A Review on the Status of Small Pelagic Fish Resources in the Lingayen Gulf for the Year 2009-2013

Rosario Segundina P. Gaerlan[1,*], Francis Greg A. Buccat[1], Felymar C. Ragutero[1]
[1]*Department of Agriculture-Bureau of Fisheries and Aquatic Resources - Regional Fisheries Office 1, Government Center, Sevilla, City of San Fernando, La Union 2500 Philippines*

ABSTRACT

This study was carried out to increase information on the status of small pelagic fish species status in Lingayen Gulf. The information includes the catch per unit of effort of fishing gears catching small pelagic and the current status of the dominant small pelagic fish species using the National Stock Assessment Program (NSAP) standard data gathering of fisheries catch and effort. The results showed that almost 50% of the total fish harvest in Lingayen Gulf are small pelagics and the commercial fisheries sector contributed the largest catch. The commercial fishing gears that mostly catch small pelagics are the Danish seine and Trawl with an annual catch per unit of effort ranging from 899 to 1,186 kg/day and 65.98 to 119.77 kg/day, respectively. The municipal fishing gears, bottom set gillnet and bottom set longline had an annual catch per unit of effort ranging from 7.04-42.95 and 7.19-13.30 kg/day, respectively. The dominant small pelagic species are *Decapterus maruadsi, Decapterus macrosoma, Selar crumenophthalmus, Rastrelliger brachysoma*, and *Rastrelliger kanagurta*. The dominant species caught by commercial fishing gears are mostly juveniles while the dominant species caught by municipal fishing gears attained maturity before they are caught. Exploitation ratio (E-values) of the dominant small pelagic species in this study exceed the optimum level of 0.5, an indication of overexploitation due to high fishing pressure.

A reproductive-biology study on small pelagic fish species is recommended to be conducted in Lingayen Gulf to determine spawning season as an additional basis to recommend fisheries management initiative for the conservation and protection of the stocks.

*E-mail: *rosariosegundinagaerlan@yahoo.com*

Keywords: *Small pelagic, Resources in Lingayen Gulf*

Received: *17 March 2017*
Accepted: *28 October 2017*

1. INTRODUCTION

The small pelagic fish contributes substantially to food security since it is considered as a less expensive protein source in any range, either be fresh, dried, paste or fermented, or in canned products. Small pelagic fish also provides a substantial source of income due to its abundance that makes it important to the commercial fishing sector as well as the municipal sector in terms of total production. It consists of fish families like Carangidae, Engraulidae, Clupeidae, Scombridae, Caesionidae, Exocoethidae and Hemiramphidae (Zaragoza et al. 2004).

But, the small pelagic are extremely frail with unexpected large mortality (Misund and Beltestad 1995) and their eggs and larvae are very vulnerable to predation and with strict environmental conditions (Bakun 1996). Although it grows fast, the small pelagic species generally attain a maximum weight of less than 500 g and has a short life span (Dalzel and Ganaden 1987) and may even decrease its average lifespan due to high reduction or exploitation (Longhurst 2002). A study of the Lingayen Gulf fisheries has been conducted by Gaerlan et al (2005) from the year 1998 to 2002. The study aims to determine the catch composition of the different gears operating in the gulf, including its production estimates; seasonality, population parameters, and yield per recruit analysis of the top species; and the maximum sustainable yield (MSY) of Lingayen Gulf. As per result, 65% of the total commercial production was contributed by Danish seine and 31% of its total yield is short fin scad (Decapterus macrosoma) whereas the trawl having 35% share to the total production of commercial fisheries, and was dominated by short mackerel (Rastrelliger brachysoma). Danish seine and trawl are considered efficient because of the wide range of species it can catch primarily demersal species, but also small pelagic stocks (Mesa et al., unpublished). Considering also their importance in marine food web (Duarte and Garcia 2004; Ward et al. 2008) and the availability of studies focusing on small pelagic in Lingayen Gulf is few, there is a need to increase information on the current exploitation of small pelagic fish in Lingayen Gulf.

Objectives of the Study

This study generally aims to determine the recent fishing status of the small pelagic resources of Lingayen Gulf based on the following indicators:

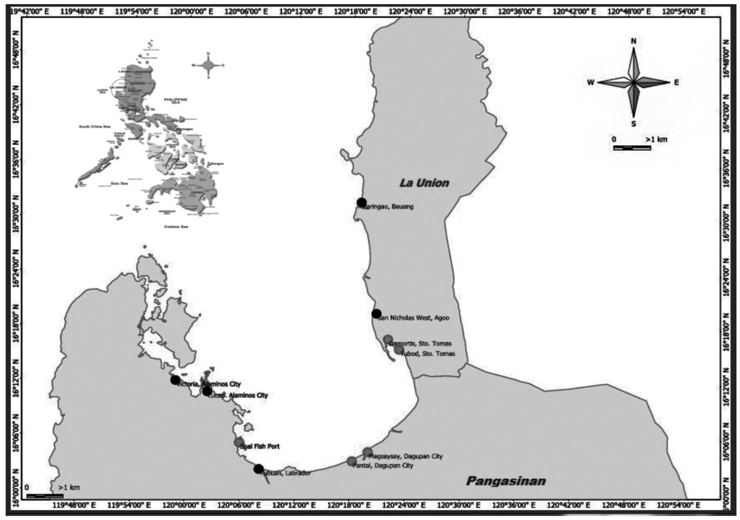

Figure 1. Map of Lingayen Gulf showing NSAP landing sites

1. Gear and Boat Inventory
2. Annual Catch and CPUE trend for Major Commercial Fishing Gears
3. Annual Catch and CPUE trend for Major Municipal Fishing Gears
4. Relative distribution of major fishing gear catching small pelagic
5. Relative Abundance of small pelagic by family and species
6. Seasonality of selected small pelagic species
7. Length Frequency Distribution of dominant small pelagic
8. Growth/Mortality Parameters of selected small pelagic species
9. Exploitation values of selected small pelagic species

Limitation of the Study

This study focused only on the dominant small pelagic fish species that are identified belonging to the top 20 and has a significant contribution to commercial and municipal fish harvest for the year 2009 to 2013. Only the most dominant small pelagic fish species are selected and presented for their seasonality, length frequency distribution and processed in FISAT for population parameters.

Description of the Study Area

Lingayen Gulf is a major area for capture fisheries, aquaculture, and coastal tourism in northwestern Luzon. It is a semi-circular embayment located off the coast of Pangasinan (west and south) and La Union (northeast) Provinces between 16˚ and 17˚ N latitude and 119˚ and 121˚ E longitude. The gulf has an approximate area of 2,100 km^2 with 160 km of coastline from Cape Bolinao to Poro Point. Its marine water area covers an area of 2,610 km^2 with an average depth of 46 meters and a maximum chartered depth of about 200 meters along its northern boundary (McManus et al. 1990).

