-day boats operated/landed and number of boats operated in lagoons in each district. (Appendix 1 Data forms).

4.3.5 Data collectors and data entry operators

For this system it is needed to allocate 1-2 Data Collectors for each 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 DFAR head office through the supervision of AD in the particular district. It is needed to allocate 5-6 data entry operators in the DFAR head office to enter the data in to the database. Training should 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.

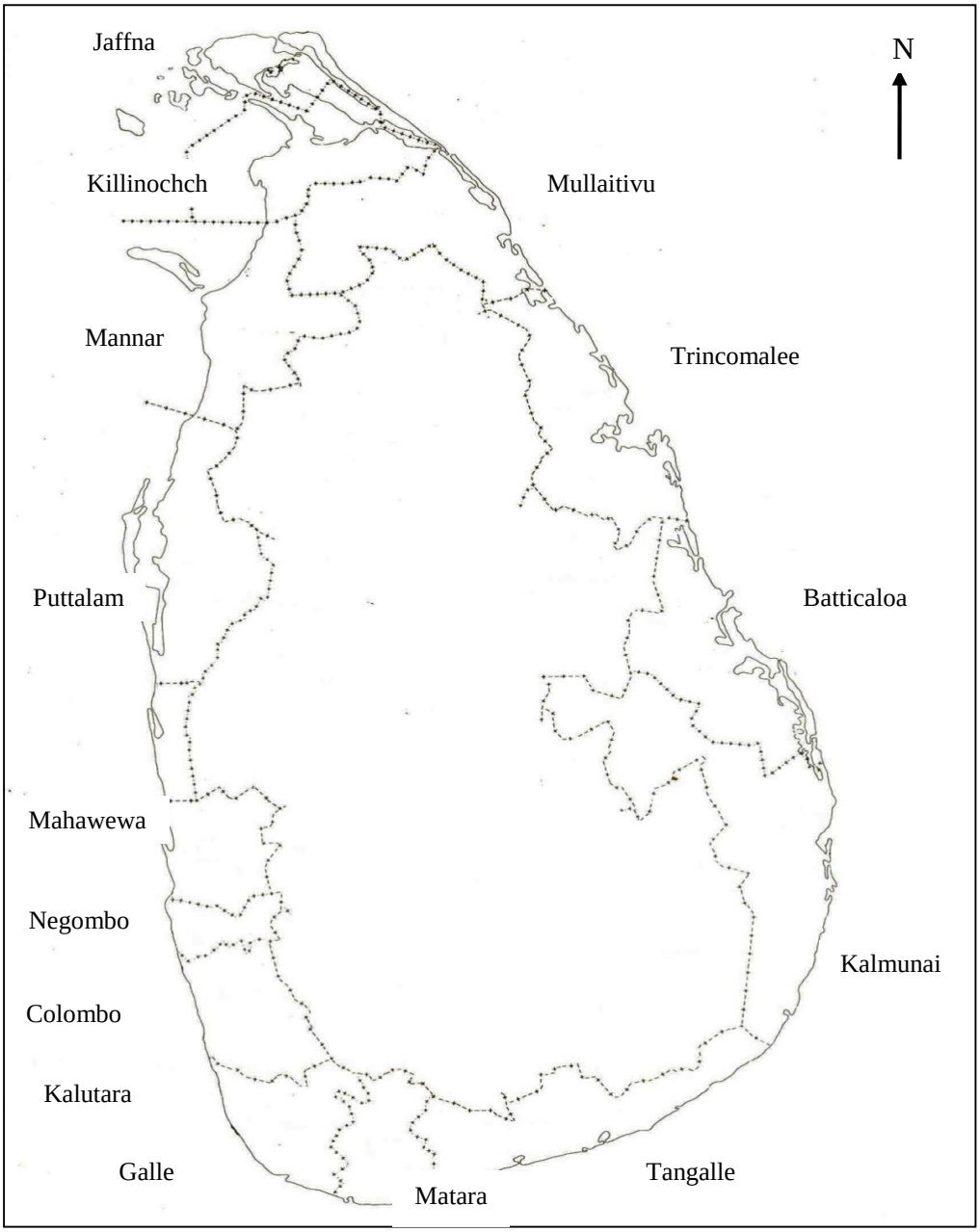


Figure 3: Coastal Fisheries Districts.

