An Assessment of the Lingayen Gulf Fisheries, Philippines[a]

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ABSTRACT

This paper covers the data gathered from September 1997 to December 2002 from five(5) commercial landing sites and five(5) municipal landing sites in Lingayen Gulf. The methods used in data collection are the National Stock Assessment Program (NSAP) standard materials and methods, while the analysis used was the FAO-ICLARM Stock Assessment Tools (FISAT).

The study aims to determine the catch composition of the different gears operating in the Gulf and the production estimates/boat/month/gear/landing site. It also aims to determine the seasonality, Maximum Sustainable Yield (MSY), population parameters and yield/recruit of the top ten species for Danish seine and trawl fisheries.

Lingayen Gulf caters to a variety of fishing gears. Based on the inventory of boats and gears conducted, Danish seine dominated the number of commercial fishing gears during the first four years of the study. Municipal fishing, on the other hand, was dominated by bottom-set gill net (BSGN), consisting 23.5% of the total municipal gears, followed by handline (17%) and multiple handline (10.8%)

Species composition for municipal and commercial fisheries from 1998-1999 has decreased but showed constant increase thereafter for 3 consecutive years. The Gulf's total production was dominated by demersal species over pelagic species. Danish seine, having a of 98.174 kg/b, contributed more (65%) to the commercial fisheries production with short fin scad (*Decapterus macrosoma)* as the most abundant with 31% share of the total Danish seine catch 1998-2002. On the other hand, the trawl having 79.58 kg/b/d CPUE, shared 35% to the commercial production and was dominated by short mackerel (*Rastrelliger brachysoma*) followed closely by commerson anchovy (*Stolephorus commersonii).* Yellowfin tuna (*Thunnus albacares*), caught by handline and multiple handline, is the most abundant species by volume in the municipal fisheries production. The CPUE of BSGN, contributes most of the municipal production, increased for the first four(4) years but declined during the 5th year. The same pattern was noticed with the rest of the sampled gears except the fish trap and fish corral which increased during the 5th year.

The MSY for the total fisheries was estimated by converting the total gross tonnage of all boats (commercial and municipal boats) into Danish seine units as the standard measurement of effort. Using the Schaefer models, the MSY is at 4,505 mt at fMSY of 2,273 GT. This indicates that in order to maintain the MSY of 4,505 mt, there should only be 113 boats operating in the Gulf (Danish seine at an average of 20GT level) with an average yield of 39.8 mt/boat/year.

Furthermore, most of the species caught by the two commercial gears indicated high exploitation rate (E values more than 0.5 levels) and are caught at their early stages.

Based on the result of the study, management measures are recommended for the sustainable fisheries in the Lingayen Gulf: reduction of effort levels of all gears, mesh size regulation and close seasons.

INTRODUCTION

The Philippines is endowed with vast natural resources, one of which is the fishery resources that supply fish and other fishery products abundantly for the increasing population. It contains one of the most diverse coral reef systems in the world and part of this lies within the Lingayen Gulf area. Lingayen Gulf is a major fishing ground of Northwestern Luzon having two distinct fishing sectors, commercial and municipal. Not only are the reefs a home to one of the most diverse marine communities but, the reefs are also the livelihood of hundreds of thousands of inhabitants of towns that surround it. However, the gulf's biodiversity has been threatened by various human activities such as over fishing, pollution, tourism, and a multitude of other direct and indirect problems as has been shown in various studies.

Inasmuch as Lingayen Gulf is not an exemption of overexploitation thus becoming the center of a heated debate among politicians, environmentalists and fishermen, reliable data is essentially needed to generate baseline information and evidences that will be utilized for sound resource management.

The sustainability of the fisheries in the country is a situation that significantly needs detailed assessment of the overexploited areas like Lingayen Gulf. This assessment study of the Lingayen Gulf's Fisheries presents the five-year results on the species and catch composition per gear, catch per unit effort and biological parameters of species providing an estimates of production that will significantly clarify the state of the Gulf's major marine resources.

REVIEW OF LITERATURE

Several studies have been conducted on the fishery resources of Lingayen Gulf. A study on the demersal species using trawl was conducted from 1978 to 1979 and it was reported that there were 166 species of fish belonging to 80 families. A hundred species were considered as foodfish and the rest were considered potential foodfish and trash fish (Aprieto and Villoso, 1982). Relative abundance and distribution of slipmouths was also conducted. Nine species were identified and 97% of the slipmouth catch was made up of *Leiognathus bindus* (Villoso and Aprieto, 193). From 1983-84 in a survey conducted by UP Fisheries, assessment was made on the catch of commercial fisheries composed mainly of bottom trawlers and classified into large and medium trawlers. The municipal fisheries consisted of fourteen types of fishing gears. The trawl fleet numbered to 23 during the survey (Mines, 1986).

Results from an economic analysis made on the medium trawlers from 1984 to 1988 established that under the levels of exploitation at that time, trawling is financially unprofitable but economically viable due to rents accruing to labor. (Cruz and Silvestre, 1988). A study on economics of municipal fisheries was also conducted. This study presented information on the capital assets, costs and returns, and household expenditures. Obtained information indicates considerable unemployment, low nets returns and abject poverty of municipal fishermen. It was suggested that measures should center on alternative livelihood and better management of resources (Añonuevo, 1989). Preliminary results of a study on municipal fisheries have also been done from 1987 to 1988. Results indicate that there is a relatively high annual extraction rate of 10.1 t/km2 of municipal fishing ground.

Recommendations center on the need for reduction in fishing effort and improved management of fisheries (Calud et al, 1989). Results from survey of commercial trawl fisheries from 1987 to 1988 indicate that catch consisted of 158 species distributed among 58 families. Data was gathered from 24 medium and 2 large trawlers (Ochavillo et al. 1989). Exploitation of the demersal stocks has also been reported. Results indicate that excessive fishing effort and the use of destructive fishing methods have reduced demersal biomass to about 15-30% of original levels (Silvestre, 1990). The paper on the assessment of the capture fisheries of Lingayen Gulf conducted in 1987 to 1988 summarizes the major findings from assessment studies in the area relevant to the status of prevailing exploitation of the fisheries resources. The capture fisheries of Lingayen gulf is characterized by a multiplicity of gear used to harvest the multi-species mix. Twenty-eight different types of fishing gear were used by municipal fishermen while only one type of gear, the trawl, is used by commercial fishermen. At the start of the monitoring activities in May 1987, trawling represented the only form of commercial fishing activity in Lingayen Gulf.

However three Danish seines began operations in April 1988. (Silvestre, et. al. 1991). Population parameters and exploitation rates of fish caught by trawl in Lingayen Gulf has also been conducted. The exploitation levels computed are relatively high and confirm previous assessments of high extraction rates. (Ochavillo, et al. 1991). Gill net fishery of Lingayen Gulf has also been studied. The results of the study indicate that there is tremendous overlap between trawl and gill net grounds and the species and length compositions of trawl and gill catches illustrate severe competition for similar species and target groups. (Calud et al. 1991).

OBJECTIVES

- To determine the catch composition of the different gears operating in Lingayen Gulf.

- To determine estimates of production (raised catch) per boat per month per gear per landing site.

- To determine the seasonality, MSY, population parameters and yield per recruit of the top ten species for both commercial and municipal fisheries for policy formulation.

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 1998 to December CY 2002. The four months 1997 was used to conduct inventory of boats and gears and preliminary sampling at pre designated landing sites. Hence, year 1 covers CY 1998, up to year 5 which covers CY 2002.

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 (Fig.1). Ten enumerators conducted sampling surveys on the landed catch and gears of the commercial and municipal fishing boats.

1. Commercial Fisheries
   Landing sites surveyed at:

   La Union:

   a. Pagudpud, San Fernando City and Damortis, Sto. Tomas
   b. Tubod, and Casantaan, Sto. Tomas,

   Pangasinan

   a. Pantal District Dagupan City
   b. Magsaysay District, Dagupan city,
   c. Sual fish port

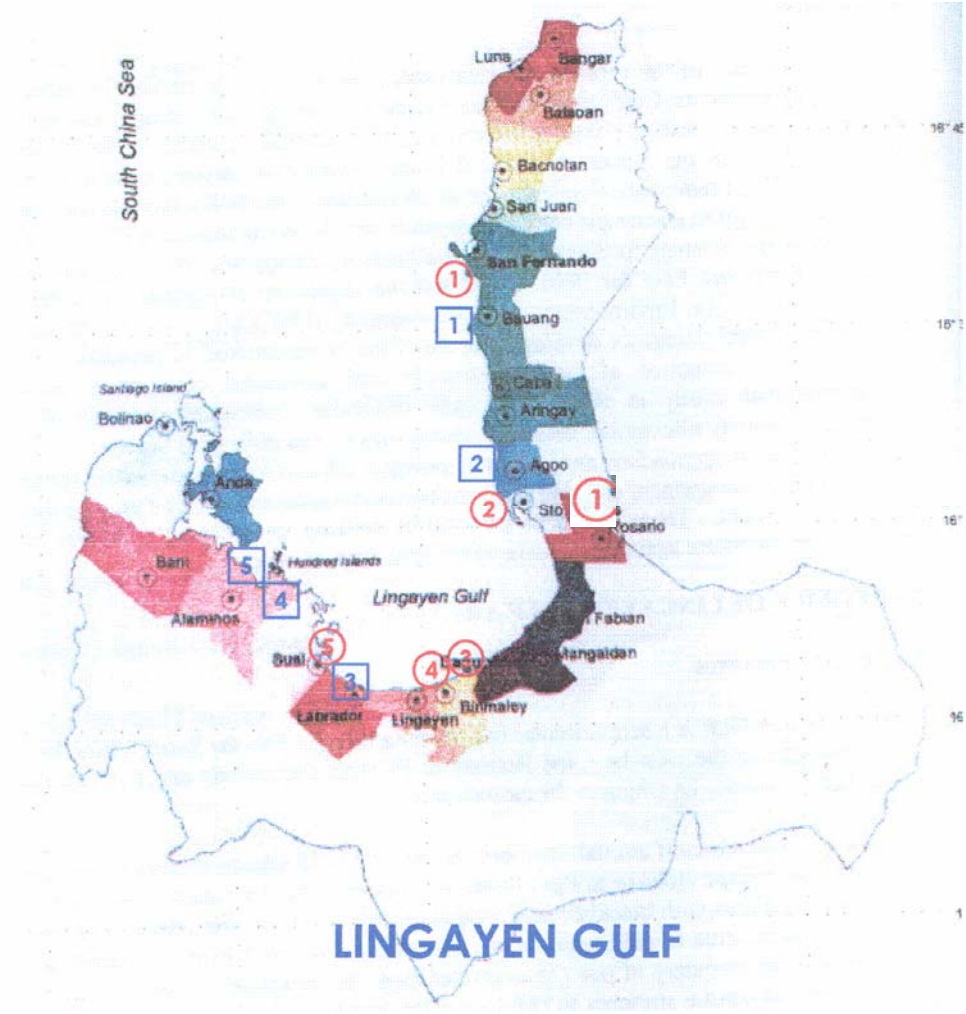
2. Municipal Fisheries

   Landing sites surveyed at:
   La Union.
   a. Paringao, Bauang ,
   b. San Nicolas West, Agoo.

   Pangasinan
   a. Tobuan, Labrador,
   b. Victoria ,and
   c. Lucap, Alaminos

3. For Maximum Sustainable Yield (MSY) computation, BAS sampling sites are included:

La Union	Pangasinan
a. Darigayos, Luna	a. Arosan, Bolinao
b. San Isidro, Agoo	b. Macandocandong, Anda
c. Rabon-Bani, Rosario	c. Maniboc, Lingayen



1. Pagudpud, San Fernando City/Damortis, Sto. Tomas
2. Tubod/Casantaan, Sto. Tomas, La Union
3. Magsaysay, Dagupan City
4. Pantal, Dagupan City
5. Sual Fish Port, Sual, Pangasinan

1. Paringao, Bauang, La Union
2. San Nicolas West, Agoo, La Union
3. Tobuan, Labrador, Pangasinan
4. Lucap, Alaminos City, Pangasinan
5. Victoria, Alaminos City, Pangasinan

Figure 1: Map of the Study Area

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 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

Species and Catch Composition:

All species were recorded and samples of each major species were measured for length frequencies and weight. The species were classified according to families.

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 for five years while for the municipal sector, inventory of boats and gear from the landing sites was only conducted for the first year. The total enumeration of boats and gears used in the gulf was undertaken during the fourth year of the study.

CPUE

Catch per unit of Effort was computed from the production of boats/day.