It is influenced by two major airstreams: the northwesterly winds which prevail during the dry season, and the southwesterly winds which dominate the wet season. The Lingayen coastal area includes 14 municipalities and three (3) cities. With three major water systems namely: Agno, Pantal-Sinocolan, and Cayangan Pantalan. Among of this three, the Agno River is the longest with 275 km long (McManus et al. 1990).

2. METHODOLOGY

Assessment of the Lingayen Gulf's fisheries started from September 1997 and is a continuing activity up to the present. For this paper, however, results presented and analyzed contain five years data starting January of CY 2009 to December CY 2013.

Sampling Sites

Sampling was conducted in ten sites, five (5) from commercial landing sites, where commercial fishing boats (more than 3 GT) landed and five (5) from municipal landing sites, where municipal boats (3 GT and below) landed. Ten enumerators conducted sampling surveys on the landed catch and gears of the commercial and municipal fishing boats.

1.1. Commercial landing sites surveyed at:
   a. Damortis, Sto. Tomas, La Union
   b. Tubod, Sto. Tomas, La Union
   c. Pantal District, Dagupan City, Pangasinan
   d. Magsaysay District, Dagupan City, Pangasinan
   e. Sual fish port, Sual, Pangasinan

1.2. Municipal landing sites surveyed at:
   a. Paringao, Bauang, La Union
   b. San Nicolas West, Agoo, La Union
   c. Tobuan, Labrador, Pangasinan
   d. Victoria, Alaminos City, Pangasinan
   e. Lucap, Alaminos City, Pangasinan

Sampling Methods

Collection of catch and effort data on selected landing sites was conducted every other two days regardless of Saturday, Sunday and Holidays. Commercial landing sites were sampled for the first day while the municipal landing sites were sampled on the second day. This was done throughout the month so that a total of twenty sampling days were conducted, ten days for each type of fishery. In cases where there are 31 days in a month, the commercial landing sites are sampled for eleven days. All pertinent data on the landed catch were recorded such as:

- name of the fishing ground
- landing center
- date of sampling
- name of boat/number of fishing days/ the actual fishing operation (time)
- total catch by boat (no of boxes/bañeras or weight by kgs)
- catch sample weight (kgs)
- length measurements (fish length & frequency)
- catch composition (scientific names of the marine species)
- name and signature of samplers/recorders

Inventory of Fishing Boat and Gear

Fishing boats and gear inventory were conducted in coastal municipalities along the Lingayen Gulf. For the commercial sector, inventory was done annually while for the municipal sector, inventory of boats and gear from the landing sites was conducted every other five years, the last inventory was conducted in 2008.

Data Processing and Analysis

All data collected were encoded and managed in database and MS Excel. This was further processed in MS Excel to generate data into tables and graphs to obtain all necessary indicators that include:

Catch, Effort, CPUE

Catch is expressed in metric tons while effort used the number of fishing day operation per sector and fishing gear. The monthly total catch was divided by the corresponding total days of fishing operation per month and per gear to derive the computed catch per unit of effort (CPUE) expressed in kg/day.

Catch Estimates

Estimated catch per boat of the different gears per landing site was computed from the monthly total catch of each gear per site multiplied by the raised fishing days. Raised fishing days were derived from the product of the raising factor to determine the raised catch per boat per month.

Relative Abundance and Seasonality of Dominant Species

Ranking was used to analyze the top species and family of catch composition based on the total yield regardless of the gears used and the sector. Also included is the monthly catch from 2009-2013 to determine the seasonal pattern of the dominant species.

Length frequency Data

Selected dominant small pelagic were monitored biologically by doing random sampling of length measurements per sampling day per month. The accumulated length frequencies were raised in order to get an estimated number of pieces in the entire population of a particular species landed per day using the weighted value. Computation of length frequency raising use the formula:

$$\text{Raising factor} = \frac{\text{Total weight of species landed}}{\text{Sampled weight}}$$

$$\text{Raised length frequency} = \text{Frequency per mid-length} \times \text{raising factor}$$

This raised length frequencies per species were used as inputs in the FiSAT software to determine its population parameters and to assess the stock status of a particular species.

Population parameters of dominant small pelagic fish species were processed using the FAO-ICLARM Stock Assessment Tools (FiSAT) software version 1.2.2 or FiSAT II (Gayanilo et al. 1996). The following are included in the software such routines to estimate the parameters in von Bertalanffy Growth Function (VBGF). ELEFAN using the Electronic Length Frequency Analysis is also one of the routines to estimate the length infinity and growth constant (k) from the k-scan. Powell-Wetherall plot estimates the ratio of mortality and K. The total mortality (Z) divided by the fishing mortality (F) obtained a quotient of the exploitation rate (E).

Growth parameters were determined first by estimating L_∞ (asymptotic length) using Powell-Wetherall method (Gayanilo and Pauly 1997) based on the equation of Beverton and Holt (1956):

$$Z = k\,((_{L\infty} - L) / (L - L'))$$

where Z is the total instantaneous mortality, k is the growth coefficient, L is the mean length, L_∞ is the asymptotic length, and L' is the initial length of the sample.

The estimated value of L∞ was further processed in ELEFAN I (ELectronic LEngth Frequency ANalysis) (Gayanilo and Pauly 1997) for the verification of the value for L_∞ and k. Analysis of the estimation of growth parameters and mortality used the von Bertalanffy growth equation of:

$$Lt = L_\infty\ (1 - e\ {-k(t\text{-}to)})$$

where Lt is the length of fish at age t, e is the base of the Naperian logarithm, to is the hypothetical age the fish would attain at length zero.

Mortalities and exploitation rate were then calculated using the equation:

$$Z = M+F$$

where Z is the instantaneous total mortality, M is the instantaneous natural mortality due to predation, aging, and other environmental causes, and F is the instantaneous fishing mortality caused by fishing.

Furthermore, M was estimated using Pauly's (1984) empirical formula of:

$$\text{Log } M = 0.654 \text{ Log } k - 0.28 \text{ Log } L_\infty + 0.463 \text{ Log} T$$

where L∞ and k are the Von Bertalanffy Growth Function (VBGF) growth parameters and T is the annual mean habitat temperature (˚C) of the water in which the stock in question lives.

Expanding the equation for mortality would lead us to the computation of exploitation rate using:

$$E=F/Z$$

where E is the exploitation rate. Using the equation from growth parameters and mortalities, prediction of recruitment patterns and virtual population analysis could be estimated using the routines found in FiSAT programs (Gayanilo and Pauly 1997).