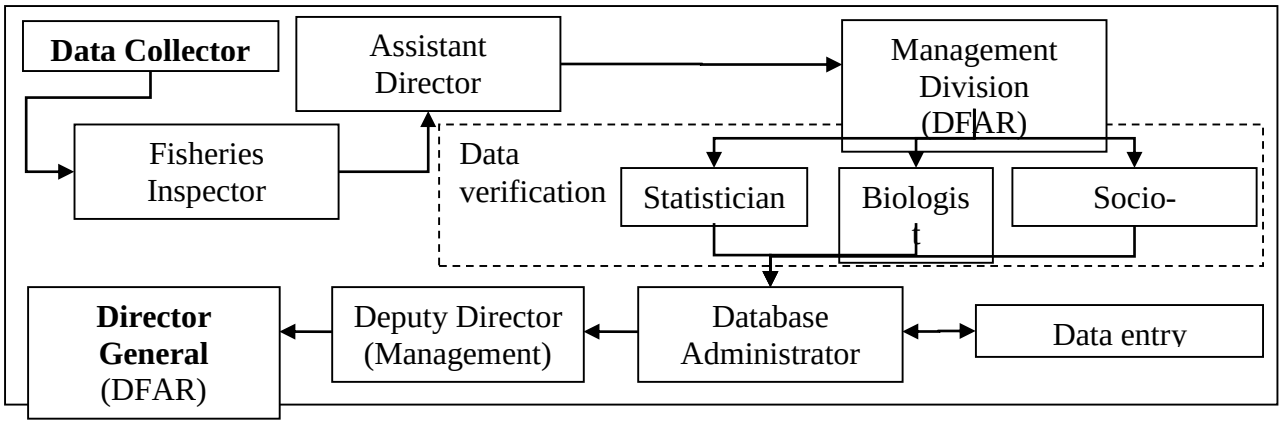


Figure 4: Data collection and data base management process.

4.4 Estimation process

4.4.1 Coastal and lagoon fishery

The calculations below apply to each boat type (IDAY, OFRP, MTRB, NTRB, NBSB, and FWCR) in each fishery (OF, BW).

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

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

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;

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

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

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

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,

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

$\bar{\mathrm{C}}$, 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

$$\mathrm{M} = \mathrm{Z} \times \mathrm{D}$$

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.

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

where;

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

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

4.4.2 Offshore fishery

To calculate the monthly production of offshore fishing fleets, the following method is used for the two boat types (IMULL, IMULS) as,

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

Where;

$\bar{C}$ = average catch per boat per day
M = Number of operated boats in the district per month obtain from PR1 form

To calculate the average catch, $\bar{C}$, the total sampled catch C divided by the number of sampled boats per month in the district

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

where C = Total catch by all sampled boats

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

N = no of boats sampled per month in the district

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

5 PROPOSED DATABASE

5.1 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 Sri Lanka. 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 Sri Lanka fisheries.

5.2 Methodology

The proposed fishery database is a Client/Server application, developed using Microsoft SQL Server 2005 (for data storage) and MS Access Project 2007 (for data input/output and processing). Excel workbooks and sheets from the CRMP data collection Excel system will be used as the building blocks to define and build the new fisheries statistics database tables and the already defined CRMP 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.

5.3 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.

5.3.1 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 (refer to the paragraph 1.1.1 in the administration manual for more detailed information and description of the code tables). 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.).

5.3.2 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 and lagoon 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 **harbour landing site or anchorage** (See paragraph 1.1.2 in the administration manual for more detailed information and description of the data tables). Through the user client main menu the user (data entry operator) will be able to input the data through data entry forms.

