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# ANALYSIS OF TUNA LONGLINE DATA AND PROPOSED PILOT SAMPLING SCHEME FOR SMALL SCALE FISHERIES IN TIMOR-LESTE

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## ABSTRACT

The aim of this project is twofold and deals with two very different aspects of the fisheries in Timor-Leste. The first objective of the work was the analysis of tuna logbook data kept by fisheries officers assigned as observers on board long-liners. The second objective was to construct a sampling plan for the small scale fisheries of Timor-Leste as a pilot study. In the sampling plan the aim is to collect data to estimate total catches of the main species caught and biological information on these species. The catch is mostly dominated by mackerel tuna species were the total catch for the four years was 172 tonnes, for albacore 59 tonnes, 57 tonnes of skipjack, bigeye 49 tonnes, 13 tonnes of southern bluefin, yellowfin 7 tonnes and pacific bluefin 2 tonnes. The results of the analysis of the tuna longline data showed, the highest CPUE values are for the mackerel in 2007 or 12.55 tonnes with a standard deviation of 15.305. Low CPUE value in 2006 amounted to 0.53 tonnes with a standard deviation of 0.763 tonnes. Mackerel tuna species are always caught along with other large pelagic species. Economic Exclusive (EEZ) of Timor-Leste has the potential tuna consisting of seven species such as Alabacore (*Thunnus alalunga*), Bigeye (*Thunnus obesus*), Pacific bluefin (*Thunnus orientalis*), Mackerel (*Euthynnus affinis*), Southern Bluefin (*Thunnus marcoyii*), Skipjack (*Katsuwonis pelamis*) and Yellowfin (*Thunnus albacares*). Based on the results of the survey in 2010-2012, there were fishing centers spread across 162 locations along the coast, fishermen there are 6,162 people, boats without engine 1,903 units, boats with long-tail engine 528 units, boats with outboard engines 310 unit, boats with inboard engine 5 units. The target population in this study is the catches of 28 species of fish, mollusks and crustacean from the small-scale fisheries in Timor-Leste.

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# TABLE OF CONTENTS

**LIST OF FIGURES**

**LIST OF TABLES**

# 1 SCOPE OF THESIS

The aim of this project is twofold and deals with two very different aspects of the fisheries in Timor-Leste. The first objective of the work is the analysis of tuna logbook data kept by fisheries officers assigned as observers on board long-liners. The second objective is to construct a sampling plan for the small scale fisheries of Timor-Leste as a pilot study. In the sampling plan the aim is to collect data to estimate total catches of the main species caught and biological information on these species. The thesis begins with a brief background information on Timor-Leste and its fisheries in chapter 2, then the analysis of the logbooks from the long-line fleet targeting tuna is the focus of chapter 3. Finally the sampling plan is presented in chapter 4.

# 2 BACKGROUND: TIMOR-LESTE AND ITS FISHERIES

## 2.1 Geography and location

Timor-Leste is located between two large countries, Australia and Indonesia. Located on the position: 8º17'S - 10º22'S and 123º25'E - 127º19'E. The country is administratively divided into 13 municipalities. Timor-Leste is a small country with a land area about 15, 007 $km^2$ and sea waters 101, 256 $km^2$. The waters self-area 24,003 $km^2$, coastline of about 740 km, Exclusive Economic Zone (EEZ) approximately 77,256 $km^2$ (SAUSP, 2014). According to the 2004 census, the population of Timor-Leste was around 923,108 inhabitants and by 2014 it is estimated to be around 1,212,107 inhabitants, with an average population growth of 2.41% per year (NDS, 2014). Continued population growth will be accompanied by increased need for food, especially animal protein from fish products. This will result in increased fishing that will put pressure on the aquatic environment.

## 2.2 Ecosystem

Along the coast of Timor-Leste there are mangroves, sea grass and diverse coral reefs stretches. When viewed from land to sea, the sea begins the general typology of mangrove forests, followed by sea grass and coral reefs. Mangrove has a function as prevent erosion and abrasion, provide nursery area and producers nutrients. Sea grass as binds sediments, provide nursery, feeding and spawning area also producer nutrients. Coral reef as provide physical buffers, provides varies habitats, feedings and spawning areas also uses nutrients efficiency. According to Gillis *et al.* (2014) these marine ecosystems each have a variety of functions and actions that have mutual relationships between these ecosystems. Each of the marine ecosystem has many functions and actions are interlinked between the three of these ecosystems.

Coral reef ecosystems has a function as a place for fish to spawn, child rearing and foraging and shelter of thousands of species of fish, animals, plants and other sea foods containing high protein, which many human needs in the field of food and a focus for us. In addition, the potential economic value is very high and generates income for the livelihood of fishermen. Given the enormous benefits to society provided by coral reef ecosystems, many neighboring countries have taken the initiative to manage and preserve so long-term use.

## 2.3 The Coral Triangle Initiative

The similarity of natural resources among several countries in the ecoregion then encourage the formation of interstate cooperation called Coral Triangle Initiative (CTI). The Coral Triangle is a geographical term so named as it refers to a roughly triangular area (Figure 1) of the tropical marine waters of Indonesia, Malaysia, Papua New Guinea, Philippines, Solomon Islands and Timor-Leste that contain at least 500 species of reef-building corals in each ecoregion.


Figure 1: A map of CTI on Coral Reefs, Fisheries and Food Security Implementation Area (CTI, 2010).

The Coral Triangle is a tuna spawning ground, it also provides nursery grounds and migratory routes for southern bluefin tuna, bigeye tuna, yellowfin tuna, skipjack tuna and albacore tunas from the Indian, Southern and Pacific oceans, where most of the world's tuna catch occurs (CTI, 2010).

## 2.4 Fishing

The fishing grounds along the coast north and south of Timor-Leste still have high biodiversity and are relatively unexploited. This potential fishery is very important because it might provide employment, reduce poverty and provide animal protein for the population of Timor-Leste. Besides all that the fisheries sector can generate revenue for the state to build and improve infrastructure and various for the population of Timor-Leste.

In Timor-Leste, there are about 6,162 fishermen spread along the coast (NDFA, 2012). Fishing activities are still artisanal and small scale with 99.5% of the boats under 9 meters. Fishing in Timor-Leste usually involves a family crew and the boats are made from tree trunks or from fiberglass. The boats are open mouth with a width 0.5-1.5 meters and a depth of 0.5-1 meters. Fishing trips normally take less than 12 hours and depend on good weather conditions. The small-scale fishery in Timor-Leste was estimated to have produced 144,117 tons in 2012 (FAO, 2014).

# 3 ANALYSIS OF LOGBOOK DATA FROM LONG-LINERS TARGETING TUNA IN TIMOR-LESTE

## 3.1 Introduction

### *3.1.1 Overview of Tuna Fisheries in the Pacific and the Coral Triangle Ecoregion*

Tuna is not a single species of fish, but rather several species. Scientists often use the term "tuna and tuna-like fish" which includes a total of 61 species, fourteen of which are considered "true tuna". Four species are of major commercial importance in the Pacific Islands and as Timor-Leste is part of the South Pacific Islands the same applies there: skipjack, yellowfin, bigeye, and albacore. These four species of tuna are quite distinct with respect to many properties such as how they are captured, the amount presently captured, the size of the populations, and the end use of the product (SPC, 2014).

Annual catches of the four main tuna species (skipjack, yellowfin, bigeye and albacore tunas) in the Convention Area of Western Central Pacific Fisheries Commission (WCPFC-CA) have increased continuously since the beginning of commercial exploitation in the early 1950s (Figure 2). In 2009, the highest ever catch of 2.46 million tonnes was recorded. The expansion in the total catch over the past 30 years has been due primarily to the development of purse seine fishing in the region. As a result, catches of skipjack, the main target of the purse seine fishery, and yellowfin, a secondary target species, have been the main source of catch increases. The value of the landed catch has also grown, and has been USD 4-5 billion in recent years (SPC, 2014).