Beverton and Holt's (1957) relative yield per recruit and biomass per recruit models were used in the prediction of yield and standing biomass. Relative yield per recruit model is suitable for assessing the effect of mesh size regulations and it belongs to a length-based model as parameters. Biomass per recruit on the other hand expresses the annual average biomass of survivors as a function of fishing mortality, and that average biomass is related to the catch per unit of effort. The said prediction model uses the equations:

$$(Y/R)' = E^*U\ M/k\ (1\text{-}3U/1\text{+}m + 3U2/1\text{+}2m\ - U3/1\text{+}3m)$$

$$(B/R) = \exp(-M^*(Tc\text{-}Tr))\ ^*W_\infty{}^*\ (1/Z - 3S/Z\text{+}k + 3S2/Z\text{+}2k - S3/Z\text{+}3k)$$

where:

$m = \dfrac{1\text{-}E}{M/k} = k/Z$ E = F/Z T_c – Age at first catch

$U = 1\text{-}\ Lc/L_\infty$ Tr – Age at first recruit W – weight at infinity

3. RESULTS AND DISCUSSION

There are ten NSAP sampling sites in Lingayen Gulf with five commercial and five municipal landing sites. Eight sites were monitored with small pelagic fish species landings, that is all commercial and the three municipal landing sites. The two remaining municipal landing sites are Brgy. San Nicolas West, Agoo and Brgy. Paringao, Bauang which catch mostly large pelagic fish species.

Boat Inventory

The number of fishing boats from the year 2009-2013 based on actual inventory is shown in Figure 2. Most of the fishing boats are mainly from the municipal landing sites covered by NSAP. The NSAP landing sites with the highest number of boats landed are in La Union (Brgy. San Nicolas West, Agoo and Brgy. Paringao, Bauang) and in Pangasinan (Brgy. Tobuan, Labrador). The least number of municipal boats operating in Lingayen Gulf is found in Brgy. Lucap and Brgy. Victoria, Alaminos City in Pangasinan. Commercial fishing boats of Lingayen Gulf based on actual inventory are mostly within the medium-scale (3.1 – 100 GT). Brgy. Damortis and Tubod, Sto. Tomas in La Union have 21 and seven fishing boats, respectively, mainly using the trawl fishing gear. Brgy. Pantal and Magsaysay in Dagupan City, Pangasinan use Danish seine having a total of 14 and 11 boats, respectively. In the fish port of Poblacion, Sual in Pangasinan, there is a total of 17 fishing boats using Danish seine and trawl.

Gear Inventory

The landed gears from the year 2009-2013 based on actual inventory are shown in Table 1. Most of the numbers of fishing gears are from municipal sector; the line gears such as handline, multiple handline, and bottom longline outnumber most of the gears. The least number of gears operating among municipal fishing gears are speargun, fish trap/pot, and push net. For the commercial sector, the Danish seine has 37 units while trawl has 29 units. Results are compared from the total boat and gear inventory conducted by 10 enumerators in the 10 landing sites of Lingayen Gulf in 2008 and observed an increase in the number of boats and gears. The major fishing gears catching small pelagic in Lingayen Gulf are handline, bottom set gillnet, speargun, and the two commercial gears.

Catch and CPUE

Table 1 shows the estimated total and the annual contribution of small pelagics, and its relative abundance in Lingayen Gulf from 2009-2013. Generally, the small pelagic contribute almost 50% of the total estimated yield from the year 2009-2013. The same to what Freon et al. (2005) cited that small pelagic contributes 50% of the total landings of marine species. The highest yield of small pelagics was 57.39% in the year 2010, and the lowest was 45.92% in the year 2012.

The annual estimated yield on small pelagic fish in Lingayen Gulf by sector is presented in Figure 3. Based on the graph, the commercial sector contributed most of the yield as compared to municipal sector.

Table 1. Relative percentage contribution of small pelagic fish to the estimated total yield of Lingayen Gulf for the year 2009 – 2013

Year	Total Yield (MT)	Small Pelagic Yield (MT)	% Contribution of Small Pelagic
2009	474.08	255.93	53.98
2010	618.91	355.19	57.39
2011	615.24	344.41	55.98
2012	563.12	258.61	45.92
2013	564.70	282.71	50.06

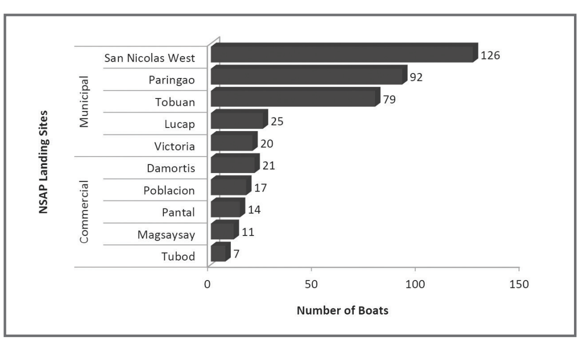

Figure 2. Number of fishing boats for commercial and municipal landing sites in Lingayen Gulf from 2009-2013

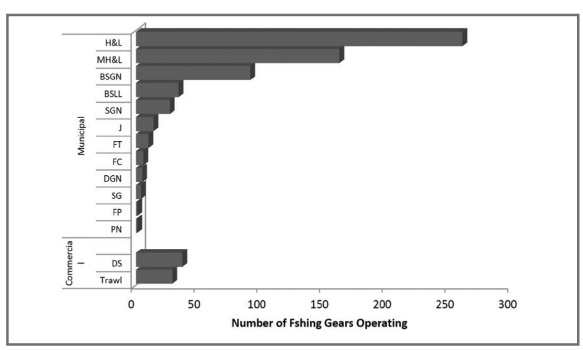

Figure 3. Number of fishing gear for commercial and municipal sector in Lingayen Gulf from 2009-2013

It shows a fluctuating trend from 2009-2013. The decrease in catch is also observed in 2011 for the municipal sector which was found to be associated with the reduction of total yield of bottom set gillnet. For the commercial sector, there was an increase from 2009 to 2010 and a decrease from 2010 to 2012, while for the municipal sector there was an increase from 2009 to 2010 and from 2012 to 2013, respectively.

The trend of catch, effort, and CPUE is important in determining the changes in small pelagic stock. In this study, the annual CPUE is expressed in kg/day for the commercial gears (Figure 4) and municipal gears (Figure 5) in Lingayen Gulf for the year 2009 to 2013. The standard effort used was the number of fishing days.

As observed, the catch and CPUE of Danish Seine has a decreasing trend (Figure 5). The highest annual CPUE of Danish seine is attained in 2010 while the lowest is in 2012. For the trawl, smaller range of annual CPUE from 4.98 – 27.90 kg/day, an irregular trend of catch, and a decreasing CPUE are observed. The lowest CPUE is observed in 2012 (65.70 kg/day) and the highest is in 2009 (119.77 kg/day).