MSY

Gross tonnage was used as the effort in MSY computation. Danish seine was used as the representative effort. All other gears were converted into Danish seine units for standardization

Production Estimates:

Estimated production per boat of the different gears per site was computed from the monthly total catch of each gear per site divided by the total number of boat landings. The result was multiplied by the raising factor to determine the raised catch per boat per month. The raising factor is determined by dividing the number of days in a month over the number of sampling days (RF is 2.82 for 31 days with 11 sampling days, 3 for the months with 30 days and 3.1 for the months with 31 days with 10 sampling days).

The raised catch per boat per month was computed by the formula:

$$\text{Raised catch} = \frac{\text{Total Catch}}{\text{No. of boat landed}} \times \text{raising factor};$$

- $\text{Raising factor} = \frac{\text{No. of days in a month}}{\text{No. of sampling days}}$

The length frequencies were also raised to the corresponding raise in weight with the following formula:

$$\text{Raised length} = \text{Frequency} \times \text{raising factor};$$

- $\text{raising factor} = \frac{\text{Total weight}}{\text{sampled weight}}$

Statistical Tool:

The tools used in analysis are MS Excel for the line graphs and FAO-ICLARM Stock Assessment Tools (FISAT) in the estimation of population parameters like growth, mortality and exploitation rate.

Models Used:

Fox and Schaefer's models were used in the determination of the MSY,

Fox $Y = f e^{(a+bf)}$

Schaefer $Y = af + bf^2$

Where: Y = Yield
a = intercept
b = slope
f = effort

Scope and Limitations:

- Total boat and gear inventory was conducted for coastal municipalities within the gulf (commercial and municipal).
- The production data comes from commercial (Trawl and Danish seine) fisheries landings and municipal fisheries landings.
- The municipal fisheries production data gathered is limited to the actual gears sampled in the landing sites. Inclusion of BAS data for other landing sites was used for the computation of MSY.
- Fishing effort was recorded by number of fishing days for commercial boats while number of hours per trip was recorded for municipal fishing.
- Effort was standardized to gross tonnage of boats for the commercial fisheries and municipal fisheries.
- Damortis landing site was included from the third to the fifth year data.
- Data analyzed started from Jan 1998 to Dec 2002.

RESULTS AND DISCUSSION

Lingayen Gulf, its Description:

Lingayen Gulf is located off the coast of Pangasinan and La Union Provinces in Northwestern Luzon. It is a semi-circular bay opening directly into the South China Sea. It is bounded in the west by Cape Bolinao in Western Pangasinan and by Poro point in San Fernando, La Union in the eastern part.

The Lingayen gulf coastal area includes fourteen (14) municipalities and three (3) cities. From Bolinao to Poro point, the coastline stretches to 160 kilometers and from the coastline to the outermost boundary, the marine waters cover an area of 2,610 km^2.

Three major systems drain into the Lingayen Gulf, namely, Agno, Pantal-Sinocolan and Cayangan Pantalan. These river systems drain watersheds that span eight provinces in Regions I, II and III. The most important is Agno River, whose 574, 900-ha watershed includes the mining district of Benguet province.

The Gulf can be divided into three (3) sectors based on the arbitrary subdivision scheme adopted by Prof Mines (1986). Sector I start from Silaqui Island to Sual and consist of hard, coralline bottom substrates. Sector II from Labrador to San Fabian has soft silt and mud bottom. Sector III includes all towns of La Union. The bottom substrate is characterized by sandy coralline bottom. (Fig.2)

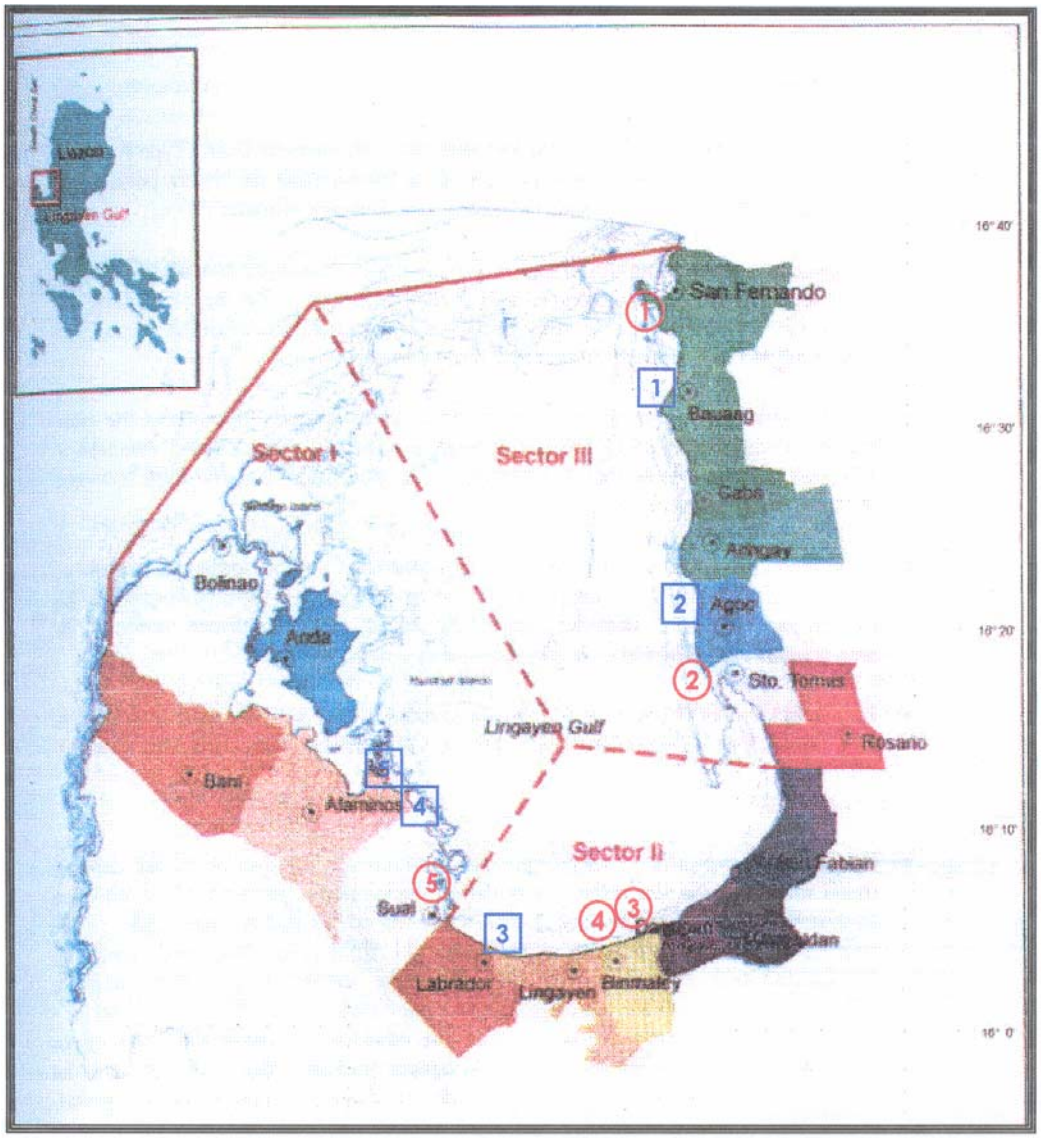


Figure 2: Description of Fishing Ground

Study Area.

Lingayen Gulf is one of the major fishing grounds in the country. It is also one of the primary aquaculture areas where milkfish is the main commodity produced in ponds, pens and cages. The gulf is also one of the tourist destinations particularly the Hundred Islands National park and the beaches along the coast.

Unregulated Fishing activities coupled with environmental, social and economic problems make the gulf susceptible to degradation as evidenced by its declaration as an Environmentally Critical Area (Pres. Proc. # 156). Several studies on the status of the fisheries have been conducted for the past 20 years where most of the results indicate that there is over exploitation of the fish resources

Results from the recently conducted Lingayen Gulf Resource and Social Assessment (RSA) by UP MERF in 2001 further shows, that there is a very high fishing pressure on a dwindling state of fisheries resources. The study was conducted under the Fisheries Resource Management Project (FRMP).

Management efforts are ongoing and aside from the campaign on anti illegal fishing activities, resource enhancement projects are already in place. A total of seven fish sanctuaries, fifteen mangrove reforestation and one eco tourism project are being supported under the FRMP aside from the initiatives of the Local government units. Efforts are also under way to register all commercial and municipal boats leading to the licensing of all fishermen. This will lead to regulation not only of commercial fishing boats but also of municipal fishing boats and fisherfolk fishing in municipal waters.

The results of the on-going national stock assessment project in Lingayen Gulf aims to show the status of the fisheries resources from a five year sampling period and be able to give recommendations on the proper management and sustainable use of resources of the gulf.

Boat and Gear Inventory

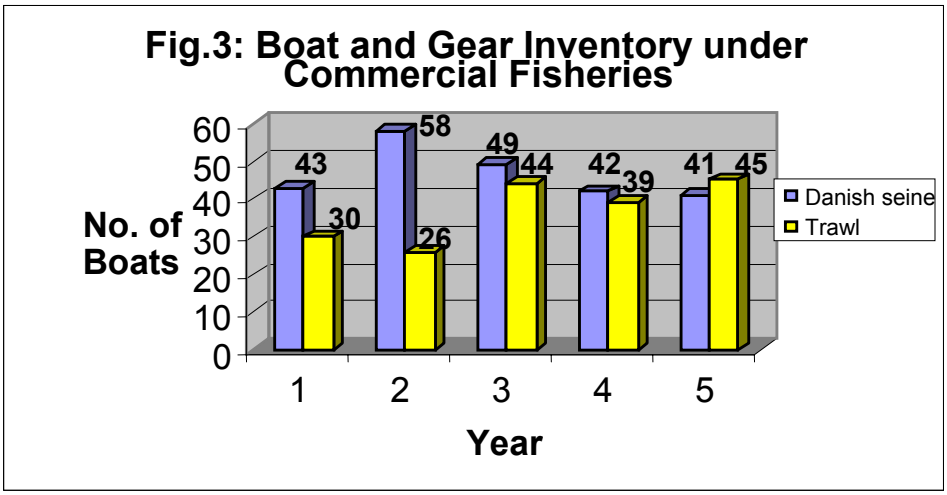
Commercial Fisheries

Commercial fishing in Lingayen Gulf is mainly contributed by trawl and Danish seine (Fig. 3). The boat and gear inventory showed Danish seine as consistently dominating commercial fishing in the gulf for the four years of the assessment. This is in spite of the fact the commercial catch in the gulf came solely from trawl fishing even before the outbreak of world war two. Danish seines as introduced from the Samar Sea started operating in the gulf by April 1988 with three boats (Silvestre, et. al, 1991). Aside from dominating the number of boats in commercial fisheries except in the fifth year of the study, the domination of catch of Danish seine in the commercial fisheries

was brought about by its higher CPUE (1.12 kg/man-hour) than trawl (0.84 kg/man-hour) (Lingayen Gulf RSA, 2001)

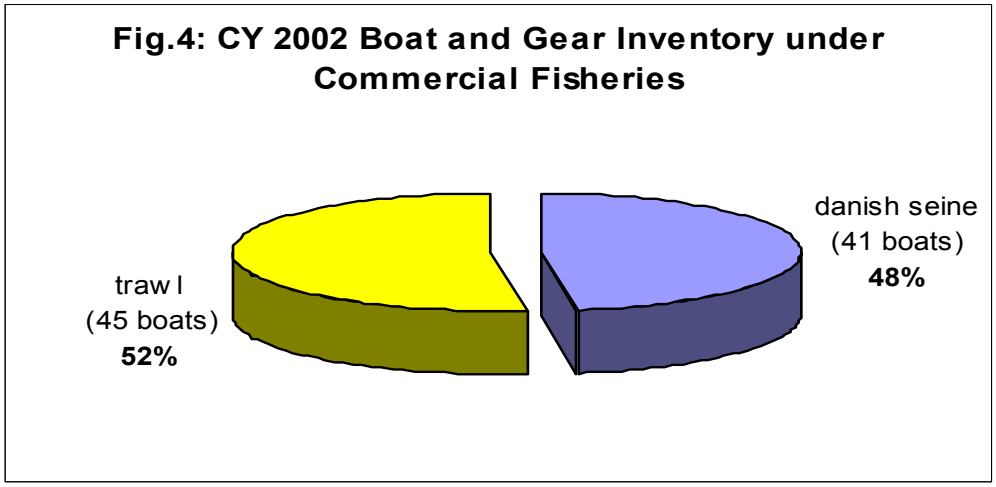
However, trawl outnumbered Danish seine in the fifth year of the survey (Fig. 4). This could be attributed to the fact that the medium sized Danish seine has shifted some of their operation in the Ilocos Coast as shown by the permits and licenses issued by the office. A new landing site was also included during the third year of the survey where trawl landed their catch.

Moreover, this trend could also be attributed to some factors such as destruction by natural phenomenon and the effect of interplay between cost of operation and cost of production.