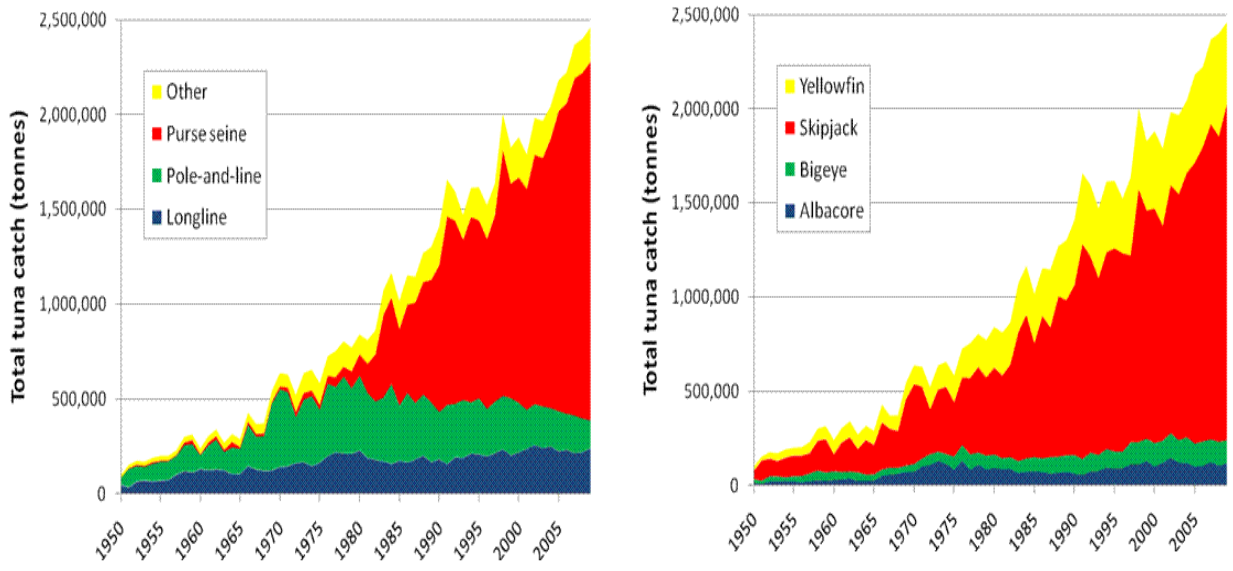


Figure 2: Total catch of the main tuna species in the WCPFC-CA by gear type (left) and by species (right) (SPC, 2014).

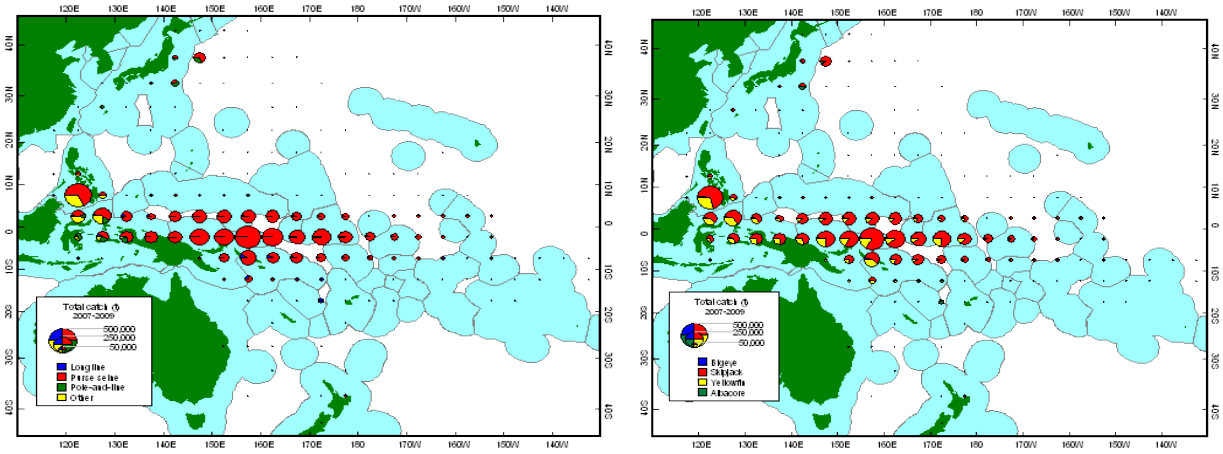

Figure 3: Total catch by gear type (left) and by species (right) for 2007-2009 (SPC, 2014).

The catch is highly concentrated in the equatorial zone, due to the concentration of the purse seine fishery, and skipjack catches, in this area (Figure 3). This also results in a concentration of catch in the equatorial EEZs of Federated States of Micronesia, Indonesia, Kiribati, Philippines, PNG and Solomon Islands, and in international waters (Figure 4).

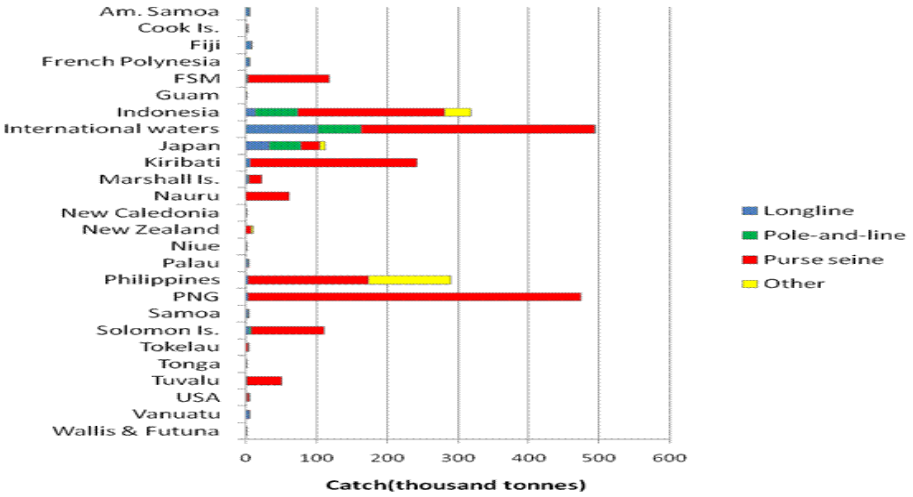


Figure 4: Average annual catch of tuna in 2007-2009, by EEZ (Secretariat of Pacific Communities, 2014).

### *3.1.2 Tuna Fishing in Timor-Leste*

In 2006, the government of Timor-Leste through the Ministry of Agriculture and Fisheries granting licenses to foreign companies for tuna fishing in the waters of the exclusive economic zone (EEZ) with a fishing vessels 3 units. Long lines are the only fishing gear used to catch tuna in the waters of the Timor-Leste. The total amount of tuna caught from 2006-2008 and in 2012 was 358 tons. The division of catches by species are: albacore (16 percent), bigeye (14 percent), yellowfin (2 percent), southern bluefin (4 percent), skipjack (16 percent), mackerel (48 percent) and slightly bluefin (1 percent) (NDFA, 2014), Figure 5 and Table 1.

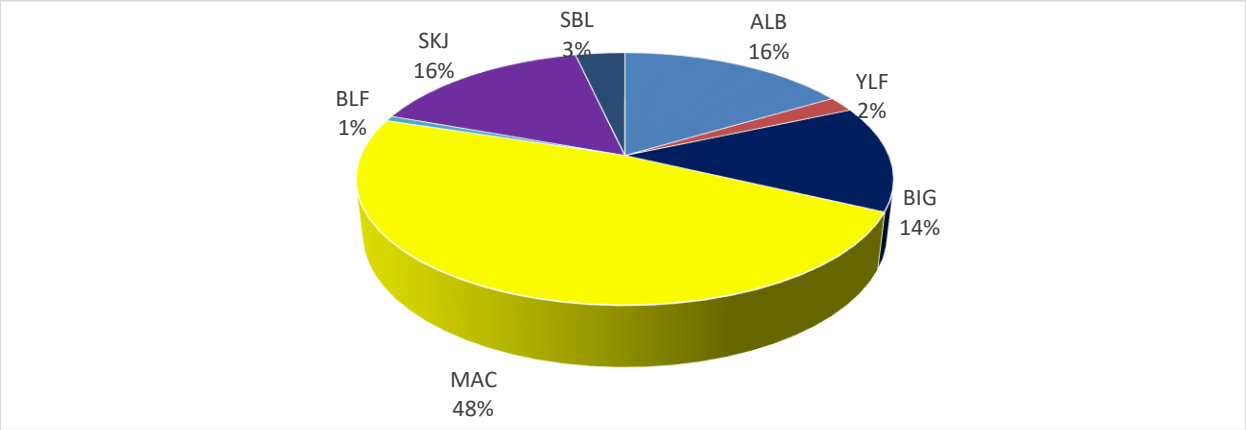


Figure 5: Percentage of tuna species from total catch in southern coast of Timor-Leste in 2006-2008 and 2012 (NDFA, 2014).

Tuna that is caught by the small-scale fishery in Timor-Leste is only for domestic consumption and is sold at a price of about US $ 4-5 per kg, while the price on the international market, especially the Japan which is the world's largest consumer of tuna, the selling price per kg varies each year but is much higher than in Timor-Leste. In 2013, record bluefin tuna auctions at Tokyo's Tsukiji fish market, unit price is ¥ 703,167 / kg (US$ 3,603 / lb) (Wikipedia, 2014).