The main fishing gears that catch a large volume of small pelagic fish among municipal gears in Lingayen Gulf are bottom set gillnet and bottom set longline. The catch, effort, and CPUE of these two gears are presented in figure 6. For bottom set gillnet, the CPUE is found highest in 2013 and lowest in 2009. The observed sudden decrease in catch and CPUE of bottom set gillnet in 2011 is associated with the effort. There is no operation of gillnetters in Lingayen Gulf during the first and second quarter. For bottom set longline, the minimum CPUE is observed in 2009 with 1.07 kg/day and the maximum CPUE is observed in 2010 with 2.68 kg/day of small pelagic fish.

Relative Distribution by Gear

Figure 7 shows the relative distribution of the commercial and municipal gears catching small pelagic in Lingayen Gulf from the year 2009 to 2013. Between the two commercial fishing gears, the Danish seine dominated the highest catch on small pelagic by 90.65%. The trawl that usually targets demersal fish has 6.68% catch on small pelagic fish. The remaining percentages fall into the municipal gears such as the bottom set gillnet (1.61%), bottom set longline (0.66%), fish corral (0.29%), and other gears (0.10%).

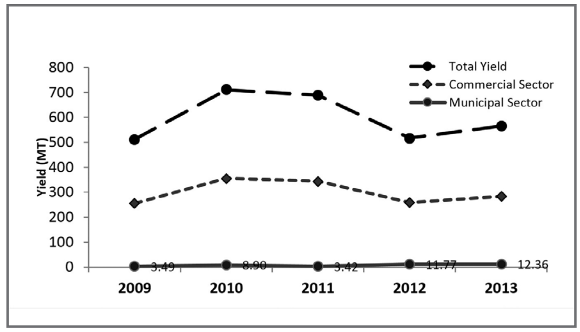

Figure 4. Annual yield of small pelagic fish in Lingayen Gulf for the year 2009 to 2013

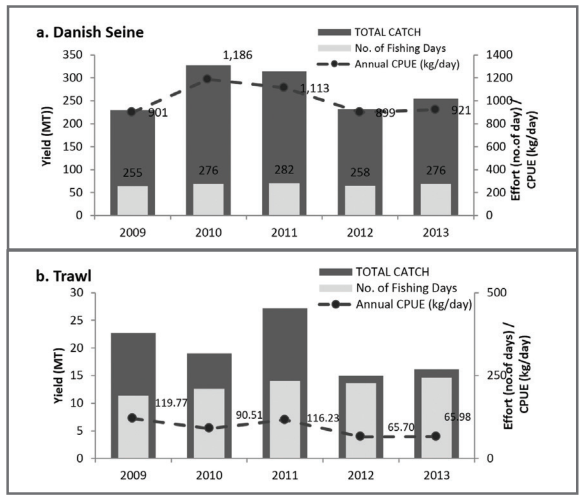

Figure 5. Annual catch, effort, and CPUE of major commercial fishing gear Danish Seine (a) and Trawl (b) of small pelagic fish of Lingayen Gulf for the year 2009 to 2013

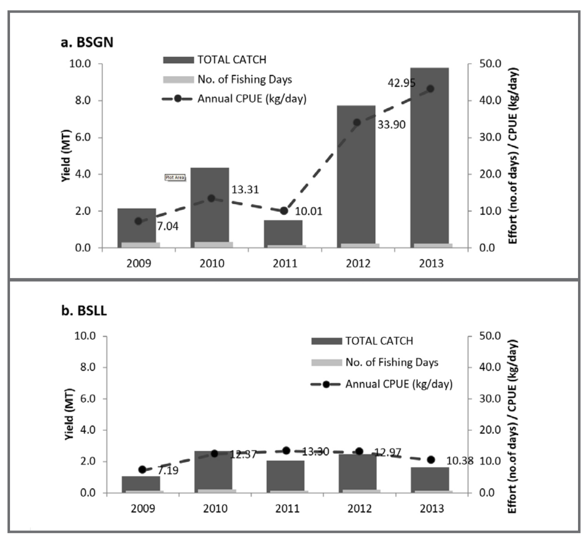

Figure 6. Annual catch, effort, and CPUE of major municipal fishing gear Bottom Set Gillnet (a) and Bottom Set Longline (b) of small pelagic fish Lingayen Gulf for the year 2009 to 2013

Relative Abundance by Family

Figure 8 shows the relative abundance of dominant small pelagic fish of Lingayen Gulf for the year 2009 to 2013. Among the six families, Carangidae garnered the highest catch percentage of 72.45%, followed by Scombridae (18.37%), Menidae (5.67%), Engraulidae (2.07%), Clupeidae (0.97%), and Caesionidae (0.40%). Based on the five-year data, the six dominant small pelagic fish family are mainly caught by fishing gears Danish seine, trawl, bottom-set gillnet, bottom-set longline, and fish corral.

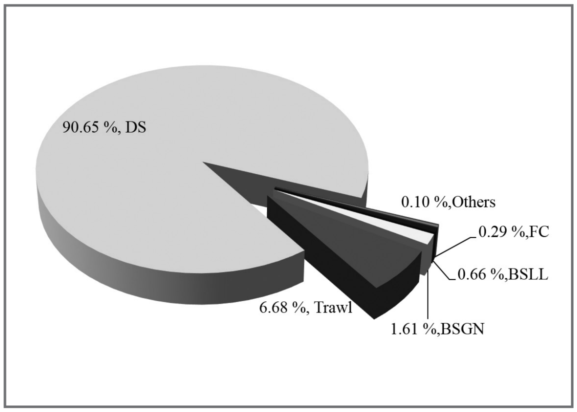

Figure 7. Relative distribution of small pelagic caught by different fishing gears of Lingayen Gulf from 2009 to 2013

Species Relative Abundance

The 20 dominant species of small pelagic fish identified based on the volume of the catch is shown in Table 2. The English and local names of these 20 species were taken from Ganaden and Lavapie-Gonzales (1999). Among these, there is Carangidae species *Decapterus maruadsi* (32%) and *Decapterus macrosoma* (16.17%), which are both caught by Danish seine and trawl; and *Selar crumenopthalmus* (11.78%) which is caught by the two commercial gears and bottom set gillnet. These three are relatively abundant, which comprises the large catch of small pelagic fish in Lingayen Gulf.

The Danish seine, trawl, bottom set gillnet, and bottom set longline also caught the species of Scombridae *Rastrelliger brachysoma* (8.96%) and *Rastrelliger kanagurta* (7.58%), and the species of Carangidae *Atule mate* (5.77%). Then, the *Mene maculata* (5.75%), the only species of Menidae caught by Danish Seine, but mainly by trawl. The least abundant among the species are from the family Engraulidae, Clupeidae, Caesionidae, and two species of Carangidae and Scombridae. Generally, the 20 dominant small pelagic fish species are caught mostly by Danish seine and trawl, except the species *Caesio cuning* which is caught only by fish corral and bottom set longline.