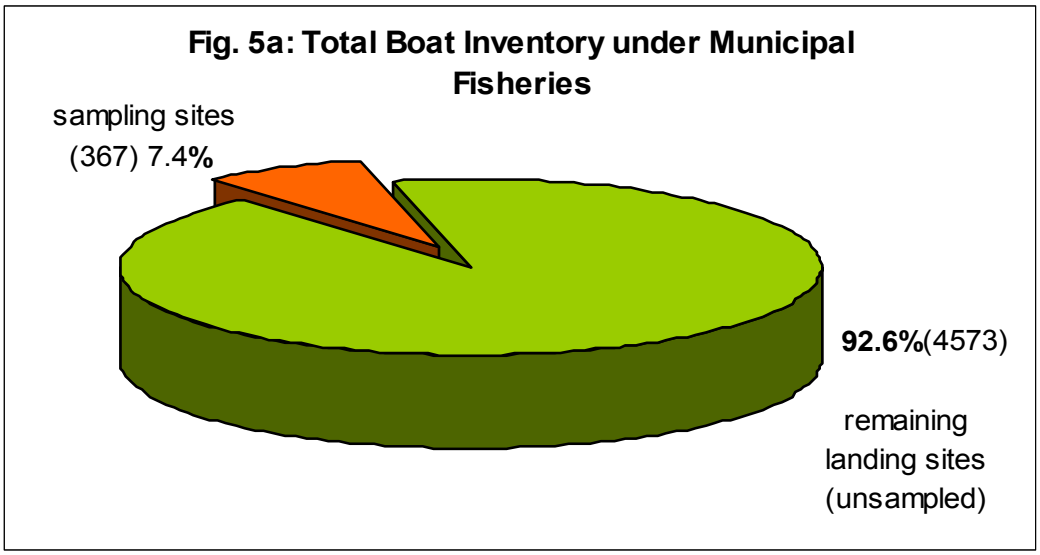
The consolidated boat and gear inventory report is shown in Appendix 1.

During the fifth year of inventory (fig. 4), a total of 86 commercial fishing boats were operating along the Lingayen Gulf, 41 boats or 48% used Danish seine while 45 boats or 52% used trawl.

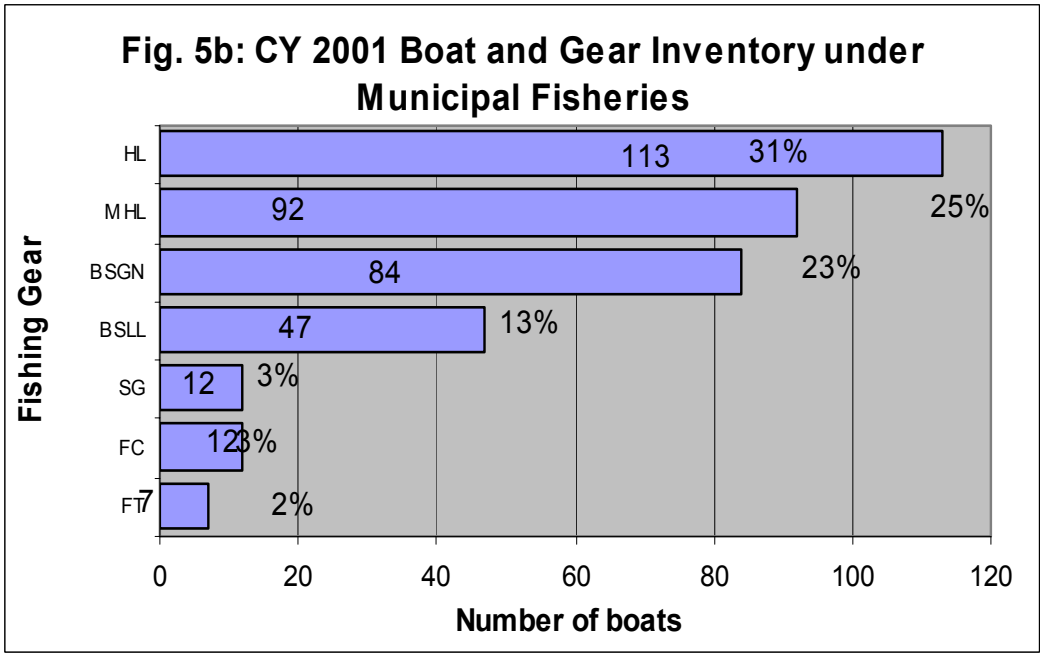


Municipal Fisheries

A total of 4940 municipal fishing boats (motorized and non motorized) were surveyed to be operational along the Lingayen Gulf area. However, only 367 boats which accounted for only 7.4 % of the total number were regularly sampled for catch and effort at the sampling sites, while 92.6% or 4573 boats comprise the remaining unsampled sites. (Fig.5a)

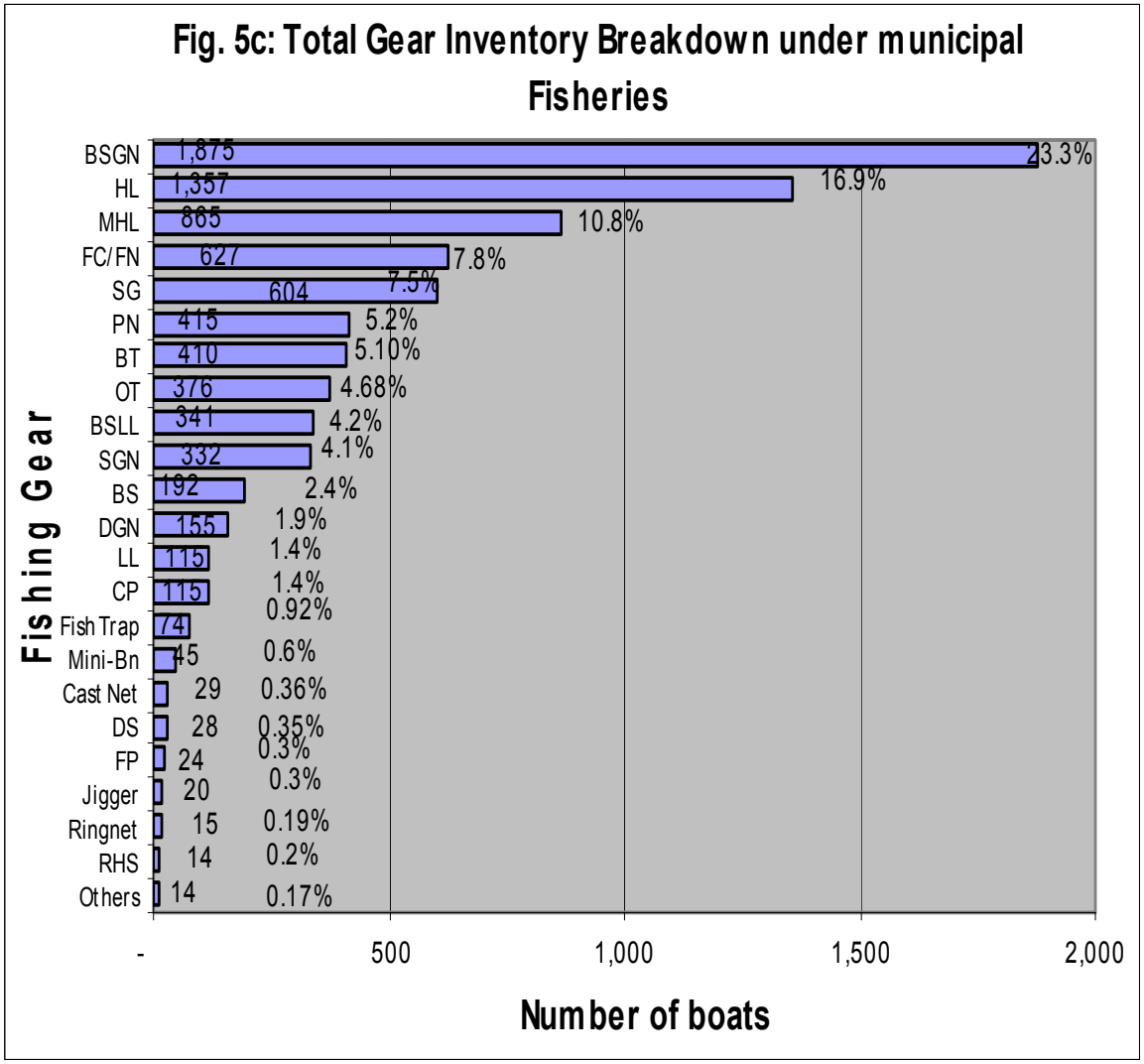


There are 7 gears being sampled under the municipal fisheries. Hook and line and multiple handline make up more than half of the sampled municipal fishing boats and gears, followed by bottom set gill net and bottom set long line. Most of the fishermen shift from one gear to another depending on the season (e.g. MHL is used when big tuna and tuna like species are out of season) (Fig 5b)



A total boat and gear inventory from the 17 municipalities and cities was conducted during the fourth year of survey (Fig. 5c). Bottom set gill net is the most dominant gear followed by hook and line and multiple hand line. Combining the gill net fishery (bottom set, surface, and drift gill net) will make it the most used gear at 31.3 %. This is also shown in the assessment made by RSA of Lingayen Gulf in 2001 which states that gill net fishery(including bottom set, surface, tuna and drift gill net) is the most prevalent and popular gear among the coastal barangays of the gulf. The gill net as widely used dominates the municipal fishing gear because of its flexible application to all the sectors of the gulf which ranges from soft/muddy to silty and coralline substrate.

Based on the inventory, a total of 8,042 gears from 28 types of municipal fishing gears are used in the gulf (Appendix 2). This is lower than the RSA of Lingayen Gulf where 33 types of municipal fishing gears were listed as being practiced while Mines (1986) listed 14 types of gears used.



Of the boats inventoried, the number of fishers totaled to 10,318 lower than the data of the Lingayen Gulf RSA(2001) which is about 16,000. The data reflects only the number of fishermen fully operating the fishing boats and gears while the part time fishermen were not included (Table 1).

Table 1 Number of fishers, number of boats and number of fishing gear per municipality along Lingayen Gulf (2001)

Name of Municipality	No. of fishers	No. of boats	No. of fishing gear
Pangasinan			
1. Alaminos City	1490	554	1808
2. Anda	352	117	665
3. Bani	397	264	393
4. Binmaley	150	135	135
5. Bolinao	1422	758	907
6. Dagupan City	303	99	100
7. Labrador	156	78	78
8. Lingayen	220	107	107
9. San Fabian	465	272	409
10. Sual	236	118	118
La Union			
1. Agoo	2095	669	955
2. Aringay	400	220	220
3. Bauang	820	522	804
4. Caba	467	162	164
5. San Fernando City	426	330	530
6. Sto Tomas	756	372	486
7. Rosario	163	163	163
Total	**10,318**	**4,940**	**8,042**

Boat and Crew Status

Commercial fisheries

Trawl fisheries operate daily. Boats are characterized by small (3GT-20GT) to medium (21GT-150GT) sized boats. Small trawlers range from 2.85 GT to 19.67GT with an average size of 7.26GT. They are operated by an average of 5 crew ranging from 4–14 fishermen. Medium sized trawlers range from 23.8GT to 35.82GT with an average size of 29.37GT, operated by an average of 13 crew ranging from 11-15 fishermen.

Danish seine fisheries operate from 3 to 5 days and characterized also by small to medium sized boats. Small Danish seine range from 4.18GT to 17.92GT with an average of 11.2GT. They are operated by an average of 12 crew ranging from 5-16 fishermen. Medium sized Danish seine range from 21.83GT to 39.09GT with an average of 29.04GT and operated by an average of 14 crew ranging from 12-18 fishermen.

Although there are more medium sized Danish seine than trawl operating in the gulf, trawls are more frequent in unloading their catch than the Danish seine (trawl operates daily while Danish seine operate from 3-5 days). Danish seine having more crews and exerting more time/ effort produce fair catch to sustain its operation. In commercial fisheries, Danish seine contributes more production and employs more fishers; however, it exerts more effort which adds pressure to the gulf. It is worth noting that the fishing pressure exerted in Lingayen Gulf by both Danish seine and trawl has already extended to the coast of the Ilocos region and elsewhere. (Lingayen Gulf RSA, 2001).

Municipal fisheries

A total of 4487 motorized boats are fishing in the gulf with 8893 fishermen having an average of 2 fishermen on board and an average gross ton of 0.94GT. The non motorized boats numbered to 453 with a total of 1425 fishermen having an average of 3 fishermen on board.