Table 1: Tuna production of Timor-Leste (kgs) (NDFA, 2014).

| Species\Years | 2006 | 2007 | 2008 | 2012 |
|---|---|---|---|---|
| Albacore tuna | 48,779 | 5 | 301 | 9,942 |
| Bigeye tuna | 27,765 | | 697 | 20,243 |
| Southern bluefin tuna | 9,754 | 3,001 | | |
| Bluefin tuna | | | | 852 |
| Yellowfin tuna | 1,536 | 23 | | 7,088 |
| Mackerel tuna | 90,161 | 49,942 | 5,413 | 25,586 |
| Skipjack tuna | 24,489 | 14,633 | 4,093 | 13,783 |
| Total | 202,484 | 68,301 | 9,807 | 73,827 |

### 3.2 Research objectives

The objective in this section of the thesis is to analyze the available logbook data from the industrial tuna fishery in order to estimate catch rates (CPUE) and spatial and temporal changes in the fisheries.

### 3.3 Materials and methods

The data available to this study is from tuna long-liners, from logbooks kept by fisheries officers assigned as observers on board long-liners who obtained a license from the government through the Ministry of Agriculture and Fisheries, especially National Directorate of Fisheries and Aquaculture.

The data available only contains the date of capture, amount caught by species and the geographical position (Latitude and Longitude) of the catches. No information is available on the number of hooks employed nor of the soaking time of the long-line. Therefore it is assumed that these two factors are constant between all fishing vessels and years. In the calculations it is assumed that all sets have 1,200 hooks. Bait used is round sacds (*Decapterus* sp) and milkfish (*Chanos chanos*).

## 3.4 Results and discussion

### *3.4.1 The composition of the catches of tuna*

According to the logbook entries the total catch in 2006 was 203 tonnes, 2007 68 tonnes and in 2008 amounted to 10 tonnes and finally in 2012 it amounted to 77 tonnes (Figure 6). No logbook entries are available for 2009-2011 because there is no tuna fishing activities. In 2007 catches fell considerably from 203 tonnes in 2006 to 68 tonnes. This decrease occurred as one of the 3 long-line fishing vessels, passed into Australian waters and was subsequently detained by the Australian Fisheries Management Authority (AFMA).

In 2009-2011 there were no tuna fishing activities. In 2012, other companies than those permitted to fish in 2006-2008, got permission from the government for fishing tuna inside the Timor-Leste EEZ. Thus, there is an increase in the catches of tuna species (Figure 6).

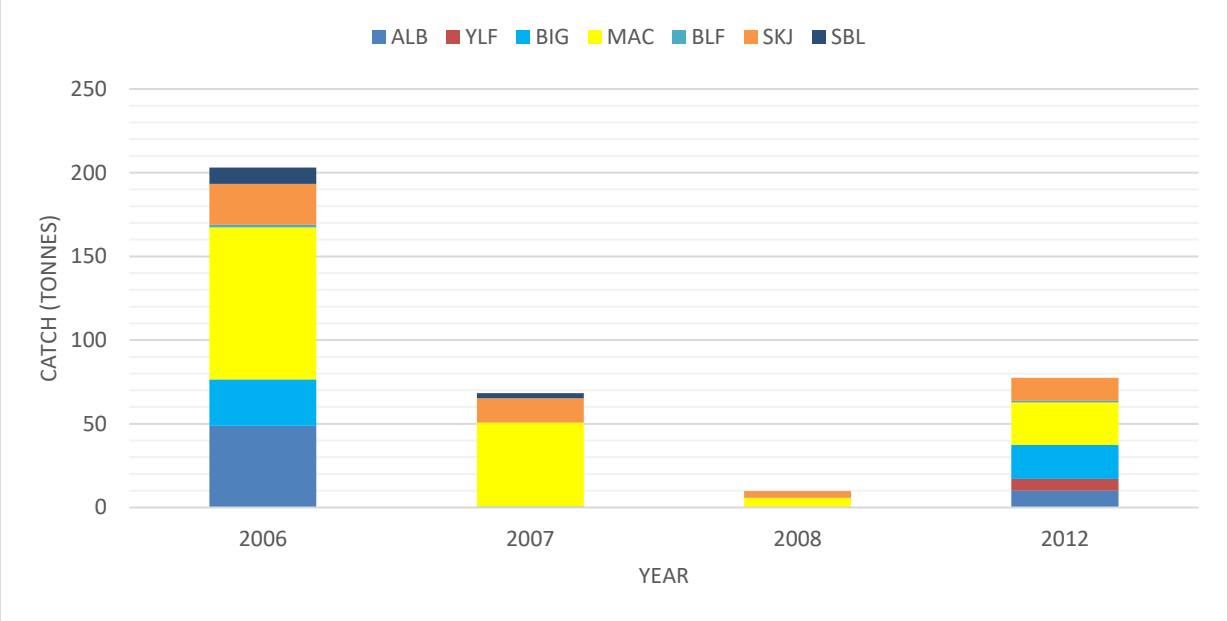


Figure 6: The composition of weight of tuna in total catch in 2006-2008 and 2012.

### *3.4.2 Estimates of Catch per Unit Effort (CPUE) for different tuna species*

The number of logbook records on the different species of tuna every year vary greatly. Number of records (n), annual estimates of CPUE and its standard deviation (SD) by tuna species and year from the logbooks is presented in Table 2.

Table 2: Number of record (n) annual estimates of Catch per Unit Effort (CPUE) and Standard Deviation (SD) of tuna species in southern coast in Timor-Leste from long-liner logbooks.

| Species | 2006 | | | 2007 | | | 2008 | | | 2012 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *n* | *CPUE* | *SD* | *n* | *CPUE* | *SD* | *n* | *CPUE* | *SD* | *n* | *CPUE* | *SD* |
| ALB | 51 | 0.92 | 0.841 | 1 | 0.01 | - | 2 | 0.15 | 0.063 | 14 | 0.75 | 0.848 |
| BIG | 16 | 1.74 | 2.552 | 3 | 0.23 | 0.314 | - | - | - | 19 | 0.98 | 0.997 |
| BLF | 2 | 0.77 | 0.236 | - | - | - | - | - | - | 3 | 0.28 | 0.113 |
| MAC | 69 | 0.53 | 0.763 | 2 | 12.55 | 15.305 | 2 | 2.77 | 2.280 | 5 | 4.79 | 4.081 |
| SBF | 43 | 0.23 | 0.378 | 6 | 0.50 | 0.407 | - | - | - | - | - | - |
| SKJ | 104 | 0.23 | 2.374 | 5 | 2.98 | 4.313 | 2 | 2.11 | 0.188 | 6 | 2.30 | 1.190 |
| YLF | - | - | - | 1 | 0.03 | - | - | - | - | 18 | 0.48 | 0.422 |

As can be seen in table 2 the logbook data is rather fragmented and in many cases the low number of observations means that no firm conclusions can be drawn from the data. The only comparison that can be made is between 2006 and 2012 for the Albacore and Bigeye tuna. It seems that the CPUE for these two species has decreased somewhat in the period.

Based on the table 4, the highest CPUE values are for the mackerel in 2007 or 12.55 tonnes with a standard deviation of 15.305. Low CPUE value in 2006 amounted to 0.53 tonnes with a standard deviation of 0.763 tonnes. Mackerel tuna species are always caught along with other large pelagic species. According to Lyle and Read (1985), mackerel tuna is a tropical and subtropical species that occurs along the North coast of Australia, Timor and in the Arafura seas. Individuals rarely exceed 65 cm fork length and are commonly between 50 and 60 cm (2 to 4 kg). Mackerel tuna is not only caught by the large-scale offshore fishery but also many are caught by small-scale near the coast (onshore).

The results of the study by the research vessel MV. SEAFDEC in 2005, fishing with pelagic long-line and drift gill nets in the same fishing grounds as the tuna long-liner are interesting in this context. From SEFDEC vessel, the total catch of tuna with longline for bigeye tuna species average was 102 kgs and 17 kgs for yellowfin tuna (MAF, 2005).

Looking at the data record logbooks, the total catch for four years was recorded for bigeye tuna is 48,705 kgs, from the results of the survey research vessel MV. SEAFDEC average is 34 kgs or about 0.12%, if compared with data from logbooks. Also on yellowfin tuna of the logbook is 8,647 kgs of the total production of tuna species, the results of a survey from SEAFDEC, recorded the average is 17 kgs or about 0.19%, when compared with data from logbooks.