The top 10 small pelagic fish species of commercial and municipal gears in Lingayen Gulf is shown in Table 3. For commercial fishing gears with top species caught, the Danish seine mainly caught the *Decapterus maruadsi* (35.40%) while the trawl caught *Mene maculata* (25.91%). For major municipal fishing gears catching small pelagic fish, bottom set gillnet caught *Rastrelliger brachysoma* (57.09), bottom longline caught *Caesio cuning* (51.43%), and fish corral caught *Anodontosma chacunda* (87.75%).

As observed most of the gears catching small pelagic fish species in Lingayen Gulf are demersal fishing gears. Though the fishing gears Danish seine, trawl, bottom set gillnet, and bottom set longline are known to target demersal species, it can also catch pelagic fish species where Mesa et al. (unpublished) considered efficient because of the wide range of species it can catch. Just like the bottom dragged gears such as trawl, they also have the tendency to catch mid-water and pelagic species because of high mount openings (Armada 1998). This is also due to the fact that many pelagic species, especially medium-sized ones, are frequently found close to the bottom during daytime and are, therefore, vulnerable to semi-pelagic fishing gear and even to bottom trawls (Nieland 1982).

Seasonality of Selected Species

Figure 9 shows the monthly seasonal pattern of most dominant small pelagic species in Lingayen Gulf for the year 2009 to 2013. For *Decapterus macrosoma (a)* and *Decapterus maruadsi (b)*, a variation of the monthly seasonal pattern is observed. For *Decapterus maruadsi*, most observable peak months are August and April while *Decapterus macrosoma* peaks in the second and third quarter months.

For *Selar crumenophthalmus (c)*, the peak is mainly in the month of July. For *Rastrelliger brachysoma (d),* the peak months are observed mostly in the second quarter of the year, but also peaks during June, July, and August of 2012 and 2013. The species *Rastrelliger kanagurta (e)* peaks during months of the third to last quarter of the year. *Mene maculata* (f) peaks during the last quarter and continues until the first quarter of the succeeding year.

Table 2. Relative abundance of dominant species of small pelagic fish of Lingayen Gulf for the year 2009 to 2013

Family/Species	Common English Name	Local Name	%
Decapterus maruadsi	Japanese scad	Galunggong/Bulilit	32.09
Decapterus macrosoma	Shortfin scad	Galunggong/Bulilit	16.17
Selar crumenophthalmus	Bigeye scad	Mataan/Matangbaka	11.78
Rastrelliger brachysoma	Short mackerel	Hasa-hasa/Kabalyas	8.96
Rastrelliger kanagurta	Indian mackerel	Alumahan/kabalyas	7.58
Atule mate	Yellowtail scad	Ekol/Salay batang	5.77
Mene maculata	Moonfish	Bulan-bulan/Sapatero	5.76
Selar boops	Oxeye scad	Mataan/Matangbaka	3.68
Decapterus kurroides	Redtail scad	Urot/Galunggong	1.92
Rastrelliger faughni	Island mackerel	Kabalyas	1.6
Stolephorus indicus	Indian anchovy	Dilis	1.21
Selaroides leptolepis	Yellowstripe scad	Balanghay ekol	0.97
Stolephorus commersonnii	Commerson's anchovy	Dilis	0.83
Sardinella gibbosa	Goldstripe sardinella	Tamban	0.45
Caesio cuning	Redbelly yellowtail fusilier	Dalagang bukid	0.40
Anodontostoma chacunda	Chacunda gizzard shad	Kabasi	0.28
Auxis thazard	Frigate tuna	Tulingan	0.24
Amblygaster sirm	Spotted sardinella	Tamban	0.23
Decapterus tabl	Roughear scad	Galunggong/Bulilit	0.07
Sardinella lemuru	Bali sardinella	Tamban	0.01

Table 3. Top small pelagic species caught by (a) commercial and (b) municipal fishing gears operating in Lingayen Gulf for the year 2009 to 2013

	Species	%			Species	%
A. Commercial						
	Danish Seine				**Trawl**	
1	*Decapterus maruadsi*	35.40		1	*Mene maculate*	25.91
2	*Decapterus macrosoma*	17.79		2	*Rastrelliger brachysoma*	17.69
3	*Selar crumenophthalmus*	12.66		3	*Stolephorus indicus*	14.27
4	*Rastrelliger kanagurta*	7.73		4	*Stolephorus commersonnii*	12.49
5	*Rastrelliger brachysoma*	7.54		5	*Selar boops*	7.16
6	*Atule mate*	6.00		6	*Sardinella gibbosa*	6.73
7	*Mene maculate*	4.44		7	*Selar crumenophthalmus*	3.92
8	*Selar boops*	2.89		8	*Rastrelliger kanagurta*	3.73
9	*Decapterus kurroides*	2.12		9	*Atule mate*	3.35
10	*Rastrelliger faughni*	1.76		10	*Amblygaster sirm*	1.99
	Others	1.66			Others	2.75
B. Municipal						
	Bottom Set Gillnet				**Bottom Set Longline**	
1	*Rastrelliger brachysoma*	57.09		1	*Caesio cuning*	51.43
2	*Rastrelliger kanagurta*	18.74		2	*Selar boops*	37.54
3	*Selar boops*	18.29		3	*Atule mate*	9.08
4	*Selar crumenophthalmus*	3.07		4	*Rastrelliger brachysoma*	1.45
5	*Atule mate*	2.61		5	*Rastrelliger kanagurta*	0.50
6	*Rastrelliger faughni*	0.18				
7	*Anodontostoma chacunda*	0.02				
	Fish Corral				**Others**	
1	*Anodontostoma chacunda*	87.75		1	*Caesio cuning*	55.98
2	*Selar boops*	11.22		2	*Decapterus macrosoma*	16.98
3	*Caesio cuning*	0.70		3	*Rastrelliger kanagurta*	11.44
4	*Selaroides leptolepis*	0.33		4	*Rastrelliger brachysoma*	10.14
				5	*Selar boops*	5.85

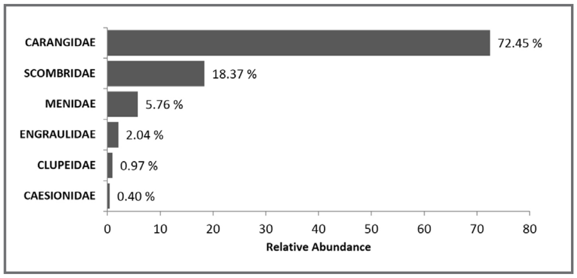

Figure 8. Relative abundance of dominant small pelagic fish family in terms of volume of catch in Lingayen Gulf for the year 2009 to 2013

Length Frequency Distribution Analysis

The data on length frequency distribution of the dominant small pelagic species was processed and analyzed for a specific year using one-centimeter class interval, and the length at first capture (L50/Lc) and the length at first maturity (Lm) as indicators of exploitation. The L50/Lc is the length at which 50% of the fish of that size are vulnerable to capture (Sparre 1987) while the Lm is the average length at which fish of a given population mature for the first time.