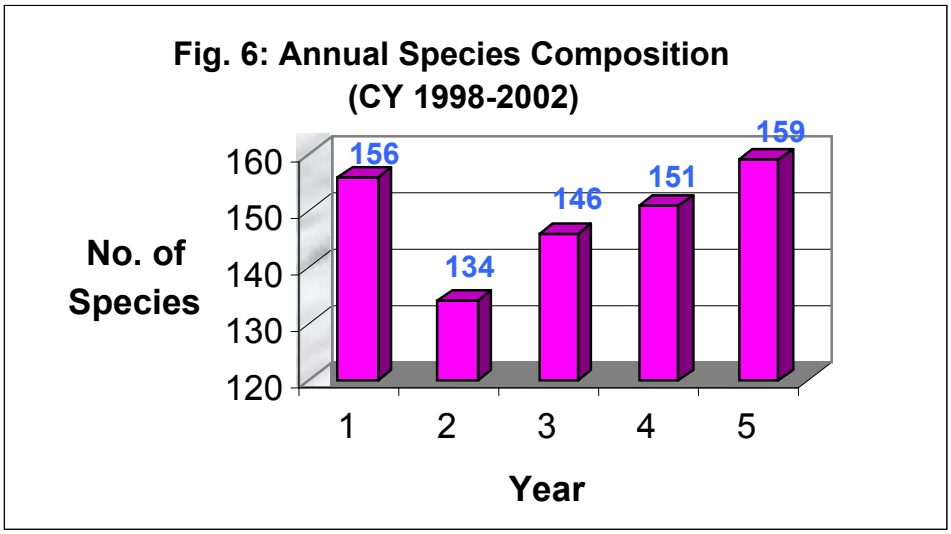
Because of a remarkable decline in fisheries production, shifting of areas and modifications of fishing gears have been documented. Motorized boats which formerly utilize reef flats and shallow areas of the gulf, as their traditional fishing ground, have shifted their fishing areas (e.g. hand liners in the South China Sea) and left the shallower areas to the non-motorized boats. Fishers of motorized boats, on the other hand, compete with commercial fishers in the gulf.

This set up and the 1:3 ratio of non-motorized boats and fishers indicate low income of these fishers. However, the number of motorized fishers is six times more than the non motorized fishers. These instances reflect that the greater percentage of the fishers in the Lingayen Gulf is dependent on municipal fishing where their catch per unit of effort is much lesser than those in commercial fishing.

Species and Catch Composition: (commercial and municipal)

Data from the five years sampling yielded a total of 216 species of marine organisms belonging to 48 families. However, yearly catch ranged from 134 to 159 species (Fig. 6). Based from earlier studies, a study on demersal species was conducted using trawl from 1978 to 1979 and it was reported that there were 166 species belonging to 80 families (Aprieto and Villoso, 1982) as compared to this study where 216 species are represented from only 48 families. This could be attributed to various means of fishing gears used by fishermen along the gulf as sampled by this study and also the new system of nomenclature where some species which were placed in other

families were merged with other families such as the family Thunnidae which was placed under Scombridae.



Of the 48 families represented 67% are demersal while 33% are pelagics. However, of the 216 species, 58% belong to the demersal species while the remaining 42% belong to the pelagic species. Most of the families and species are demersal since most of the gears sampled are catching demersal species. However, the commercial fishing gears like trawl and modified Danish seine catch also pelagic and demersal making the fishery very vulnerable to the fishing gears used. Demersal species are represented by 28 families of fish, 1 family of rays, 2 families of crabs and shrimps and 1 family of shells. Pelagic are represented by 12 fish families, 2 families of sharks/ rays and 2 families of squids/ cuttlefish. However, pelagics like Carangidae has the most number of species followed by Scombridae. Demersal species like Leiognathids ranked third while the Nemipterids ranked fourth. Other demersal species like Lutjanids and Serranids ranked fifth and sixth while the rest are represented with one to eight species (Table 2).

In the study of E. Villoso and V. Aprieto in 1978- 1979, the abundance of Leiognathidae dominated by *Leiognathus bindus* made up 43,2% of the commercial trawl catch with highest standing rate of 90.18 kg/hr between 80-90 meters depth. This is also noticed in the entire Lingayen Gulf fisheries (commercial and municipal) at the span of this study (1998-2002). This is due to the fact that most of the fishing gears being sampled targets demersal fishes aside from the overlapping of the area of operations of the commercial and municipal fishing gears.

TABLE 2: Species Composition of Lingayen Gulf Fisheries classified according to Family (commercial and municipal)

	Demersal				Pelagic	
	Family = 67%	**Species =58%**			**Family = 33%**	**Species = 42%**
1	Leiognathidae	13		33	Carangidae	34
2	Nemipteridae	12		34	Scombridae	19
3	Lutjanidae	10		35	Cluperidae	8
4	Serranidae	9		36	Belonidae	4
5	Mullidae	8		37	Engraulidae	4
6	Lethrinidae	7		38	Istiophoridae	3
7	Siganidae	7		39	Trichiuridae	3
8	Haemulidae	5		40	Caesionidae	1
9	Sphyraenidae	5		41	Chirocentridae	1
10	Mugilidae	4		42	Coryphaenidae	1
11	Scaridae	4		43	Elopidae	1
12	Synodontidae	4		44	Menidae	1
13	Teraponidae	3		Sharks/rays		
14	Gerreidae	3		45	Carcarhinidae	2
15	Acanthuridae	2		46	Mobulidae	1
16	Priacanthidae	2		Squids		
17	Soleidae	2		47	Loliginidae	6
18	Apogonidae	1		48	Sepiidae	2
19	Centropomidae	1				
20	Holocentridae	1				
21	Labridae	1				
22	Platycephalidae	1				
23	Scatophagidae	1				
24	Sciaenidae	1				
25	Stromatidae	1				
26	Kyphosidae	1				
27	Monacanthidae	1				
28	Muraenidae	1				
Rays						
29	Dasyatidae	3				
Crabs/shrimps						
30	Portunidae	6				
31	Penaeidae	4				
Shells						
32	Pectinidae	1				
TOTAL						**216**

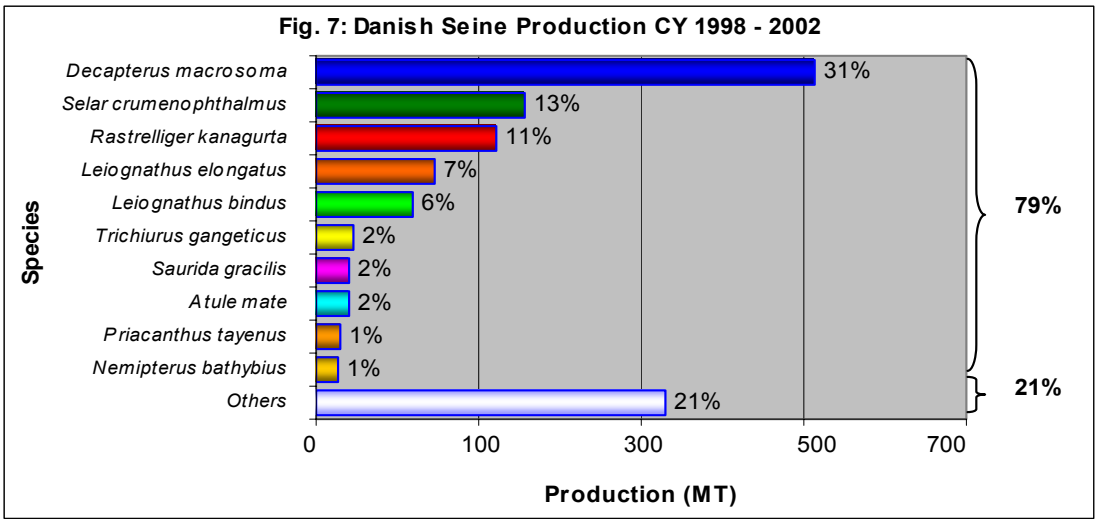
Catch Composition by Gear

Sampling was conducted from nine (9) types of fishing gear operating in the Lingayen Gulf, two gears represent commercial fishing while municipal fishing is represented by seven gears. However, for municipal fishing there are 21 other gears operating in the gulf but were not sampled for their catch.

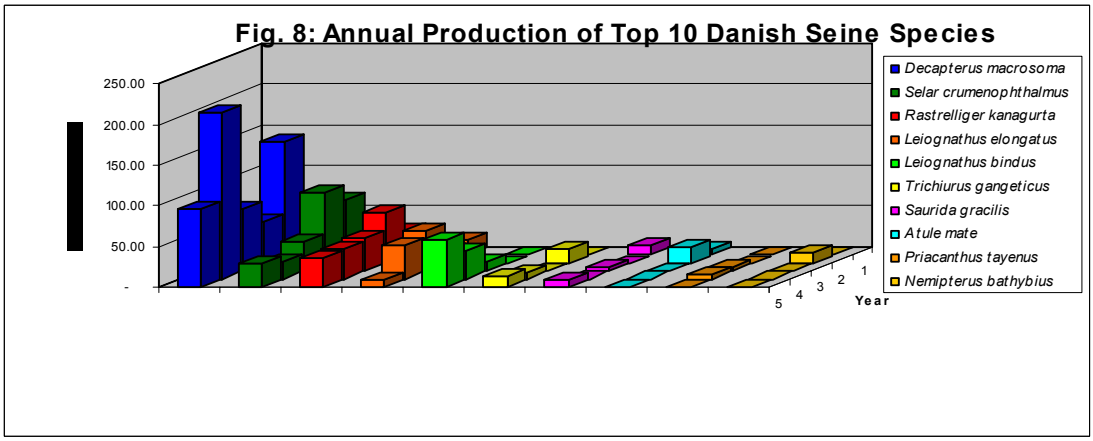
Commercial Fisheries

1. Danish Seine:

The most abundant species caught by Danish seine based on sampled catch is the shortfin scad, *Decapterus macrosoma* (31%) representing one third of the total catch, followed by big eye scad, *Selar crumenopthalmus* (13%). The Indian mackerel, *Rastrelliger kanagurta* (11%) ranks third while the slipmouths occupy fourth and fifth ranks*, Leiognathus elongatus* (7%), *Leiognathus bindus* (6%) respectively. Hairtail, lizard fish, yellow tail scad, purple spotted bigeye and thread fin bream comprises the sixth to tenth rank respectively. These top ten species comprise 79% of the total production of the said gear, whereas, the remaining species comprises 21% (Fig 7).

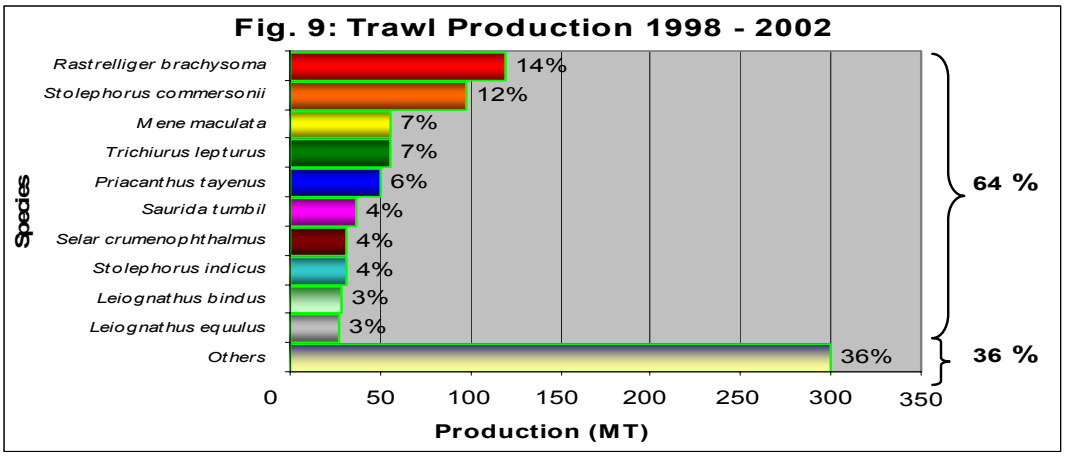


For most of the five year period, shortfin scad, *Decapterus macrosoma* dominated the Danish seine catch except for year 2 where both *Selar crumenopthalmus* and *Rastrelliger kanagurta were* more abundant than the shorfin scad. However for the rest of the years, shortfin scad still dominated the catch. The other top seven species had different yearly peaks (Fig.8).