### *3.4.3 Spatial Distribution of Tuna Catches*

The topography of the Timor Sea waters are characterized by a very deep canal which serves as a migration path for pelagic fish from the Pacific Ocean to the Indian Ocean. The current that runs from the Pacific Ocean to the Indian Ocean through the Arafura and Timor seas carries rich nutrients that provides food for small and large pelagic fish. Northern and southern coast of the island of Timor is an area of very fertile and rich in nutrients. According to ATSEA (2010), the Ombai Strait and Timor Passage, adjacent to the north and south coast of Timor, respectively, are major paths for migrating marine mega fauna. It is therefore not surprising that tuna is caught in considerable abundance in the waters south of Timor-Leste.

The spatial distribution of all tuna catches, irrespective of species, for all the four years is fairly even. As most of the records are from 2006 there is little difference between the maps for all years combined and the map showing only the 2006 data (Figure 7).

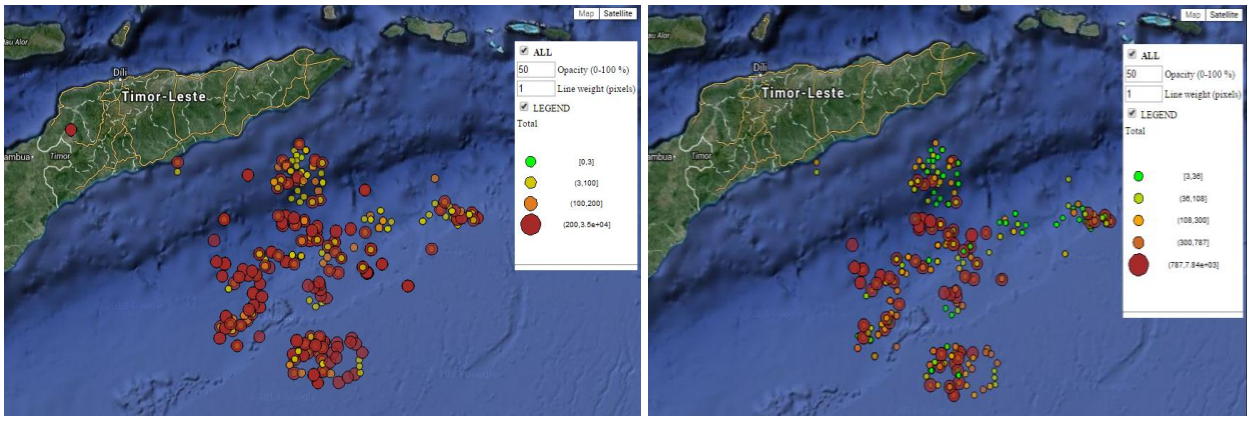


Figure 7: A map of spatial distribution of albacore tuna during 4 years (left) and spatial distribution in 2006 (right).

In 2006, 6 species of tuna were recorded in the logbooks: albacore tuna, bigeye, bluefin, mackerel, southern bluefin and skipjack (Table 2). Large size tuna species most commonly found are albacore that looks more than bigeye, Figure 8. Given the available data no conclusions can be made regarding different spatial distribution of the various species. The reason is the limited number of records in the logbook data.

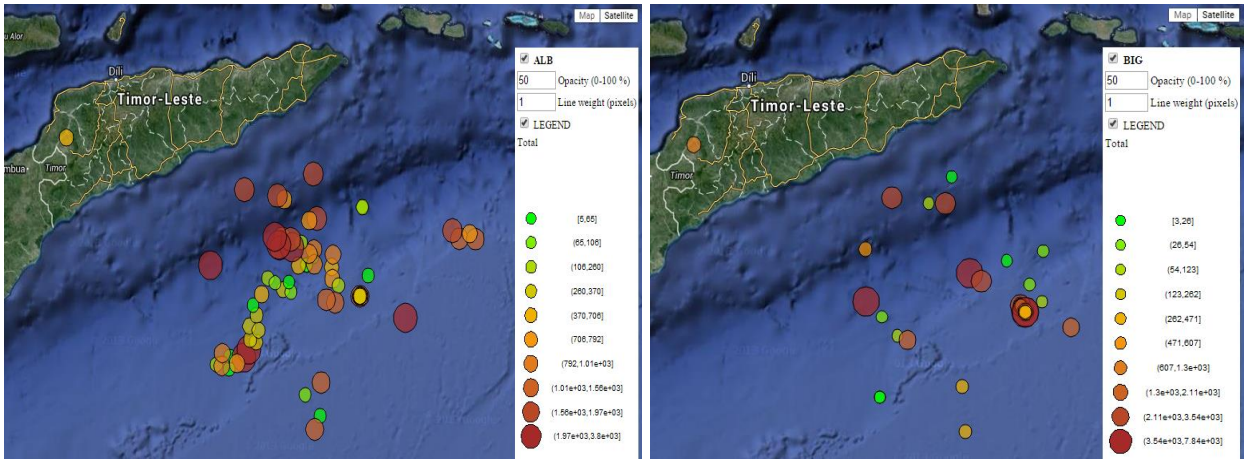


Figure 8: A map of spatial distribution of albacore (left) and bigeye tuna species (right) during trip 1$^{th}$ in 2006.

## 3.5 Conclusions and Recommendations

### *3.5.1 Conclusions*

Based on the observations contained in the logbooks it can be claimed that there are seven species of tuna are found in the waters of the southern part of Timor-Leste. Seven species of tuna are caught are Alabacore (*Thunnus alalunga*), Bigeye (*Thunnus obesus*), Pacific bluefin (*Thunnus orientalis*), Mackerel (*Euthynnus affinis*), Southern Bluefin (*Thunnus marcoyii*), Skipjack (*Katsuwonis pelamis*) and Yellowfin (*Thunnus albacares*).

The catch is mostly dominated by mackerel tuna species were the total catch for the four years was 172 tonnes, for albacore 59 tonnes, 57 tonnes of skipjack, bigeye 49 tonnes, 13 tonnes of southern bluefin, yellowfin 7 tonnes and pacific bluefin 2 tonnes.

This report provides fragmented information on temporal and spatial variability in abundance of different tuna species caught between the 2006-2008 and 2012 along the south coast of Timor-Leste. This information could be useful for planning future data sampling activities of the fishery that could then become the basis of stock assessments and tuna management plan.

### *3.5.2 Recommendations*

The government could grant permission for tuna long-liner fleet containing limited number of boats, i.e. 3 to 5 fishing vessels. The placement of observers and researchers on vessels to collect data should be mandatory part of the licensing.
Granting further permissions for fishing tuna should be done only gradually, because CPUE value is inversely proportional to the value of effort, where each additional effort will reduce the catch per unit effort (CPUE). This is due to the resource will tend to decrease if fishing effort is done increasing.

# 4 PROPOSED PILOT SAMPLING SCHEME FOR SMALL SCALE FISHERIES

## 4.1 Introduction

### *4.1.1 The State of Small-Scale Fisheries in Timor-Leste*

In Timor-Leste more than 99.5% of the capture fisheries is taken by the traditional fleet (artisanal fisheries) with the size of the boat under 12 meters with or without outboard motors. They are generally concentrated along the coast, operating in shallow waters and return to the landing site in just one day (one day of fishing). Fishing gear used by fishermen to catch fish varies. Normally the boat can use a single fishing gear or more than one, for example a combination of nets with hook and line, harpoon, spear gun, diving etc.

Fishing areas for small-scale fishermen are restricted according fishery regulations to depths above 200 meters. Most of the fishing ground area is therefore restricted to about 2 nm to 3 nm from the shore. Fish are the main target of the demersal and small pelagic species (Table 3).