The commercial gear Danish seine is the only gear catching the Japanese scad (*Decapterus maruadsi)* with a minimum mid-length caught of 11.5 cm and a maximum mid-length of 17.5 cm (Figure 10). For the year 2012, Japanese scad generated L50/Lc of 13.64 cm and Lm of 17.1 cm. Based on these indicators, it was observed that the generated L50/Lc is less than the Lm, which means Japanese scad is vulnerable to capture without attaining maturity. Danish seine also caught almost 99.97% juvenile of Japanese scad while only 0.03% attained maturity stage.

Figure 11 shows the *Decapterus macrosoma* with a minimum mid-length caught of 7.5 cm and a maximum mid-length of 22.5 cm is observed. The commercial gears Danish seine and trawl are the gears catching shortfin scad. For the year 2012, it generated L50/Lc of 9.3 cm and Lm of 19.6 cm. It was observed, based on these indicators, that the generated L50/Lc is far less than the Lm. Danish seine and trawl exploited mostly (99%) juveniles.

The big-eye scad (*Selar crumenophthalmus)* for the year 2013 has a minimum mid-length of 12.5 cm and a maximum mid-length of 28.5 cm caught (Figure 12). It generated L50/Lc of 15.54 cm and Lm of 20.5 cm for. The generated L50/Lc is less than the Lm. This was caught by the commercial gears Danish seine and Trawl, and the municipal gear bottom set gillnet. These three fishing gears catch lengths of almost 90-95% beyond the Lm; however, the commercial gears exploited smaller big-eye scad compared to municipal gear.

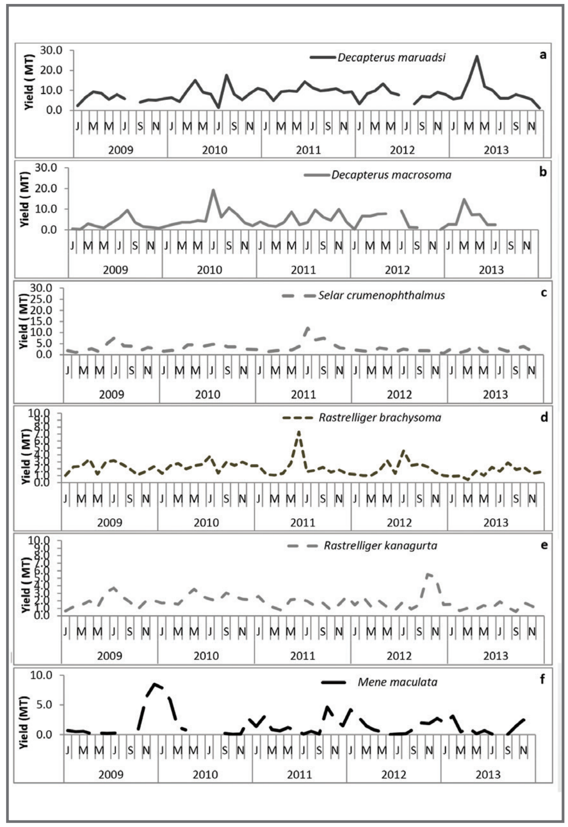

Figure 9. Seasonality of dominant small pelagic fish family of Lingayen Gulf for the year 2009 to 2013

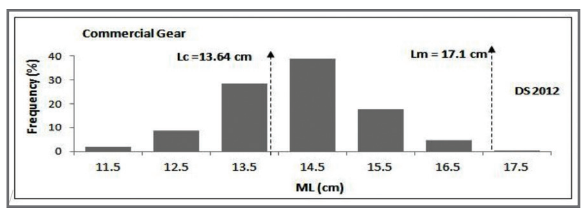

Figure 10. Length frequency distribution of *Decapterus maruadsi* by commercial gear, Danish seine in Lingayen Gulf for the year 2012

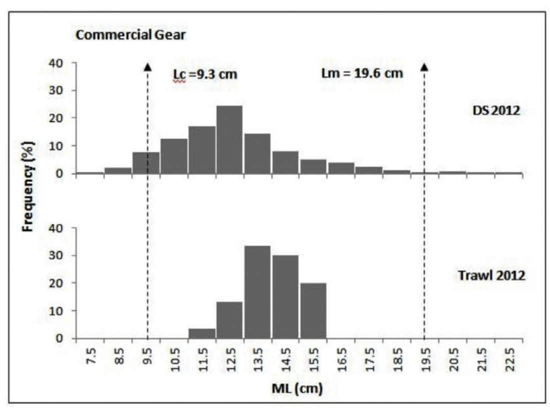

Figure 11. Length frequency distribution of *Decapterus macrosoma* by commercial gears, Danish seine and Trawl in Lingayen Gulf for the year 2012

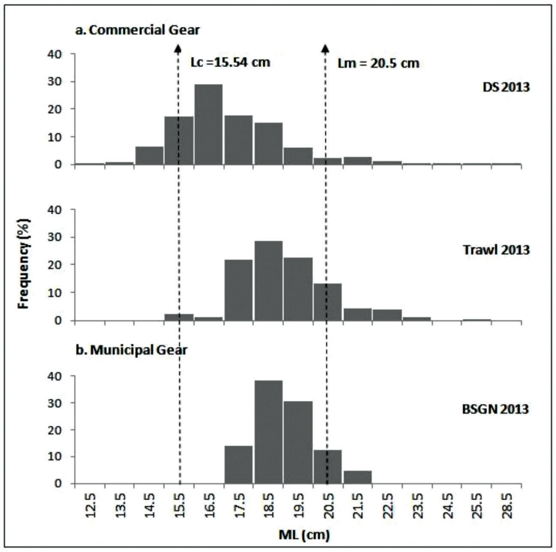

Figure 12. Length frequency distribution of *Selar crumenophthalmus* by commercial gears (a), Danish seine and Trawl; and municipal gear (b), bottom set gillnet in Lingayen Gulf for the year 2013

In 2012, the *Rastrelliger brachysoma* has a minimum mid-length of 11.5 cm and a maximum mid-length of 44.5 cm caught (Figure 13). It generated 12.34 cm length at first capture and 18.0 cm length at first maturity. Based on these indicators, it was observed that the generated Lm is greater than the L50/Lc. The commercial fishing gears caught sizes beyond the Lm; almost 65% for trawl and 93% for Danish seine are juveniles. In the case of municipal fishing gears, 44% for bottom set gillnet and almost 100% for bottom set longline are mature and are capable of reproduction.