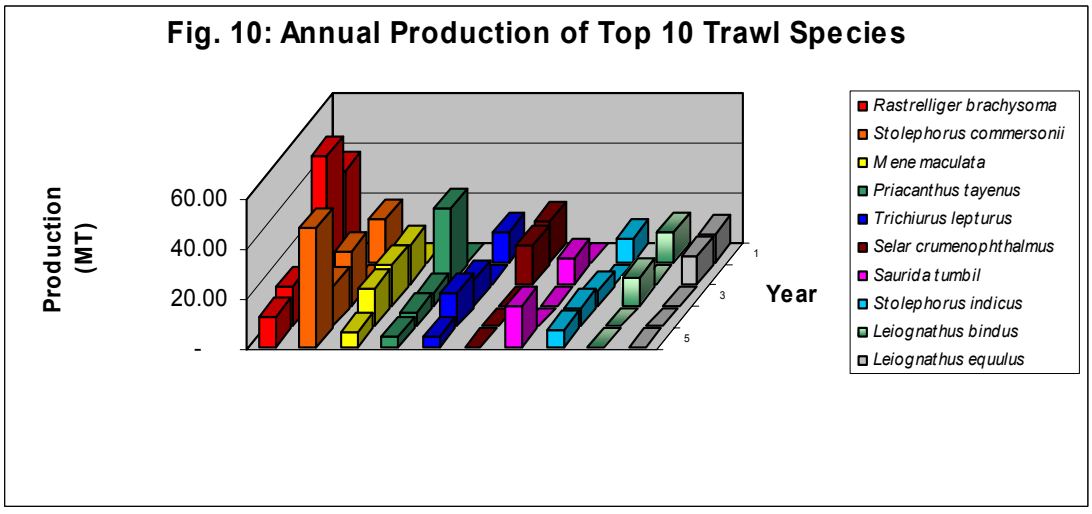


2. Trawl:

The most abundant species caught by trawl based on the sampled catch comprising 64% of the five-year trawl production are short mackerel, *Rastrelliger brachysoma* (14%), *commerson's* anchovy, *Stolephorus commersonii* (12%), moonfish, *Mene maculata* (7%), hairtail, *Trichiurus lepturus* (6%), purple spotted big eye, *Priacanthus tayenus (*6%), lizard fish, *Saurida tumbil* (4%), big eye scad, *Selar crumenopthalmus* (4%), Indian anchovy, *Stolephorus indicus* (4%), and the slipmouths, *Leiognathus bindus* (3%) *and Leiognathus equulus* (3%). While the rest of the catch comprises 36% of five-year trawl production (Fig 9).



As to annual production of these top ten species, the first two years of study was dominated by the short mackerel, *Rastrelliger brachysoma*, while the fifth year was dominated by commerson's achovy, *Stolephorus commersonii.* Moonfish dominated the catch in year three while purple spotted big eye was very abundant during the second year. The rest of the top species had different peaks per year (Fig 10).

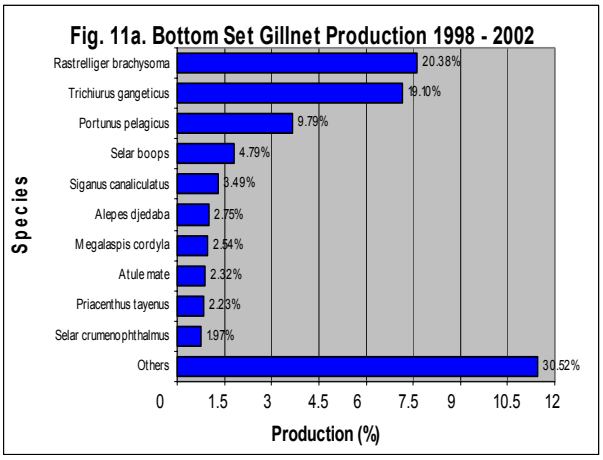


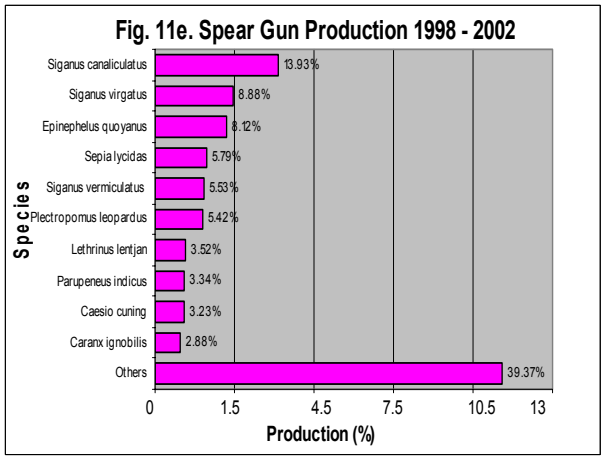
From the Lingayen Gulf RSA (2001) slipmouths made up most of the total catch volume of trawl in the gulf followed by mackerel, milkfish and cutlass fish or hairtail. Compared with this five year study, mackerel dominated the catch of trawl.

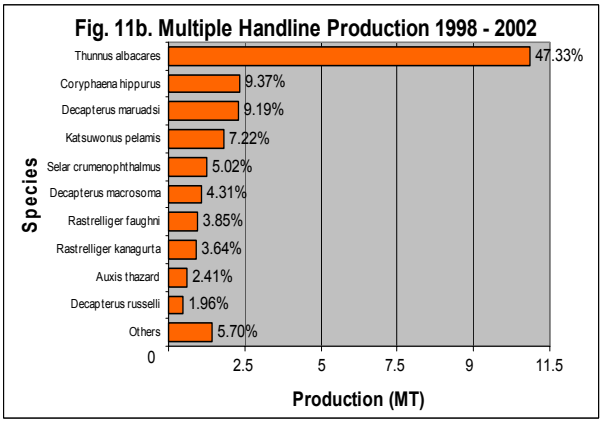
On the other hand, the catch of Danish seine for five year data reflects the dominance of scads, mackerels and slipmouths. This shifting of catch composition as a result of the level of fishing pressure was also cited in the RSA and previous studies.

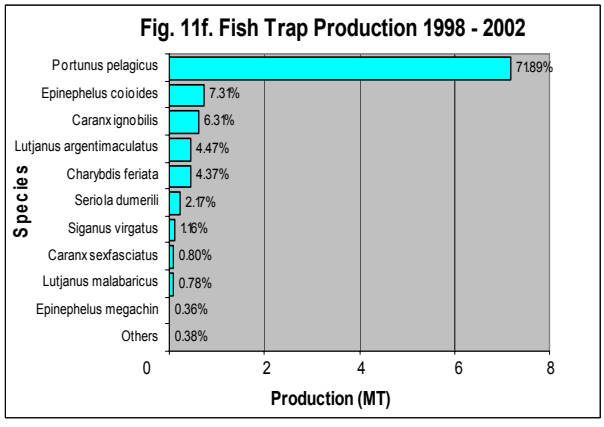
Municipal Fisheries:

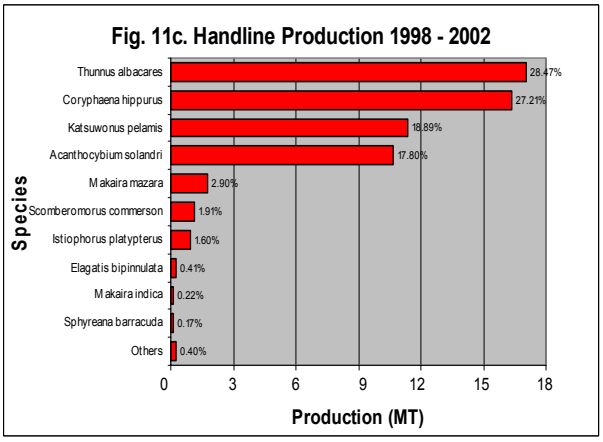
Species notably caught by bottom set gillnet are short mackerel, *Rastrelliger brachysoma* and hairtail, *Trichiurus gangeticus.* Yellow fin tuna, Thunnus *albacares is caught by both multiple handline and handline* while Emperors, *Lethrinus miniatus* and *L. Lentjan* are caught by bottom set longline Blue crab, *Portunus Pelagicus* is caught by both fish trap and fish corral. Rabbit fish *Siganus vermiculatus, Siganus canaliculatus* and *S. virgatus* are the top species caught by fish corrals and spear gun (Fig 11.a-g).

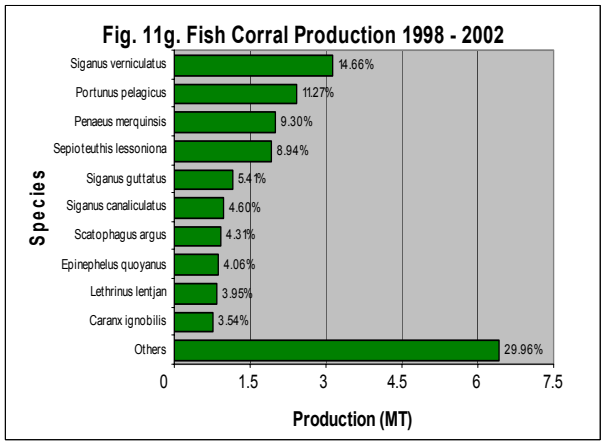


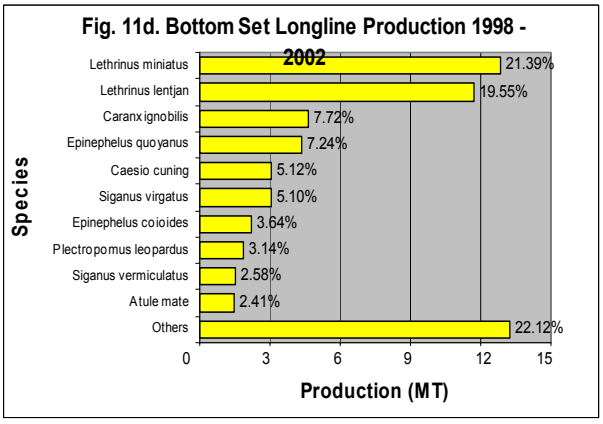






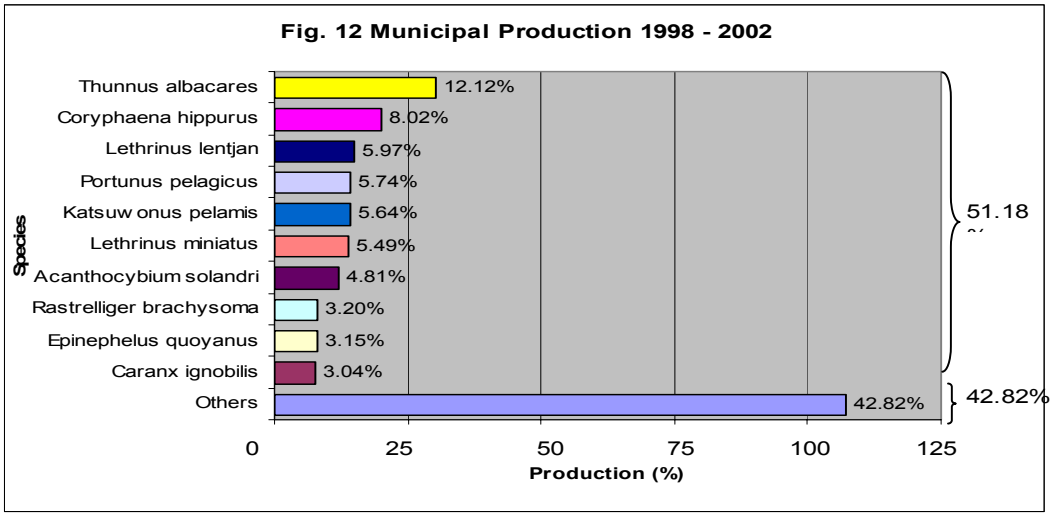






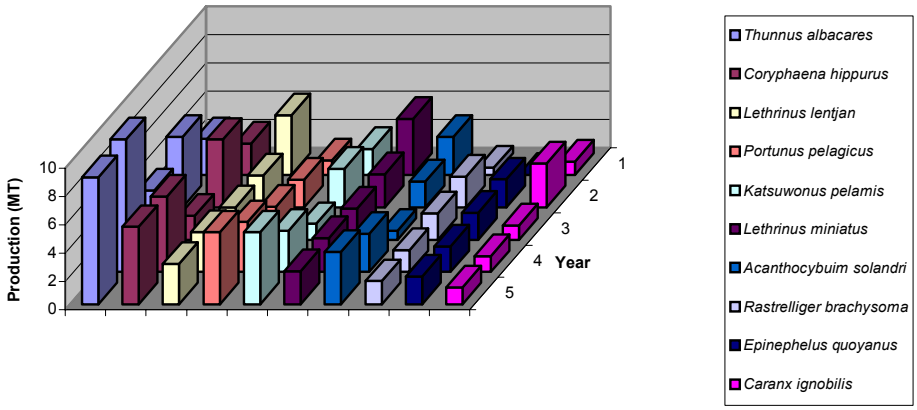
From the fish catch data of the municipal fishing gears, species like *Rastrelliger brachysoma, Trichiurus gangeticus, Selar crumenopthalmus* and *Priacanthus tayenus* are caugh by both bottom set gill net and commercial fisheries (Trawl and Danish seine).

The top ten species comprise almost 70% of the fish caught in municipal fishery (Fig. 12).