Table 3: Marine capture fisheries production of Timor-Leste (tonnes) (FAO, 2014).

| Years\Species | Chepalopods | Merine crabs | Marine fish | Nantian decapods | Tropical lobsters | Tuna like fish | Yellowfin tuna |
|---|---|---|---|---|---|---|---|
| 1999 | 16 | 16 | 3320 | 29 | 16 | 3 | 1 |
| 2000 | 18 | 18 | 3530 | 30 | 17 | 3 | 3 |
| 2001 | 18 | 18 | 3470 | 29 | 18 | 3 | 3 |
| 2002 | 19 | 19 | 3630 | 29 | 17 | 3 | 3 |
| 2003 | 20 | 20 | 3755 | 30 | 19 | 3 | 3 |
| 2004 | 18 | 18 | 3900 | 31 | 20 | 3 | 3 |
| 2005 | 17 | 17 | 3215 | 33 | 18 | 3 | 3 |
| 2006 | 16 | 16 | 2835 | 29 | 17 | 3 | 3 |
| 2007 | 15 | 15 | 2835 | 27 | 15 | 3 | 3 |
| 2008 | 16 | 16 | 3160 | 28 | 16 | 3 | 3 |
| 2009 | 15 | 15 | 3120 | 28 | 15 | 3 | 3 |
| 2010 | 15 | 15 | 3120 | 28 | 15 | 3 | 3 |
| 2011 | 15 | 15 | 3120 | 28 | 15 | 3 | 3 |
| 2012 | 15 | 15 | 3120 | 28 | 15 | 3 | 3 |

In the demersal fishing the main fishing gear used are hand lines and the types of fish that are caught in general are species of snapper, grouper, rabbitfish, scads, barramundi, yellowtail fusiliers, purple-spotted bigeye, threadfin brean, emperor, goat-fish etc. Trevally species, Spanish mackerel and other pelagic are caught in trolling line. Spear gun is used by a minority of fishermen while diving is also used to catch all kinds of bottom fish, such as lobster, octopus, squid, cuttlefish, etc. For catching pelagic species the main fishing gear used are gill nets to catch flying fish, sardines, overpasses, trevally etc. Mini purse seines are used for circular fish around fads for fish scads, sardine and other pelagic. Catching shrimp generally uses trammel nets. While these types of prawns, crabs, bivalves and cephalopods and others collected by coastal communities, both men, women and children at the time of low tide. Trap fishing gear made of woven bamboo is used for fishing reef fish of various kinds.

### *4.1.2 Characteristic of Fishing Boat Used by Small-Scale Fishery*

The number of boats registered in the National Directorate of Fisheries and Aquaculture of the entire Timor-Leste is 2,787 units of varying length. The fleet can be broadly split into four groups based on the length of the boat and the engine type (Table 4, Figure 9).

Table 4: Characteristic of boats used by small-scale fishery in Timor-Leste (NDFA, 2012).

| Number of boats | Length categories (m) | Type of engine | Power main (HP) | Fishing area (nautical mile) |
|---|---|---|---|---|
| 1,903 | 3-5 | Without engine | - | <1 |
| 528 | 5-7 | Longtail engine | 3.5-5.5 | 2-4 |
| 310 | 7-9 | Outboard engine | 12-15 | 4-6 |
| 5 | 10-14 | Inboard engine | 250-350 | 6-12 |


Figure 9: The shapes and size of boats used by small-scale fisheries, length 3-5 (left), 5-7 m (second from left),7-9 m (third from left) and 10-12 m (right).

The distance from shore a vessel fishes at varies between boats. The smallest boats, without engines, only fish up to 1 nautical mile from shore. Boats using long-tail engine, go out to 4 nautical miles. Boats length 7-9 m are able to fish up to 6 nautical miles from shore. Finally the largest boats with inboard engines go up to 12 nautical miles from shore.

### *4.1.3 Fish Landing Sites and Fishing Centers*

Fish landing sites were built by the government in 2009 in all the municipal coastal states (Figure 10). But until now these places are not functioning properly because of the lack of basic and other support facilities. There is only the building itself and it is used by several staff to provide technical information to the fishermen. Thus, fishermen generally prefer the boat landing near the house where they live.


Figure 10: A map of Timor-Leste showing the 11 municipalities coastal state.

The number of fishermen on the north coast is considerably higher than on the south coast. Table 5 lists the number of fishing centres, fish landing sites, fishermen, fishing fleet with and without an inboard and outboard engine by 11 municipalities coastal state in Timor-Leste.

Table 5: Number of fishing center, fish landing site, fishermen, distribution fishing boat with and without engine by 11 municipalities coastal state in Timor-Leste (NDFA, 2012).

| Municipality coastal state | Fisher | Fish Landing Site | Fishing centres (Homeport) | Canoes without engine | Boat with long-tail engine | Boat with outboard engine | Boat with inboard engine |
|---|---|---|---|---|---|---|---|
| Dili/Atauro | 2,885 | 1 | 32 | 579 | 86 | 57 | 3 |
| Oecusse | 335 | 1 | 18 | 199 | 48 | 10 | 1 |
| Ainaro | 31 | 0 | 4 | 18 | 6 | 2 | - |
| Bobonaro | 468 | 1 | 11 | 169 | 128 | 24 | - |
| Liquica | 573 | 1 | 23 | 296 | 57 | 86 | - |
| Baucau | 615 | 1 | 16 | 220 | 55 | 50 | - |
| Manatuto | 364 | 1 | 14 | 43 | 75 | 32 | - |
| Lautem | 313 | 1 | 17 | 60 | 48 | 49 | - |
| Viqueque | 171 | 1 | 8 | 83 | 16 | 15 | - |
| Manufahi | 101 | 1 | 6 | 91 | 12 | 1 | - |
| Covalima | 301 | 1 | 13 | 145 | 19 | 4 | 1 |
| Total | 6,162 | 10 | 162 | 1,903 | 550 | 330 | 5 |

### *4.1.4 Statistical Sampling of Commercial Catch Data*

Population size in an aquatic ecosystem can be determined or estimated from data collected in a statistically sound way. But in its implementation, sampling is faced with many obstacles. The practical difficulties in taking a truly random sample from a large and heterogeneous collection of objects are considerable. These difficulties may be overcome by dividing up the whole collection into smaller and more compact sections, within which a random sample may be taken fairly readily. Two such methods of sampling are:

(1) Stratified sampling
In stratified sampling the whole collection of objects is divided into several sections, or strata, each of which is then sampled and analysed separately, e.g. landings at different ports may be taken as strata. This method is particularly useful in reducing bias and variance when there is a marked difference between Strata.

(2) Two-stage sampling
First a sample is taken and then sub-samples from them. Example we would randomly sample 5 landings ports and then sample catches from these ports.

If sampling is done in a correct manner, the data can be used for stock assessment (Stomatopoulos, 2002).

### ***The Target Population***

According to ICES (2011) target population that is accessible for sampling will typically be distributed in clusters of ports, vessels, trips, hauls and knowledge of the structure is important for designing the sampling scheme (Figure 11). Knowledge of this structure of the target population is very important for sample design and correct raising of samples.