Figure 14 shows that the *Rastrelliger kanagurta* has a minimum mid-length of 9.5 cm and a maximum mid-length of 32.5 cm, caught by commercial gears and municipal gears in 2012. It generated 14.25 cm length at first capture and 20 cm length at first maturity. It was observed, based on these indicators, that the generated L50/Lc is less than the Lm, same as the other dominant species stated. The commercial fishing gears catch lengths beyond the Lm; almost 77% for trawl and 88% for Danish seine are juveniles. For municipal gears, most of the sizes caught are mature by 96% for bottom set longline; and only 47% for bottom set gillnet.

Generally, municipal gears observably catch bigger size of most of the dominant small pelagic species over commercial gears. The captured sizes of bottom set gillnet especially the bottom set longline are mostly sexually mature and likely spawned before caught. In contrast, most of the dominant small pelagic species caught by commercial gears are juveniles and not yet mature. This implies that municipal gears are better than commercial gears since most of the stocks caught attained maturity, especially for the bottom set longline, thus not contributing to growth overfishing.

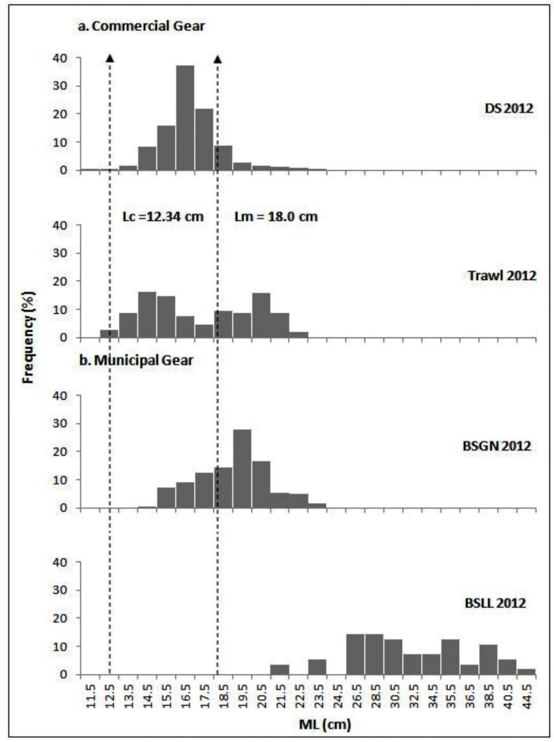

Figure 13. Length frequency distribution of *Rastrelliger brachysoma* by commercial gears (a), Danish seine and Trawl; and municipal gears (b), bottom set gillnet and bottom set longline in Lingayen Gulf for the year 2012

Growth Parameters

Growth parameters include the length infinity (L_∞), growth constant (K), and the growth index (Ø’). The length infinity, also known as asymptotic length, is the length that the fish of a population would reach if they were to grow indefinitely. The growth constant (K), also known as growth coefficient, is a parameter of the Von Bertalanffy growth function expressing the rate (1/year) at which the asymptotic length is approached. The growth performance index or the phi prime is the weight-based index of growth performance.

Table 4 shows the growth parameters obtained and the data from other literatures for dominant small pelagic species (Froese et al. 2011; Lavapie-Gonzales et al. 1997). For *Decapterus maruadsi*, the L_∞ is not stable thru time; likewise to *Decapterus macrosoma* and *Selar crumenophthalmus*.

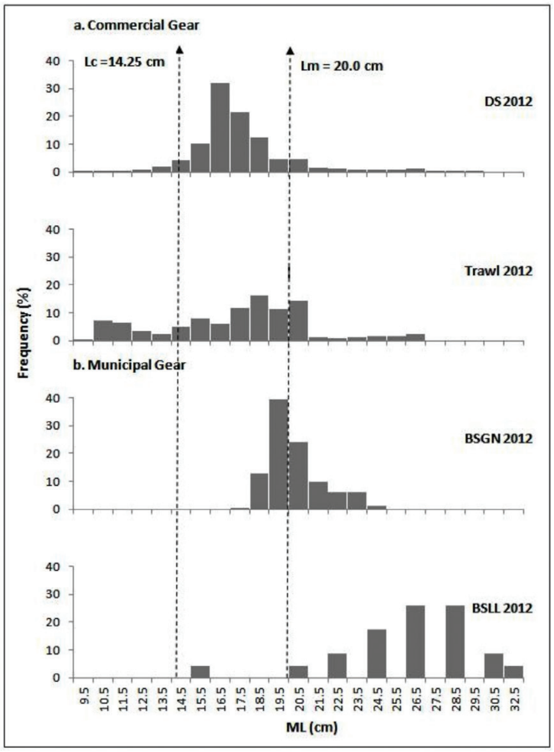

Figure 14. Length frequency distribution of *Rastrelliger kanagurta* by commercial gears (a), Danish seine and Trawl; and municipal gears (b), bottom set gillnet and bottom set longline in Lingayen Gulf for the year 2012

The length infinity of *Decapterus maruadsi* is found lesser than the L_∞ of other literature because only the Danish seine caught the species that resulted in the narrow range of length captured. Same is true with the species *Decapterus macrosoma* (L_∞ = 17.85) since the gears Danish seine and trawl were catching the species at their juvenile stage. For *Selar crumenophthalmus*, its L_∞ is within other literature; the highest L_∞ of 35.96 is observed in 2013. *Rastrelliger brachysoma* and *Rastrelliger kanagurta* have also unpredictable length infinity found in other literature values. The values of K and the growth index showing small pelagic fish are fast growing species.

Mortality Parameter and Exploitation

The mortality parameters constitute the total mortality (Z) that is the summation of natural mortality (M) and fishing mortality (F). Natural mortality is caused by predation, disease, and deaths due to aging while fishing mortality is the reduction of stock due to fishing. The values of Z and F are used to obtain the exploitation rate (E) from the ratio of F over Z. High ratio beyond the threshold value of 0.5 indicates overexploitation of the stock in a certain fishing ground.

The average mortalities of the dominant small pelagic species are presented in Table 6. The F values exceeded the M values, which suggest a high exploitation among small pelagic species analyzed. *Rastrelliger kanagurta* obtained an E value of 0.50 while *Rastrelliger brachysoma* obtained 0.68. *Selar crumenophthalmus* obtained an E value of 0.75 while *Decapterus macrosoma* obtained 0.57. This indicates overfishing among the dominant small pelagic species. The annual exploitation of the most dominant small pelagic species from the year 2009-2013 is shown in Figure 15.