The hook and line fishery as dominated by *Thunnus albacares* in the La Union side of the gulf was also noticed during the Lingayen Gulf RSA and further confirmed in this study (Fig 13)

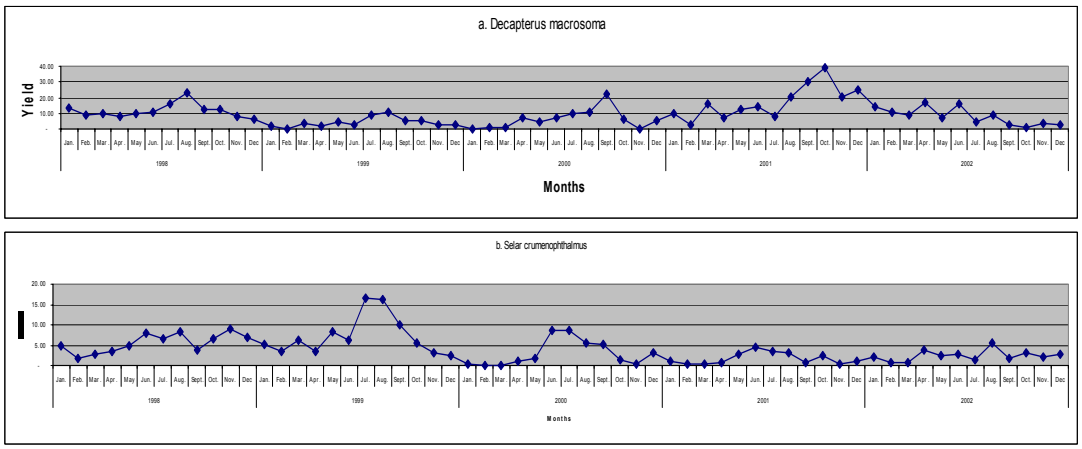
Fig 13. Annual Production of Municipal Fisheries



Seasonality of Top five Species per gear:

1. Danish Seine

The most abundantly caught 5 species were compared for their seasonality. They have almost the same pattern of peak and lean months where, peak months are seen during the 3rd and 4th quarter of the year while the lean months are manifested during the 1st & 2nd quarter of the year. However, *Decapterus macrosoma* had a higher peak in year 4 while *Rastrelliger kanagurta* and *Selar crumenopthalmus* had higher peaks in year 2 and 3 (Fig 14).



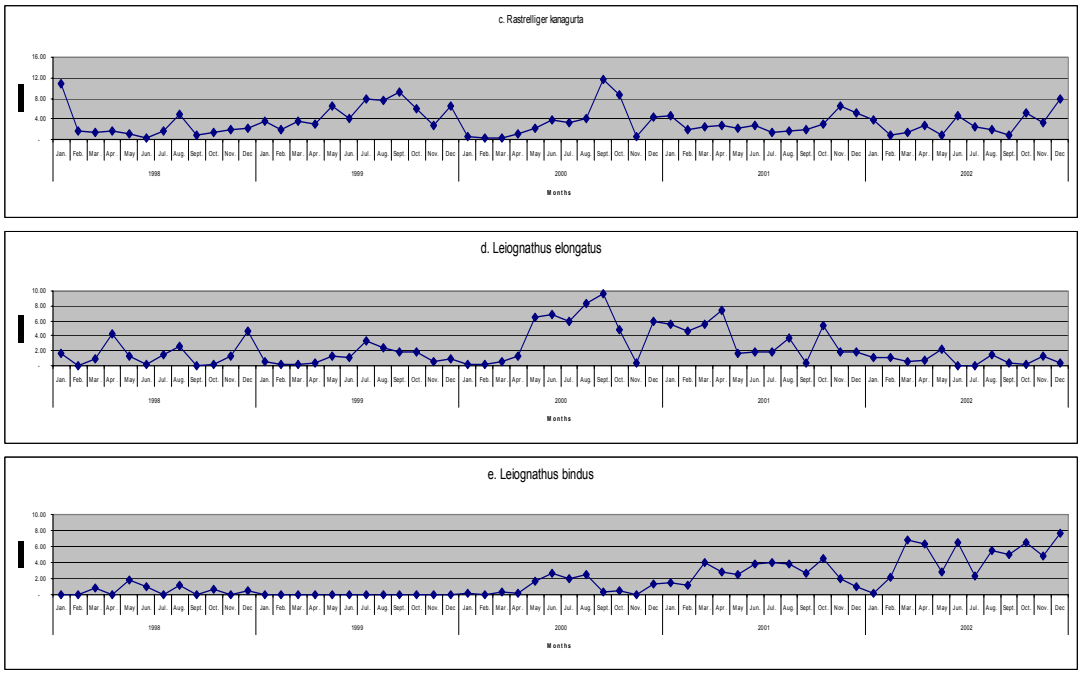


Figure 14. Seasonality of top 5 species a. *Decapterus macrosoma*, b. *Selar crumenophthalmus*, c. *Rastrelliger kanagurta,* d. *Leiognathus elongates* e. *Leiognathus bindus* caught using Danish seine in Lingayen Gulf for the period of January 1998 to December 2002

Although yearly pattern of peak and lean months were observed, the volume of production vary from year to year for each species. In the case of *Decapterus macrosoma* high volume of production was observed only during the 4th year while *Selar crumenophthalmus* had higher volume of production during the 2nd year. *Rastrelliger kanagurta* had higher volume of production during the 3rd year. The slipmouths started to increase in production only from the third to fifth year of the study.

2. Trawl

Peak months for *Rastrelliger brachysoma* was observed during the 2nd and 3rd quarter while lean months are during the first and fourth quarters. On the other hand, *Stolephorous commersonii* has pronounced peak season which is evidently observed on the 1st and 2nd quarter while lean months is pronounced during the 3rd and 4th quarters. No catch was observed for the 2nd year; however, catch was recorded from the 3rd to 5th years with the same pattern. *Mene maculata* obtained peaks during the fourth quarter and lean season during the 2nd quarter where highest peaks were in the 2nd and third years (Fig 15).

Priacantus tayennus had higher production for the second year but the succeeding years had no pronounced peaks or lean months while *Trichiurus lepturus* had exhibited pronounced peak season during the first and fourth quarters.

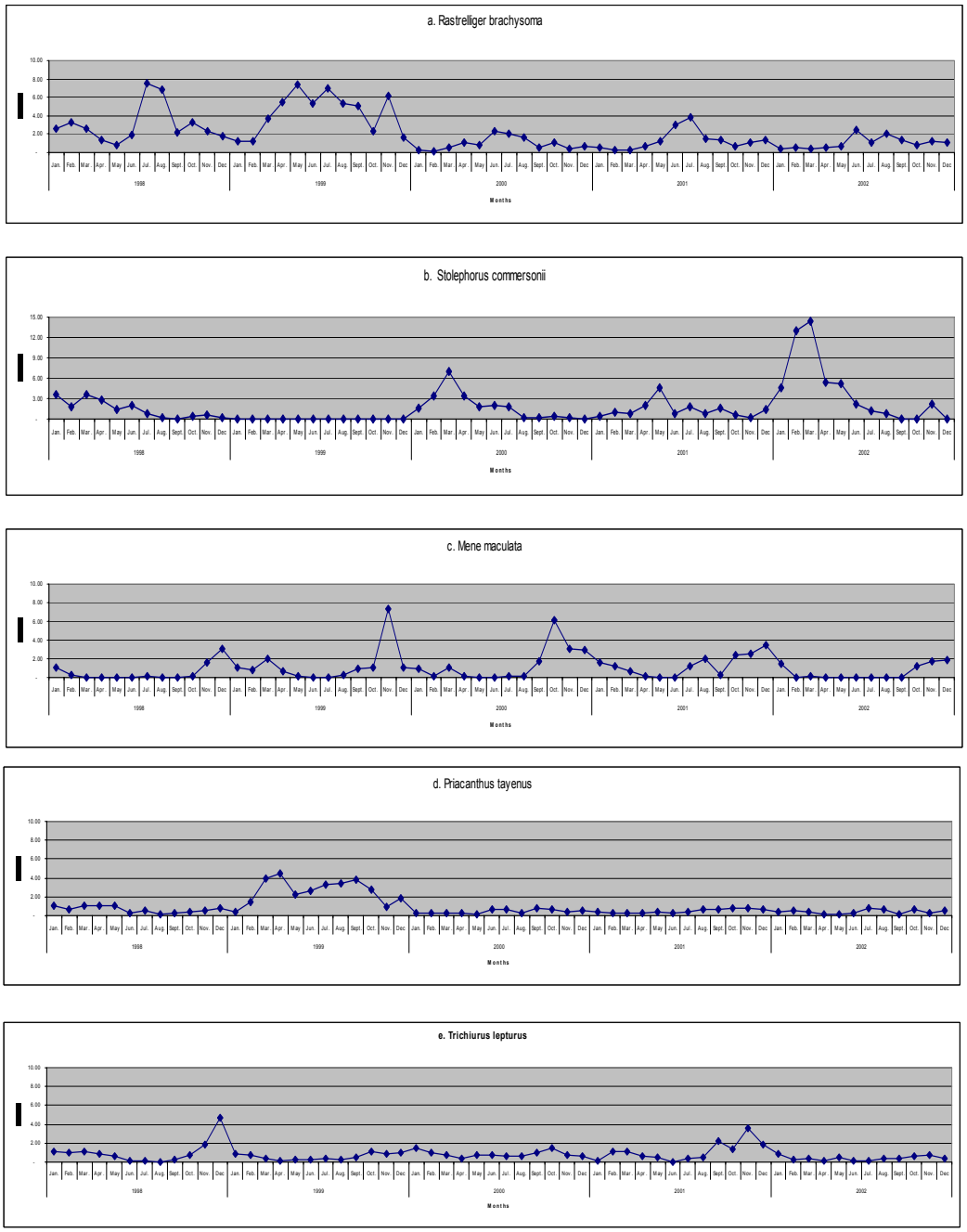


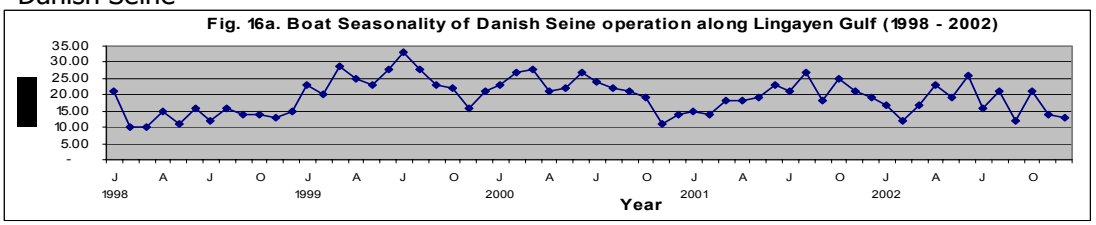
Figure 15: Seasonality of top 5 species a. *Rastrelliger brachysoma*, b. *Stolephorus commersonii* , c. *Mene maculate, d. Priacanthus tayennus, e. Trichiurus lepturus,* caught using Trawl in Lingayen Gulf for the period of January 1998 to December 2002.

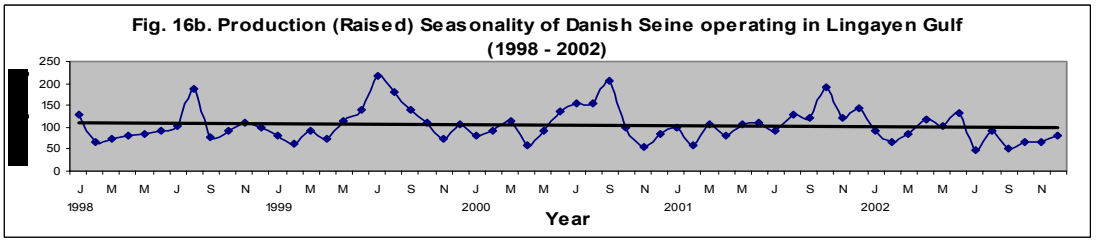
Again, for the trawl fisheries, yearly pattern was also observed for peak and lean months for the top five species. However, volume of production also vary from year to year as evidenced by the sample catch of *Rastrelliger brachysoma* where high production volume was observed during the first 2 years while lower levels of production was observed for the remaining 3 years.

Seasonality of Boats and catch

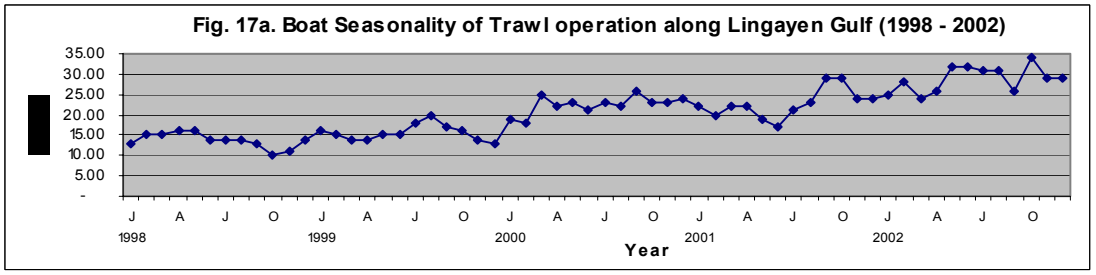
The following graphs show that the increase in number of commercial boats operating in the gulf corresponds also to the increase in production. The yearly pattern for both Danish seine and trawl operations indicate that as more boats operate the higher the production. However this does not necessarily mean that an increase in effort will lead to an increase in catch per boat. As in most cases for commercial fisheries, catch per unit effort decreases as more effort is introduced into the fisheries (Fig 16 & 17).