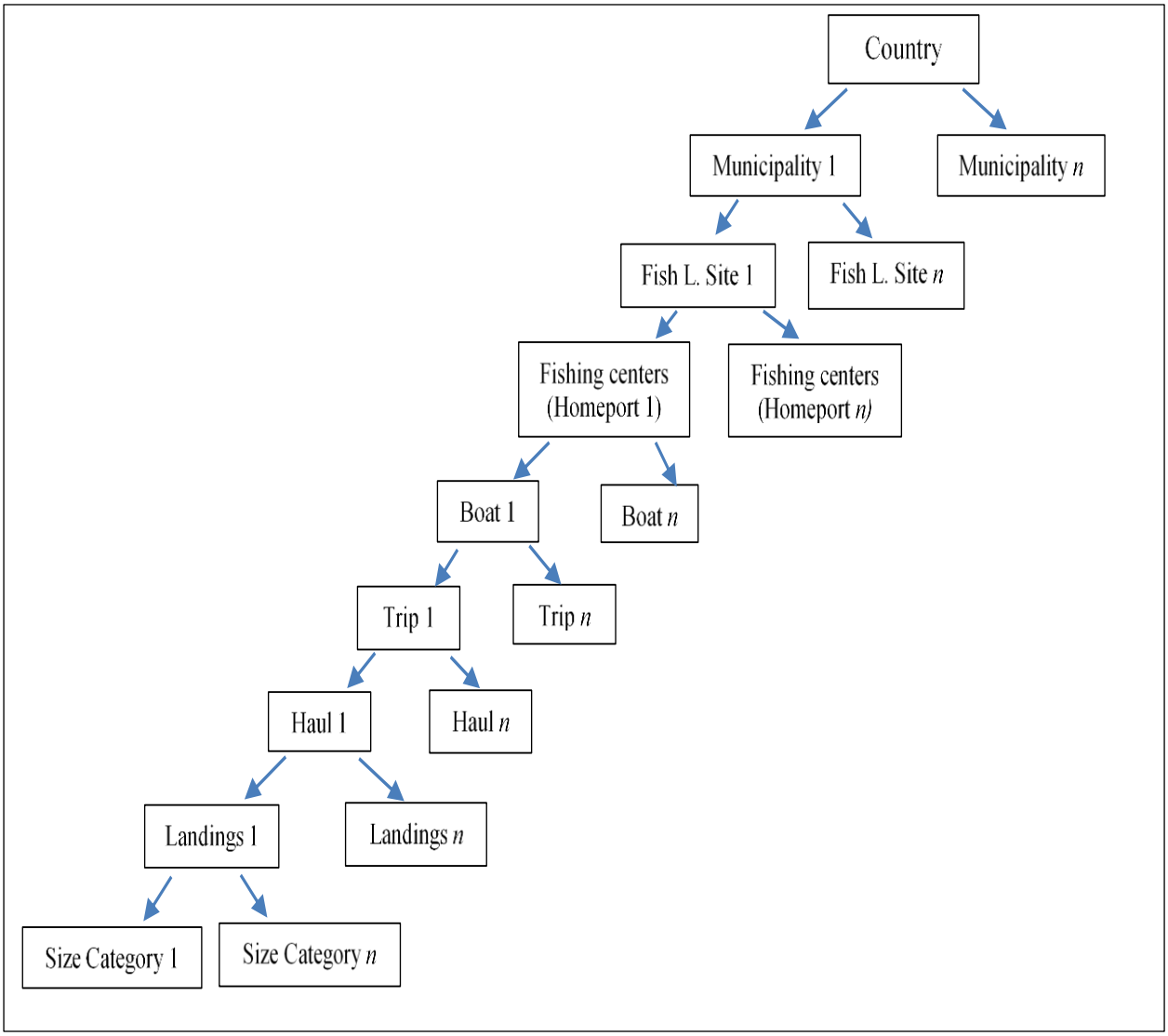


Figure 11: Hierarchical distribution of fish catches in clusters of fish landing site (homeport) within municipalities, boats within fish landing site (homeport), and trips etc., requiring a multistage sampling design. The hierarchical distribution within each fish landing site (homeport) may also vary over time, for example with varying number of boats delivering catches on a selected day (ICES, 2011).

### *Primary Sampling Unit (PSU)*

"Primary Sampling Unit (PSU) is the unit that is sampled from the population" (Lohr, 2010). These all represent a possible initial point for selecting a segment of the catch (e.g. fish from a fishing Secondary Sampling Unit (SSU) and Lower Sampling Units.

"Secondary Sampling Unit (SSU) is a subunit that is subsampled from the selected PSUs" (Lohr, 2010). Each PSU may itself be structured into **Secondary Sampling Units or SSUs** (e.g. landing at a selected port and day; individual hauls of a selected fishing trip; individual trips in a selected

fisher's logbook), which in turn may comprise tertiary or even lower level sampling units as shown in Figure 11, which can be sub-sampled or in some cases enumerated through a census (ICES, 2011).

### *Sampling Frame*

"Sampling frame is a list, map, or other specification of sampling units in the population from which a sample may be selected" (Lohr, 2010). "The complete set of these non-overlapping units (e.g. all vessel trips in a year, all site-day combinations in a year, or all fishers) is the sampling frame" (ICES, 2011). According to (FAO, 1998) a sampling frame is a complete description of structure of the primary fishery sector including an inventory of ports, landing places, number and type fishing units (boat and gear), and a description of fishing and landing activity patterns, fish distribution routes, processing and marketing patterns, supply centers for goods and services, etc.

## 4.2 Pilot scheme for sampling commercial catches in Timor-Leste

### *4.2.1 The Objectives of the Proposed Survey*

As stated above the majority of the catches in Timor-Leste are taken by the artisanal fleet. Therefore, the sampling survey will be focused on small-scale fisheries that are spread along the coast and target fish, mollusks and crustaceans.
The purpose of the sampling survey is to determine the number and abundance of the aquatic resources. Therefore, the data needed to measure for sampling surveys are as follows:

*1)* total catch and effort for multi-year time series,
*2)* catch composition (species and weight),
*3)* biological data (length, age, gonad, maturity).

Evaluation of the sampling scheme will be held periodically and adjusted to the circumstances and needs of fisheries management in the short and long term.

### *4.2.2 Fish Landing Sites and Fishing Centers Selected for Sampling Surveys*

In this pilot study, existing fish landing sites in the 11 municipality regions which have marine waters (Figure 10) will serve as the center for sampling activities. Boats and fishing activities at the chosen fishing center and on close by landing sites will be the main target of sampling. The fishing centers that will be sampled and the close by landing sites chosen are listed in Table 6. As an example on Atauro Island there will be five sampling sites, the fishing center Beloi and the landing cites Vila, Maquili, Berau and Biqueli.

The municipality for the survey were placed into two agro-ecological coastal zones: north and south coast. The northern coast municipality consists of Oecusse, Bobonaro, Liquica, Dili, Manatuto, Baucau and Lautem and southern coast consist of Covalima, Ainaro, Manufahi and Viqueque. The division of the sample frame into agro-ecological coastal zones is not to be mistaken for a stratification. Each coastal zone is treated as an independent system of agro-ecology coastal zones, the sample to be taken.

Table 6: List of landing site and fishing centers selected for sampling survey

| Number | Name of landing site | Address | GPS Position (Latitude/Longitude) | Fishing centres selected (where many fishermen gather) |
|---|---|---|---|---|
| 01 | Dili | Metinaro | 08 31.1749S/125 41.4054E | Bidau Santana, Hera and Bebonuk |
| 02 | Atauro (island) | Beloi | 08 12.5296S/125 36.4701E | Vila, Maquili, Berau and Biqueli |
| 03 | Oecusse | Oesono | 09 11.3684S/124 23.0215E | Wini , Citrana, Sakato and Maquelab |
| 04 | Bobonaro | Beacou | 08 49.3307S/125 03.1697E | Batu Gede, Sanirin and Atabae |
| 05 | Liquica | Liquica | 08 35.3143S/125 19.2777E | Tibar, Epelo, Loes and Morae |
| 06 | Baucau | Vemasse | 08 30.0738S/126 14.1831E | Watabou, Waiaka, Soba & Buiguira |
| 07 | Manatuto | Aiteas | 08 30.3041S/126 00.4823E | Ilimano, Obrato and We Ali |
| 08 | Lautem | Com | 08 21.4108S/126 03.4565E | Valu, Euquisi and Liarafa |
| 09 | Viqueque | Beaco | 08 56.5013S/126 26.5975E | Adarai and Ailembata |
| 10 | Manufahi | Betano | 09 09.5230S/125 14.8996E | Silihasan, Kolocau and Bonuk (Ainaro) |
| 11 | Covalima | Suailoro | 09 21.2614S/125 15.1484E | Kulu Oan, Salele and Beco |

### *4.2.3 The Target Population*

The target population in this study is the catches of 28 species of fish, mollusks and crustacean from the small-scale fisheries in Timor-Leste.

### *4.2.4 The Sampling Frame (FS)*

The Sampling Frame (FS) is the coastal fleet, in this pilot study the sampling frame is restricted to boats from 3 to 9 m length with and without engine. The sampling frame is based on the 2010-2012 of National Census dataset for boats and is obtained by complete total enumeration in fishing centers in 11 municipalities. All fishing centers included in our baseline survey were randomly selected for this frame.

### *4.2.5 The Selection of Primary Sampling Unit (PSU)*

The PSU in this study is the sampling site at a given day. Each sampling site will be visited at least 12 times each month. The secondary sampling unit (SSUs) in this study are the individual boats in the fishing centres. As a first iteration, 10% of all boats at the fishing center / landing sites (PSUs) within a municipality should be selected for sampling. This allocation should be reviewed after the first year of sampling based upon a thorough variance components analysis undertaken by a professional statistician. Boat recorded at landing sites (Table 7) should be selected randomly with probability proportional to their size (PPS) measured in terms of the total number of vessels landing at the site. This approach assumes that no correlation exists between the number of vessels present in each category and the size of the landing site and should be tested.

Table 7: List of boat for target sampling survey of the fish population at landing site

| Municipality | Landing Site | No of boat | Boat selected 10% from each category of boat | Proportion % |
|---|---|---|---|---|
| Dili | Metinaro | 72 | 7 | 9 |
| Atauro (Island) | Beloi | 61 | 6 | 8 |
| Oecusse | Oesono | 36 | 4 | 5 |
| Bobonaro | Becou | 140 | 14 | 18 |
| Liquica | Liquica | 46 | 5 | 6 |
| Baucau | Vemasse | 64 | 6 | 8 |
| Manatuto | Manatuto | 68 | 7 | 9 |
| Lautem | Com | 74 | 7 | 10 |
| Viqueque | Beaco | 39 | 4 | 5 |
| Manufahi | Betano | 75 | 8 | 10 |
| Covalima | Suailoro | 101 | 10 | 13 |
| Total | | 776 | 78 | 100 |

### *4.2.6 Data Recorded*

The sampling surveys will be conducted four times each month, each intermittent 3 days a week. The aim is to conduct the data collection process for all the fishing centers during the same day, a work plan for data collection in 12 days in one months have been prepared in the following ways:

- First week : 3 (three) days
- Second week : 3 (three) days
- Third week : 3 (three) days
- Fourth week : 3 (three) days

The boat sampling activities, carried out for 24 hours starting from 00:00-24:00, while for the sampling period is from 06:00-18:00, and refers to the period when the enumerator will be present at the landing site.