The exploitation value of *Decapterus maruadsi* was found highest in 2011 (E 0.66) and lowest in 2010 (E 0.34). On the contrary, high exploitation value is observed in 2010 for *Decapterus macrosoma* (E 0.64) while 2012 is the lowest with 0.52. For the two *Rastrelliger* species, the exploitation value was an exact opposite. In 2011, the exploitation value for *Rastrelliger kanagurta* (E 0.59) was found highest among other years while it was lowest for *Rastrelliger barchysoma* (E 0.54). The highest exploitation value for *Rastrelliger brachysoma* is in 2009 and 2012 while it was the lowest for *Rastrelliger kanagurta*. The *Selar crumenopthalmus* has the highest exploitation among other small pelagic species. The E value is as high as 0.86 in 2013 and as low as 0.62 in 2011. The computed average for the most dominant species is shown in Table 5.

4. SUMMARY AND CONCLUSION

Small pelagic fish species in Lingayen Gulf contribute almost 50% of the total production of Lingayen Gulf. Bulks of this small pelagic are composed of species from the family Carangidae, Scombridae, Menidae, Engraulidae, Clupeidae, and Caesionidae; and contributed the most in the commercial sector with decreasing catch trend from 2009-2013. The commercial fishing gears that could catch the most are Danish seine and trawl while for the municipal fishing gears are bottom set gillnet and bottom longline. The two commercial gears show a little decrease in catch per unit effort (CPUE) annually, whereas the municipal gear shows an increase of CPUE.

The species *Decapterus maruadsi, Decapterus macrosoma, Selar crumenophthalmus, Rastrelliger kangurta*, and *Rastrelliger brachysoma* are relatively abundant among other small pelagic species. Variation of a seasonal pattern is observed. Using L50/Lc and Lm as indicators of exploitation, the length frequency analysis of these five most abundant small pelagic

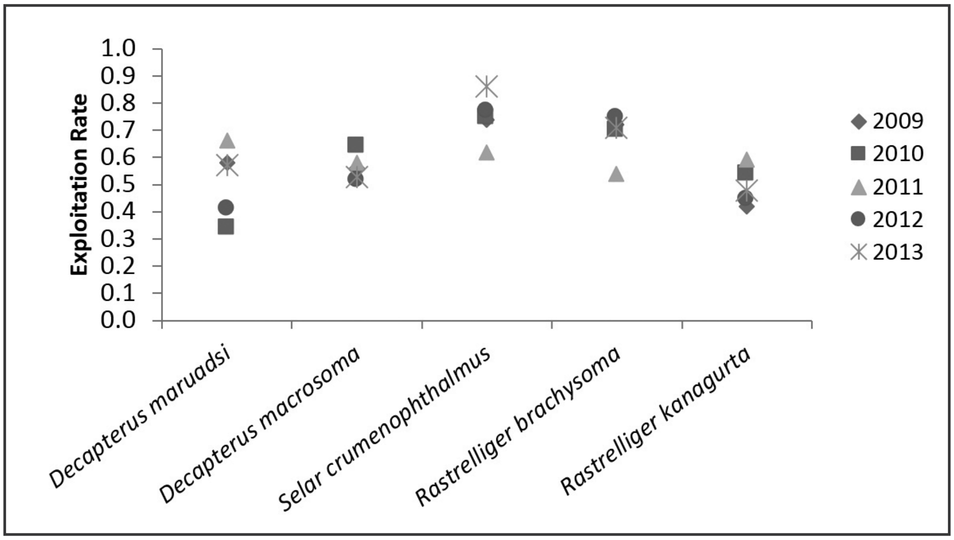

Figure 15. Annual exploitation of dominant small pelagic species from year 2009-2013

Table 4. Growth parameter values obtained for dominant small pelagic fish species

Species	*Year*	L_∞	L_∞ Range (Literatures)	K	k Range (Literatures)	Ø'	Ø'Range (Literatures)
Decapterus maruadsi	2009	17.00	22.7-27.3	1.10	0.52-1.2	2.69	2.46-2.91
	2010	15.67		1.00		2.58	
	2011	19.68		1.05		2.89	
	2012	17.38		1.20		2.71	
	2013	18.23		1.30		2.78	
Decapterus macrosoma	2009	17.85	21.4-33.0	0.85	0.5-2.30	2.65	2.56-3.02
	2010	22.25		0.70		2.82	
	2011	21.58		1.30		3.00	
	2012	22.40		1.10		3.27	
	2013	21.00		1.45		2.80	
Selar crumenophthalmus	2009	26.54	23.3-36.5	0.60	0.86-2.0	2.76	2.81-3.24
	2010	27.64		1.40		2.85	
	2011	25.29		1.10		2.84	
	2012	27.71		1.25		2.89	
	2013	35.96		1.15		2.86	
Rastrelliger brachysoma	2009	32.80	18.2-34.0	1.00	0.5-4.14	2.98	2.43-3.20
	2010	30.78		1.30		3.05	
	2011	25.66		1.00		2.88	
	2012	33.17		1.13		2.69	
	2013	29.44		1.15		2.75	
RastrelligerKanagurta	2009	27.92	25.2-39.0	1.50	0.96-1.6	2.97	2.63-3.1
	2010	28.45		1.20		3.01	
	2011	30.77		1.01		2.99	
	2012	27.52		1.06		3.11	
	2013	30.58		1.11		2.89	

Table 5. Average mortality parameter values obtained for dominant small pelagic fish species

Species	*Total Mortality (Z)*	Natural Mortality (M)	Fishing Mortality (F)	Exploitation (E)
Decapterus maruadsi	4.18	1.97	2.21	0.51
Decapterus macrosoma	3.97	2.06	2.53	0.57
Selar crumenophthalmus	8.40	1.91	6.49	0.75
Rastrelliger brachysoma	6.17	1.91	4.26	0.68
Rastrelliger kanagurta	3.76	1.98	1.77	0.50

species were found to be exploited mostly during their juvenile stage by the use of commercial gears than municipal gears. These species also are exploited due to a high value of E obtained beyond the optimum level of 0.5.

5. RECOMMENDATION

Based on the results the following recommendation is formulated: A reproductive biology study should be conducted in Lingayen Gulf on small pelagic fish species to determine the spawning season. This will help recommend a further fisheries management initiative on small pelagic for the conservation and protection of the small pelagics in Lingayen Gulf.

6. ACKNOWLEDGEMENT

The authors would like to thank Nestor D. Domenden, Director of Bureau of Fisheries and Aquatic Resources-Regional Fisheries Office 1 for his constant support. Gratitude is also given to the reviewers of this study for the advice and recommendations provided to the authors. The authors would also like to extend appreciation to the data analysts and enumerators for the support and assistance.

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