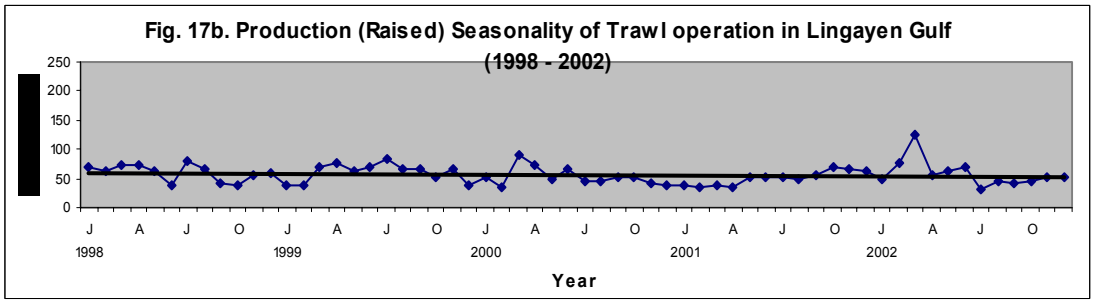
Danish Seine





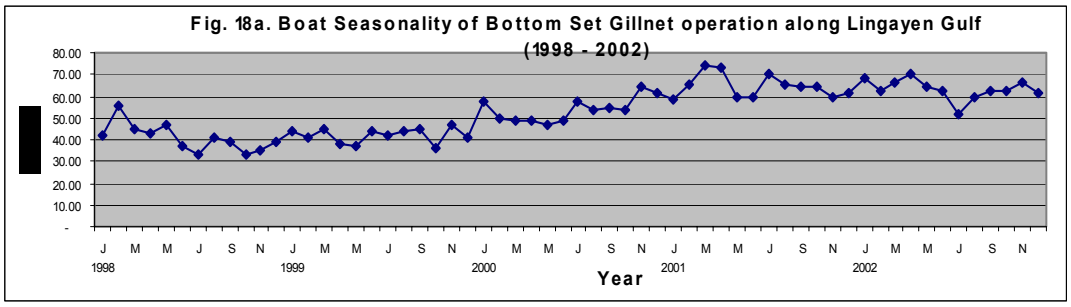
Trawl

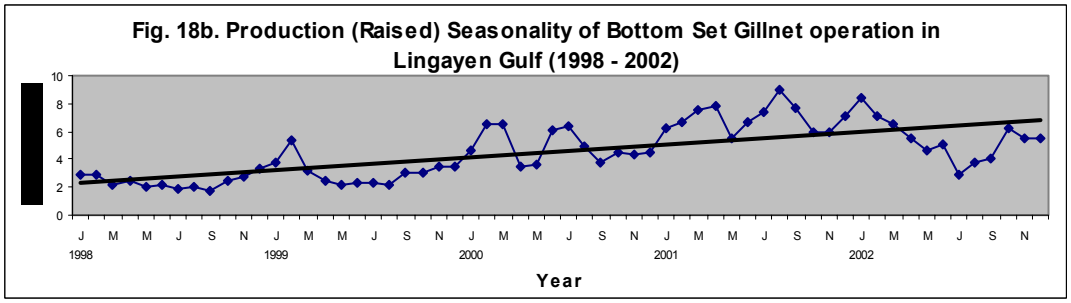




For the municipal fisheries represented herein by Bottom set gill net, there is a definite pattern where catch fluctuate from high to low even with an increase in effort. This is shown also in previous studies where municipal fisheries have very low catch per unit of effort (Fig 18a-b).

Bottom Set Gillnet





CPUE

Commercial fisheries

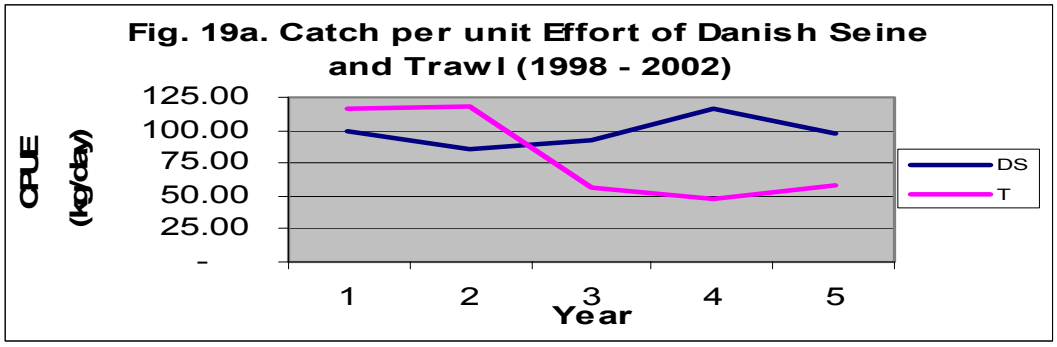
The five year data of catch per unit of effort measured at kg/boat/day for Danish seine range from 91.78 kg/b/d to 116.11 kg/b/d while that of the trawl range from 48.19 kg/b/d to 117.72 kg/b/d. (Table 3).

Table 3. Annual CPUE for Commercial & Municipal Fisheries

Gear	CPUE				
	1998	1999	2000	2001	2002
DS	99.16	85.90	91.78	116.11	97.92
T	116.53	117.72	57.33	48.19	58.13
BSGN	0.87	1.87	2.70	3.46	2.97
HL	2.18	4.20	2.46	3.68	2.90
MHL	2.05	2.82	3.96	5.53	2.82
SG	1.02	2.16	2.56	5.03	4.74
BSLL	1.39	2.36	4.15	2.77	3.15
FC	0.55	2.01	2.67	3.38	5.26
FT	1.38	3.10	5.43	5.01	5.97

The average CPUE from the five year data for Danish seine is 98.174 kg/b/d while average CPUE for trawl is 79.58 kg/b/d.

The trend starts from trawl with a higher CPUE at the start of the study gradually declining down to the fifth year. Whereas, the CPUE of Danish seine gradually increases, however, CPUE decreased during the fifth year (Fig 19.a).

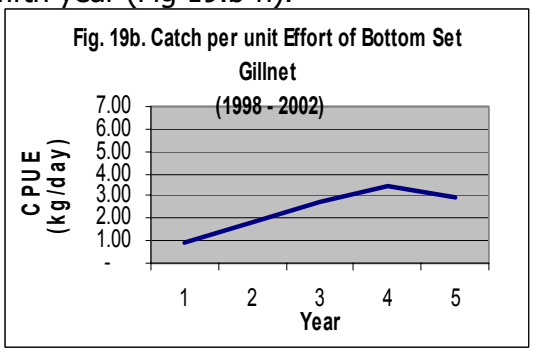


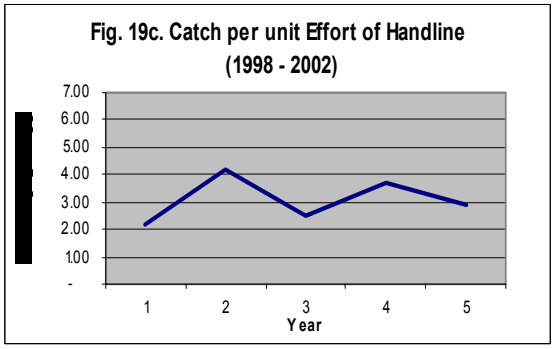
Trawl has recorded an average of 31.8 kg/ hr CPUE in 1987- 88 with the highest in June 1987 and lowest in January 1988 (D. Ochavillo et al. 1989). Compared with these previous findings, trawls CPUE has gone down to about 20 kg/hr (at 4 hrs fishing/day). At a crew of 13 fishermen, CPUE is very low at 1.5kg/m/hr. However, for Danish seine, CPUE is even lower at 14 kg/b/d at an average of 7 hrs per fishing day. With a crew of 14 the CPUE can go as low as 1 kg/m/hr.

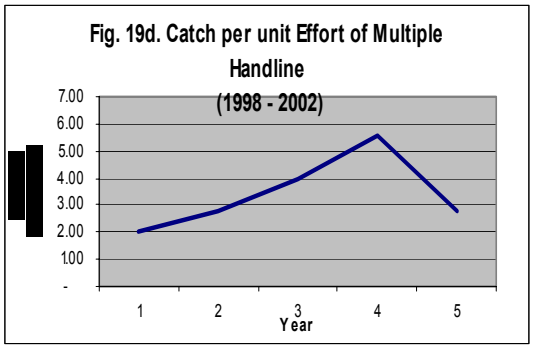
This trend is also shown in the Lingayen GULF RSA (2001) where CPUE for trawl was estimated at about 0.84 to 2.5 kg manhour-1 while Danish seine has an estimated CPUE of 1.12 kg manhour-1.

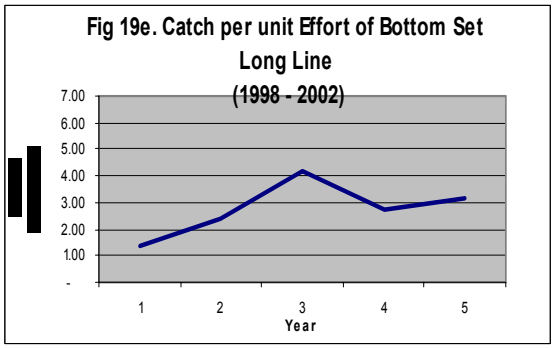
Municipal fisheries

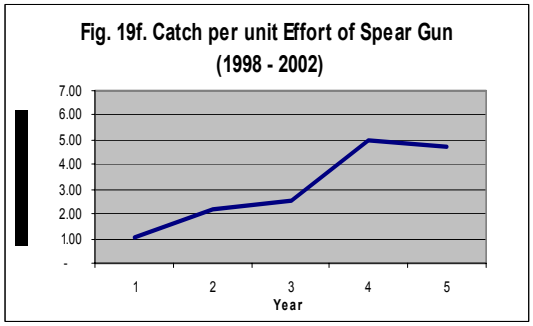
The catch per unit of effort for most of the municipal gears are also declining except for the fish corral and fish trap which increased during the fifth year (Fig 19.b-h).

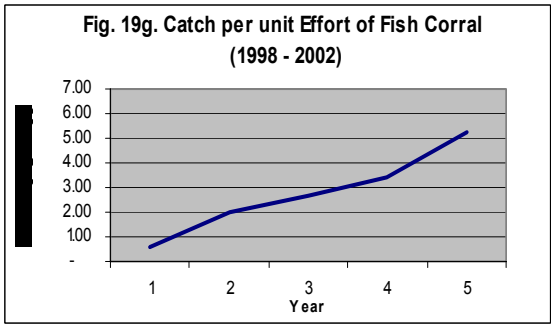


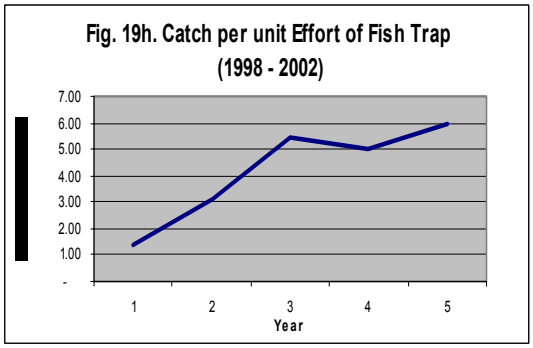












For bottom set gill net, the trend is from less than 1 kg/b/d CPUE to as high as 3.5kg/b/d. However, the fifth year decreased to less than 3kg/b/d. Gill net fishery as observed from the RSA is as low as 1.25kg man hour which is almost the same from the rates shown taking into account the average number of fishermen per banca which is 2 persons.