The active days of each vessel-gear type at each sampled landing site within each municipality should be estimated for each month through discussions with fishers at the PSUs at the end of each month. However, it may not be possible to get all the details after one month. Instead a record of a week's activity may provide a reliable estimate.

Table 8: The sampling survey for target sampling survey of the fish population at landing site

| Municipality | Fishing centres | Week I (days) | | | Week II (days) | | | Week III (days) | | | Week IV (days) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1st | 2nd | 3rd | 1st | 2nd | 3rd | 1st | 2nd | 3rd | 1st | 2nd | 3rd |
| Dili | 1. Metinaro | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 2. Hera | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 3. Bidau Santana | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 4. Bebonuk | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| Atauro Island | 1. Beloi | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 2. Vila | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 3. Maquili | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 4. Berau | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 5. Bequeli | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| Oecusse | 1. Oesono | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 2. Wini | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 3. Citrana | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 4. Sakato | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 5. Maquelab | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| Bobonaro | 1. Beacou | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 2. Batu Gede | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 3. Saniri | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 4. Atabae | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| Liquica | 1. Liquica | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 2. Tibar | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 3. Epelo | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 4. Morae | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 5. Loes | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| Baucau | 1. Vemasse | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 2. Watabou | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 3. Waiaka | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 4. Soba | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 5. Buiguira | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| Manatuto | 1. Aiteas | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 2. Ilimano | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 3. Obrato | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 4. Weali | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| Lautem | 1. Com | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 2. Valu | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 3. Liarafa | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 4. Euquisi | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| Viqueque | 1. Beaco | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 2. Adarai | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 3. Ailembata | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| Manufahi | 1. Betano | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 2. Silihasan | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 3.Silihasan | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 4. Kolocau | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 5. Bonuk | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| Covalima | 1. Suailoro | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 2. Kulu Oan | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 3. Salele | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| | 4. Beco | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |

Fishing boat with main fishing gear type used by fishermen in each municipality varies, according to the conditions in the marine waters of the region. The number of vessels and the primary fishing

gear is to be registered on each sampling day at the landing site in the 11 municipalities (Table 9). It should be noted that in many cases it may not be possible to sample all gear types at each landing site.

Table 9: Number of boats and main fishing geras record at landing site in 11 municipalities.

| Municipality | Landing Site | No of boat | Gear Type (Main) | | | | |
|---|---|---|---|---|---|---|---|
| | | | GN | PS | HL | BLL | Others |
| Dili | Metinaro | 72 | √ | √ | √ | √ | √ |
| Atauro (Island) | Beloi | 61 | √ | √ | √ | √ | √ |
| Oecusse | Oesono | 36 | √ | √ | √ | √ | √ |
| Bobonaro | Becou | 140 | √ | √ | √ | √ | √ |
| Liquica | Liquica | 46 | √ | √ | √ | √ | √ |
| Baucau | Vemasse | 64 | √ | √ | √ | √ | √ |
| Manatuto | Manatuto | 68 | √ | √ | √ | √ | √ |
| Lautem | Com | 74 | √ | √ | √ | √ | √ |
| Viqueque | Beaco | 39 | √ | √ | √ | √ | √ |
| Manufahi | Betano | 75 | √ | √ | √ | √ | √ |
| Covalima | Suailoro | 101 | √ | √ | √ | √ | √ |

Notes: GN = Gill Net; PS = Purse Seine; HL = Hook and Line; BLL = Bottom Long-Line; other = any other gear not belonging to the previous categories.

At each sampling site during the sampling period, the enumerators should with the help of fishers and/or beach community leaders, identify and record the numbers of all vessel-gear types that have landed or will land during the sampling day, and summarize this information in the following tabular format that is included on the data recording form, as in Table 10. It should be noted that the enumerator should be at the landing site before fishing boats landed.

Table 10: The number of vessels belong to each vessel-gear type landing at the site during the sampling day.

| Boat Type | Gear Type (Main) | | | | |
|---|---|---|---|---|---|
| | GN | PS | HL | BLL | Others |
| Canoes without engine | | | | | |
| Boat with long-tail engine | | | | | |
| Boat with outboard engine | | | | | |
| Boat with inboard engine | | | | | |
| Others | | | | | |

Notes: GN = Gill Net; PS = Purse Seine; HL = Hook and Line; BLL = Bottom Long-Line; other = any other gear not belonging to the previous categories.

In the implementation for each month of sampling, the enumerator should attempt to allocate sampling effort among types of fishing boat-gear type in proportion to the number of fishing boat in every type of fishing boat-gear type that landed on the sampling day. To achieve this, the enumerator should choose fishing boat for sampling in the manner described in the above example, if the team can count sampled 10 fishing craft in one day, thus their efforts should be allocated as shown in Table 11. Sampling should be twelve days per month, which is three consecutive days per week for each month in fisheries.

Table 11: The sample from each fishing boat-gear type combination with landing catch site.

| | |
|---|---|
| Number of boats (all types) that landed at the site during the sampling day (00:00 – 24:00) | 20 |
| Maximum number of boats that can be sampled | 10 |
| Sampling Proportion (%) | 50 |

After the number of fishing boats to sample has been determined then the types of boats and gear-types of the sampled boats should be recorded. The enumerators should try to sample all kinds of fishing boats-gear type landing at the site during the sampling.

Based on the fishing vessel on that day, the collector shall measure total catch, effort and biological data. For the purpose of providing data that can meet the criteria for statistical analysis, the enumerator should know the procedures of sampling in fish landing sites. Referrals to the quality of data and samples will be collected from the activities of vessels at landing sites (Table 12).

Table 12: Referrals for quality of data and samples to be collected from boat activity in landing site (Rajali *et al.* 2012).

| Number | Type of data/purpose | No. of boat activity/ fish present | Amount of data/ sample to be collected | Observation |
|---|---|---|---|---|
| 1 | Fishing vessels-gears, fishing operation and catch composition | 1-3<br>4-10<br>11-20<br>>30 | 1-3<br>4-10<br>11-20<br>>30 | • Fishing Vessels from each landing site during each sampling day.<br>• Fish sample take ten kilogram (10 kg) of sample in case of small boats with small catch should be analysed.<br>• Fish sample take for bigger take 5-10% (at least 10 kg) sample should be analysed. |
| 2 | Length of fish species | Unknown | 200-2000 | For selected species every category of fishing gear from each sample landing site per month. |
| 3 | Weight of fish species | Unknown | 30-10 | For selected species every category of fishing gear from each sample landing site per month. |
| 4 | Gonad maturity of fish species | Unknown | 30-100 | For selected species every category of fishing gear from each sample landing site per month. |

### *4.2.7 Target Species*

Marine fish species until now many captured by small-scale fishermen are small pelagic and demersal fish and a variety of reef fish. Therefore, these fish has been caught so many need attention and become a top priority in the stock assessment. Fish species on the north coast has a lot of high pressure on aquatic ecosystems because too many fishermen concentration when compared with the situation in the south coast. Given that the fish species caught are so many there is a need to prioritize. The main priority list in this study is for several species of fish, mollusks and crustaceans is listed in Table 13.

Table 13: List of selected many species of fish are caught by small-scale fishermen.

| Number | Local name (English name) | Scientific name | Figure |
|---|---|---|---|
| 01 | Bainar salar, Karapan, Salar, Golar toto, Manae (Mackerel scads) | *Decapterus spp* |  |
| 02 | Bainar fatuk, Lore, Oru mamera (Blue fusilier) | *Caesio lunaris* |  |
| 03 | Ikan manu, Aguador, Lakuafi, Lamanu (Flying fish) | *Cypselurus sp* |  |
| 04 | Sardina tilun modok, Sardina, Neba walio gogaban (Sardine) | *Sardinella spp* |  |
| 05 | Daun, Farde, Basarus (Long tom) | *Tylosurus crocodilus* |  |
| 06 | Samber dara, Iranunu rasa, Telu ana (Garfishes) | *Hemiramphus spp* |  |
| 07 | Koku metan, bainar, tongkol, lekuafi (Skipjack tuna) | *Auxis thazard* |  |
| 08 | Kasareta, Bainar, Kasareta fatuk, Antraga atun, Sakiri (Mackerel tuna) | *Euthynnus affinis* |  |
| 09 | Kasareta Bonito, Bainar mutin, Kasareta, Antraga, Sakiri（Bonitos） | *Cymbiosarda spp* |  |
| 10 | Kasareta, Bainar metan, Antraga, Tongkol (Skipjack tuna) | *Katsuwonis pelamis* |  |
| 11 | Paripa fatuk, Die kitan, Tei gaba, Mita (Spinefoot/rabbitfish) | *Siganus spp* |  |
| 12 | Kitan, Die kitan, Tei, Mita papola (Blue-lined spinefoot (rabbitfish) | *Siganus puellus* |  |