5.3.3 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.

5.3.4 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.

5.3.5 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 6: 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

5.3.6 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.

6 CONCLUSION AND RECOMMENDATIONS

This study evaluates the trends and potential developments of fisheries data collection in Sri Lanka. The development of an improved data collection system has to satisfactorily meet the reliable data/information requirements for sound fisheries management in Sri Lanka.

The accessibility of accurate and reliable output can be achieved only if the whole system is operational. Further studies are needed to test the accuracy of the sampling strategy, estimation method and the database management system.

It is recommended to include at later stage the biological information such as length and stratification by gear.

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.

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LIST OF REFERENCES

Benediktsdottir B. and Tomasson T. (2006). *Project Development study, Sri Lanka, Fisheries Statistics,* ICEIDA.

Bernacsek, G and Joseph. L. (2002). *Improvement of Statistics System for Marine Fisheries Development and Management in Sri Lanka* CRMP.

Cochran, W.G. (1977). *Sampling Techniques,* John Wiley & Sons.

Date C.J. (1987). *An introduction to Database Systems.* Volume 1 fourth edition, Addison Wesly.

De Bruin, G.H.P, Russel, B.C and Bogusch, A. (1995). *Species identification field guide for fishery purposes. The marine fishery resources of Sri Lanka*. Rome:FAO.

FAO 1998. Stamatopoulos, C. (1999). *Observations on the geometrical properties of accuracy growth in sampling with finite populations.* FAO Fisheries Technical paper. No.388.

FAO 1999. *Guidelines for the routine collection of capture fishery data*. (1999). FAO Fisheries Technical Paper no 382 Rome.

FAO 2000. Per Johan S. (2000) *Manual on sample-based data collection for fisheries assessment*. FAO Fisheries Technical Paper. No. 398. Rome.

FAO 2002. Stamatopoulos, C.: *Sample-based fishery surveys – Technical handbook.* FAO Fisheries Technical Paper. No. 425. Rome.

FAO 2004. Stamatopoulos, C.. *Safety in sampling – Methodological notes*. FAO Fisheries Technical Paper No. T454. Rome.

FAO 2005. Cadima, E.L. Caramelo, A.M. Afonso-Dias, M. Conte de Barros, P. Tandstad, M.O. and de Leiva-Moreno, J.I. (2006) *Sampling methods applied to fisheries science: a manual*. FAO Fisheries Technical Paper. No. 434. Rome: FAO.

Joseph L., Amarasekara S. and Premawardana S.P. (2005). *Report on pilot testing of new fisheries data collection system,* CRMP.

Lohr, S.L. (1999). *Sampling: Design and Analysis,* Duxbury Press.

Maldeniya, R. and Amarasooriya, P.D.K.D. (1998). *Tuna fisheries in Sri Lanka: an update.* 7th Expert Consultation on Indian Ocean Tunas. [November, 2005] <http://www.iotc.org/English/documents/doc_proceedings.php?mode=proceed&break=group,doc&group%5B%5D=15&year%5B%5D=1998>

MFAR 2008. Ministry of Fisheries & Aquatic Resources. (2009). *Fisheries Statistics 2008.*

Samaraweera, V.K. and Amarasiri, C. (2004). *Present status of Billfish fishery in Sri Lanka*. 4th Session of the IOTC Working Party on Billfish. <http://www.iotc.org/files/proceedings/2004/wpb/IOTC-2004-WPB-R%5BEN%5D.pdf>

United States Agency for International Development (USAID). (2008). *Analysis of the Fisheries Sector in Sri Lanka*.

Wijayaratne, B. (2001). *Coastal fisheries in Sri Lanka: some recommendations for future Management.* Final project United Nation University, Reykjavik, Iceland.

ATTACHMENTS

May be available up on request

Appendix 1 - Appendix 1 - Data forms
Appendix 2 - Fisheries Database – Administration manual
Appendix 3 - Fisheries Database – user manual
Appendix 4 - Guide lines for data collectors