| | | | |
|---|---|---|---|
| 13 | Fafulu metan, Sunu fafulu, Sunu karabia, Mamila (Unicornfish) | *Naso sp* |  |
| 14 | Koku metan, gurangahi, koku, sinaria, turiu (Giant trevally) | *Caranx ignobilis* |  |
| 15 | Loloi fatuk, Rongkador, Pateka, Lono lawata (Diagonal-banded sweetlip) | *Plectorhinchus lineatus* |  |
| 16 | Uleu ikun modok, Baduma, Sou, Belo-belo ikun naruk, Ruhu (Ambon emperor) | *Lethrinus amboinensis* |  |
| 17 | Toi, Garopa, Toke, Kau mamera (Coral cod) | *Cephalopholis miniata* |  |
| 18 | Gurapu fatuk laran, Garopa toke, Lehe (Honeycomb rockcod) | *Epinephelus merra* |  |
| 19 | Garopa rengah (Rockod) | *Epinephelus sp* |  |
| 20 | Jaringi fatuk, Sarangigi, Kamera, Kinalara, Hara mera (Redbass) | *Lutjanus bohar* |  |
| 21 | Jaringi tahu, Karopa, Lelo, Kamera merdani, Marahu (Mangrove jack) | *Lutjanus argentimaculatus* |  |
| 22 | Jaringi, Sarangigi, Taw, Lelo, Paka-paka mamera (Malabar Snapper) | *Lutjanus malabaricus* |  |
| 23 | Biji nangka, Biji nangka rai, Tia lemu | *Parupeneus barberinus* |  |
| 24 | Suntu (Squid) | *Loligo sp* |  |

| | | | |
|---|---|---|---|
| 25 | Suntu (Cutlefish) | *Sepia sp* |  |
| 26 | Boek metan tasi (Tiger prawn) | *Panaeus monodon* |  |
| 27 | Boek mutin tasi (White shrimp) | *Panaeus indicus* |  |
| 28 | Lagosta (Lobster) | *Panulirus sp* |  |

### *4.2.8 Raising from Sampled Boats to the Population*

In order to estimate the composition of catches by the sample vessel and the total number of fleet, length distribution and obtain biological data nationally it is necessary to raising the sampled boats to the population. Population estimates were calculated using the following equation (Spare, 2000):

#### *a. Raising factors first (I)*

Let $m$ = number of boats from which samples were taken and for any particular one of these, say the $ith$:

- $W_i$ = weight landed
- $w_i$ = weight sampled
- $n_i$ = number of fish in the sample.

then $\frac{W_i}{w_i} = r_i$ or the raising factor for the $ith$ boat.

and hence $r_i n_i = n_i \frac{W_i}{w_i}$ = number of fish of required size in sampled boat.

Adding up for all sampled boats gives the number of fish for all sampled ships, as:

$$n = \sum_{1}^{m} r_i n_i$$

#### *b. Raising factors second (II)*

Continuing with this

- W = total weight landed
- w = weight landed by sampled boats (as before)

Then R = raising factor = $\frac{W}{w}$

and $R_n$ = n $\frac{W}{w}$ = total number of fish in catches.

Total number of population (N):

$$N = \frac{W_{tot}}{w_{samp}} \sum \frac{n_i W_i}{w_i}$$

*4.2.9 Basic Equipment and Materials Required for Data Collection*

Few basic equipment and materials required in sampling purpose for stock assessment survey. The equipment and materials required for various purpose in different work is presented in the Table 14.

*4.2.10 Enumerator Capacity Building for Data Collection*

The number of vessels the enumerator team is able to sample in any one day must be established before realistic target sampling targets can be set at landing site and fishing centers in 11 municipalities. It is expected that, on average, two recorders working together should be able to record a minimum of 10 boats per landing site per day.
Skilled and trained manpower is required for data collection purpose, it is not possible to collect precise data form the field without the help of skilled and trained manpower. Hence, provisions have been kept to create skilled manpower by providing required training. At least 2 persons are required to collect data from each landing site. The mentioned 2 persons will participate for full time basis to routine data collection. Because 12 days will be spent for data collection and the remaining days will be spent for accumulating data in the regional center and to enter them into the data base. In this regards, 22 Data Collector will be required collecting data from 11 landing site and 162 fishing centers.

*4.2.11 Data Entry, Processing, Analysis and Storage*

a. After the survey was conducted, data entry personnel will be identified to enter data into the database of the sheet banking largely on internship at the department.
b. In the data analysis will be carried out using only original copies of the data sheet to ensure that there is no distortion of the data base.
c. The draft report will be prepared by the supervisor and presented with the following meeting program at National Directorate of Fisheries Resource Management (NDFRM) before the next survey begins.
d. Preparation of the final report, the adoption and implementation of the report will be decided by Directorate General of Fisheries (DGF).
e. The results of the final report will then be the dissemination of information to all shareholders at the national and international level.

Table 14: List of basic equipment and materials related to data collection from sampling site.

| No | Place of use | Name of equipment | Use of the materials/Purpose |
|---|---|---|---|
| 01 | Landing Site and Fishing Centers | Scale, Measuring tape, Measuring board | To be used for length measurement |
| 02 | | Digital Balance (big) | To be used for weight measurement |
| 03 | | Digital Balance (big) | To be used for water quality from the fishing spot |
| 04 | | Refractometer | To measured levels/concentrations of dissolved substance |
| 05 | | Bucket Thermometer | To measure the surface temperature of the sea water |
| 06 | | GPS | To be used for recording the exact global position of the place |
| 07 | | Fish weighing baskets/buckets | To weigh the fish sample |
| 08 | | Clipboards | Temporarily store what we copy |
| 09 | | Sharpeners | To sharpen pencils |
| 10 | | Erasers | To remove a typing error |
| 11 | | Water proof bags | To keeping the data sheets |
| 12 | | Data sheets | Information about the activities of the survey to be considered |
| 13 | | Note books | To record / write data in the field |
| 14 | | Rope/twine or measuring tape, at least 15 m long | To measuring boat lengths |
| 15 | | Life jackets | |
| 16 | | Gumboots | To provide the ultimate combination of fit and protection |
| 17 | | Caps (with LVFO and EU logos) | Hats headwear |
| 18 | | Umbrellas | To protect the scorching sun or rain |
| 19 | Laboratory and Landing Center | Camera (Digital) | To be used for tacking picture of the sample |
| 20 | Laboratory | Digital Slide Calipers | To be used for measurement of small fish and gonads |
| 21 | | Digital Balance (small) | To be used for weight measurement of small fish and gonads |
| 22 | | Magnifying Glass | To be used for observation of gonad and small fish |
| 23 | | Microscope | To be used for observation of gonad and measurement of ova diameter |
| 24 | | Biological dissecting box | To be used for dissecting purpose |
| 25 | | Preservatives with container | To be used for preservation purpose |

# 5 GENERAL CONCLUSIONS

The Economic Exclusive Zone (EEZ) of Timor-Leste has the potential for commercial tuna fishery consisting of seven species such as Alabacore (*Thunnus alalunga*), Bigeye (*Thunnus obesus*), Pacific bluefin (*Thunnus orientalis*), Mackerel (*Euthynnus affinis*), Southern Bluefin (*Thunnus marcoyii*), Skipjack (*Katsuwonis pelamis*) and Yellowfin (*Thunnus albacares*). In order to manage the tuna fishery it is necessary to monitor the fleet and sample detailed data on catches and effort.

Based on the results of the survey in 2010-2012, there were fishing centers spread across 162 locations along the coast, fishermen there are 6,162, boats without engine 1,903 units, boats with long-tail engine 528 units, boats with outboard engines 310 unit, boats with inboard engine 5 units.

Potential fisheries on the coast north and south of Timor-Leste can give the potential role of the fishery is very important because it providing employment, addressing poverty and ensuring the availability of animal protein.

Fisheries resources have a potential role, therefore, the management should be carried out as well as possible based on justice and equality in utilization with emphasis on the expansion of employment opportunities and improve living standards for fishermen and their families and to build sustainability of fisheries resources and the environment.

The small-scale fishermen using boats of various types and sizes are too much, in general, fishing is concentrated on the shore so the reef fishery resources, demersal and small pelagic under pressure, especially in the north of the Timor-Leste.

Therefore, the is a need to plan for the implementation of the sampling scheme for capture fisheries surveys so that it can provide valid data that decision makers make fisheries resource management plan for the long term.

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