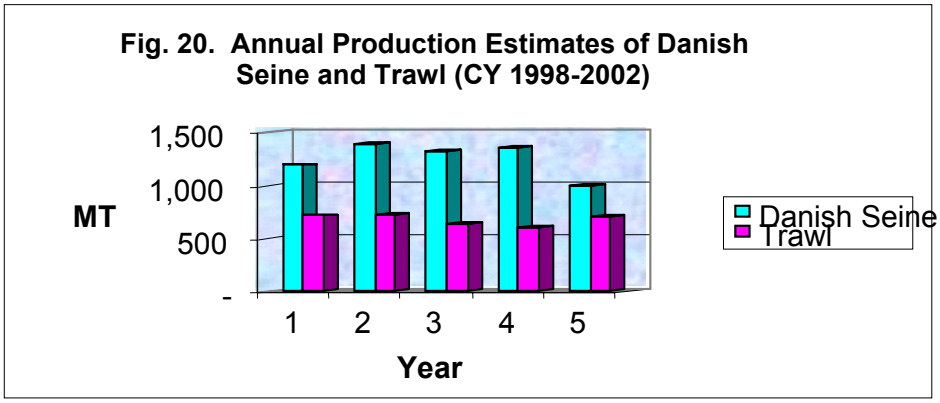
Even for selective gears like the handline fisheries, CPUE also increase for the first three years, however, CPUE is also declining for the past year.

The data from both commercial and municipal fisheries show that although catches seem to increase, however more boats and more fishers does not necessarily lead to increase in production. In fact, the more effort is used the lesser catch per unit of effort is as shown in this study and previous studies as well.

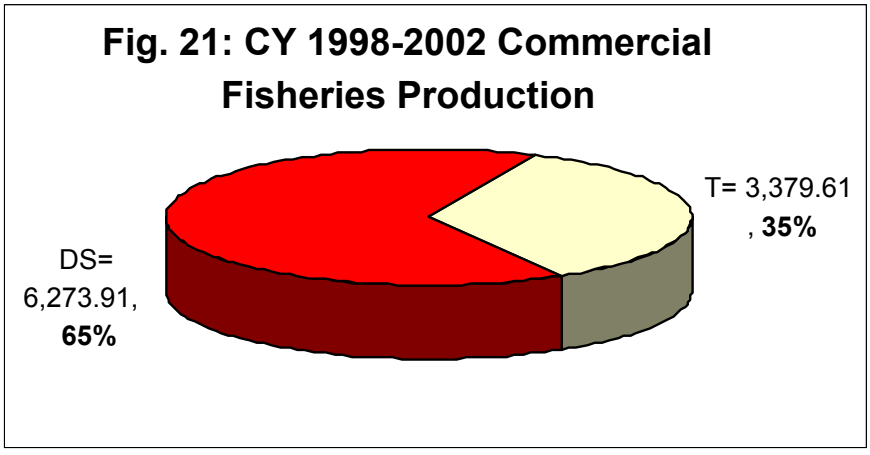
Production Estimates

Commercial Fisheries

Danish seine has consistently recorded a higher contribution over trawl to the commercial fishery production throughout the five-year course of the study. It should be noted that the Danish seine followed a "rise and fall" trend of production, while trawl production started to dwindle after the second year but began to recover during the fifth year. As shown in Fig.20, the trend of commercial fisheries production is declining.

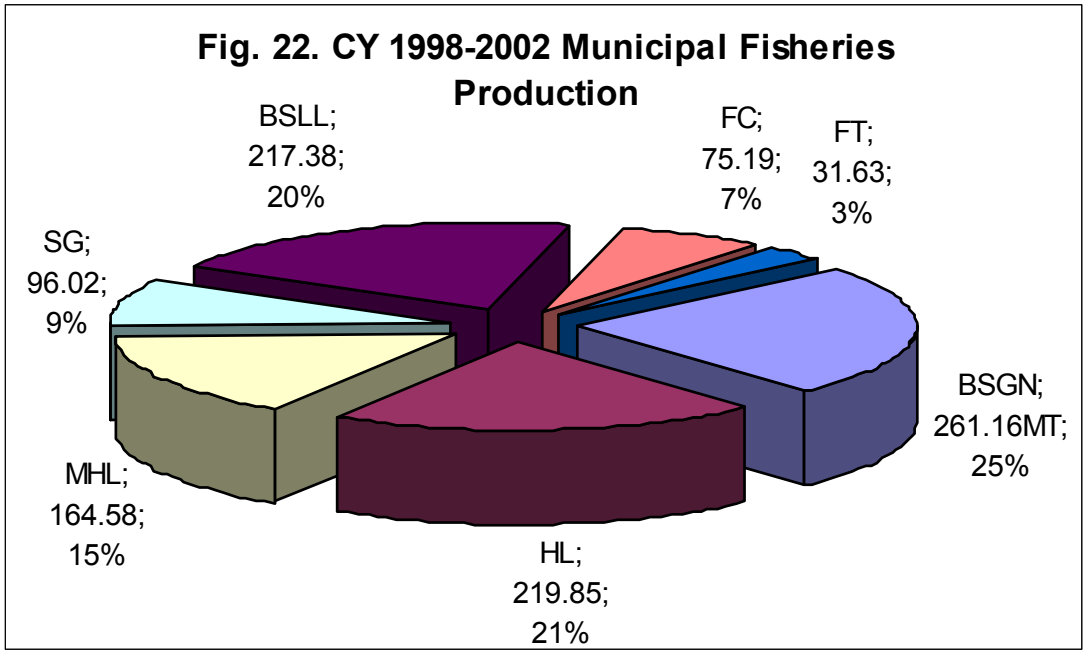


Catch from Danish seine yielded 6,273.91 MT that accounted for 65% while trawl fisheries contributed 3,379.61MT accounting for 35% of the production reaching a total of 9,653.52 metric tons for the whole five-year duration (Fig 21).



However, production estimates under the Municipal Fisheries was based only on the production of seven gears. As shown in figure below, 25% of the catch was contributed by bottom set gillnet, 21% from handline, 20%

from Bottom set longline, 15% from multiple handline, 9% from spear gun, 7% from corral and 3% from fish trap(Fig 22).



The annual production per gear per landing site is shown in Appendix 3a-b.

Maximum Sustainable Yield

The Maximum Sustainable Yield was computed using the Schaefer and Fox model. The MSY for the total fisheries was computed. The Yield was computed annually. The Effort was standardized annually based from the total number of boats by converting to total gross tonnage. (Table 4)

TABLE 4. Number of Commercial Fishing Boats per Gear with Corresponding Gross Tonnage

GEAR	Year 1 1998		Year 2 1999		Year 3 2000		Year 4 2001		Year 5 2002	
	NO.	TGT	NO.	TGT	NO.	TGT	NO.	TGT	NO.	TGT
DANISH SEINE	43	1,034.49	58	1,272.64	49	1,115.43	42	980.15	41	960.55
TRAWL	30	381.86	26	369.26	44	566.9	39	431.24	45	480.58
TOTAL	**73**	**1,416.35**	**84**	**1,641.9**	**93**	**1,682.33**	**81**	**1,411.39**	**86**	**1,441.13**

TABLE 5. Number of Municipal Fishing Boats per Gear with Corresponding Gross Tonnage

Gear	1998		1999		2000		2001		2002	
	No.	TGT	No.	TGT	No.	TGT	No.	TGT	No.	TGT
BSGN	94	80.71	70	63.09	97	91.71	84	79.83	86	83.21
BSGN (bas)	62	53.23	62	55.88	62	58.62	58	55.12	66	63.86
Handline	89	66.19	99	73.61	134	101.88	113	86.32	119	90.06
Handline (bas)	11.5	8.55	11.5	6.40	11.5	8.86	10	8.63	13	9.84
MHL	45	43.01	25	18.81	81	60.47	92	68.37	109	81.1
Spear Gun	38	32.19	26	14.14	22	15.68	12	8.49	12	8.76
Spear Gun (bas)	5	4.24	5	2.72	5	3.56	5	3.54	5	3.65
BSLL	75	53.96	58	40.73	29	20.14	47	36.69	46	33.97
BSLL (bas)	26.5	19.07	26.5	18.61	26.5	18.40	27	21.08	26	19.20
LL	115	82.74	115	80.76	115	79.87	115	89.77	115	84.93
Drift Gillnet	155	299.39	155	299.39	155	299.39	155	299.39	155	299.39
Dredge net (bas)	3	5.79	3	5.79	3	5.79	3	5.79	3	5.79
Kariskis (bas)	2	3.86	2	3.86	2	3.86	2	3.86	2	3.86
Fish Corral	46	9.17	25	18.03	17	16.99	12	15.54	9	15.46
Fish Trap	9	6.27	12	8.48	7	5.03	7	5.95	6	4.53
Fish Trap (bas)	5.5	3.83	5.5	3.89	5.5	3.95	4	3.40	7	5.29
Crab Pot	115	18.34	115	13.56	115	22.86	115	19.33	115	25.39
Filter net (bas)	2	0.081	2	0.081	2	0.081	2	0.081	2	0.081
Total	**898.5**	**790.62**	**817.5**	**727.831**	**889.5**	**817.14**	**863**	**811.81**	**896**	**838.371**

The Danish seine was used as the standard measure of effort. Municipal boats were converted to total gross tonnage and added to the commercial boats. Available data was used and similar gears were converted to one representative gear. The representative gear was then converted to the Danish seine for standardization. (Appendix 4).

Table 6. MSY Table

YEAR	Effort GT of Boats	Yield (MT)	Schaefer	Fox
1998	2,339.77	4,420.92	1.89	0.64
1999	2,519.30	4,676.21	1.86	0.62
2000	2,649.05	4,274.51	1.61	0.48
2001	2,359.50	4,555.61	1.93	0.66
2002	2,441.71	4,386.89	1.80	0.59

a	3.9635	1.8147
b	-0.0008	-0.0004
MSY	**4505.0269**	**4550.1875**
fMSY	**2273.2401**	**2019.0753**

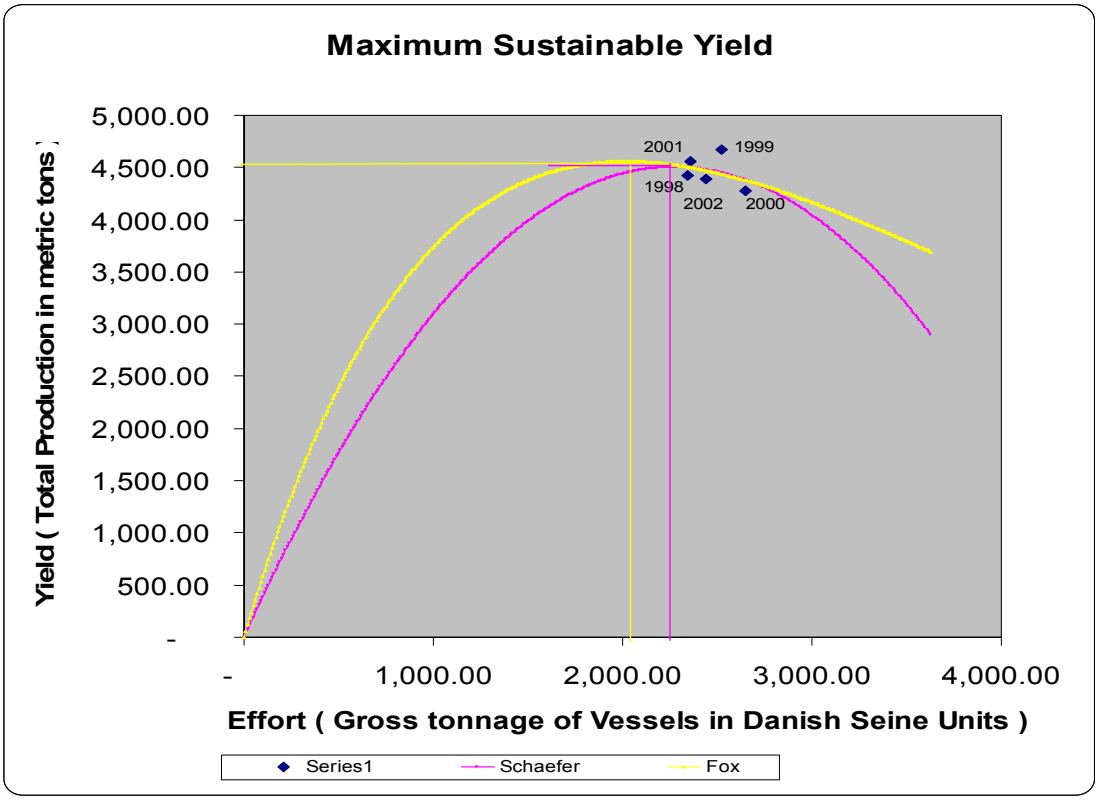


Figure 23: MSY Lingayen Gulf Fisheries

Based on the data, it indicates that MSY has been reached even before the start of the study. The Schaefer model places MSY at 4,505 metric tons with an average of 113 boats (Danish seine at an average of 20 GT level). While Fox model is even lower at 100 boats (Fig 23).

Previous assessment studies done in the gulf have shown that stocks are already over fished and over exploited even with only the trawl fisheries and municipal fisheries contributing to the extraction of the fisheries resources (Silvestre, et.al, 1990). Consequently, it has been recommended that there is a need to decrease effort in order to sustain the fisheries.

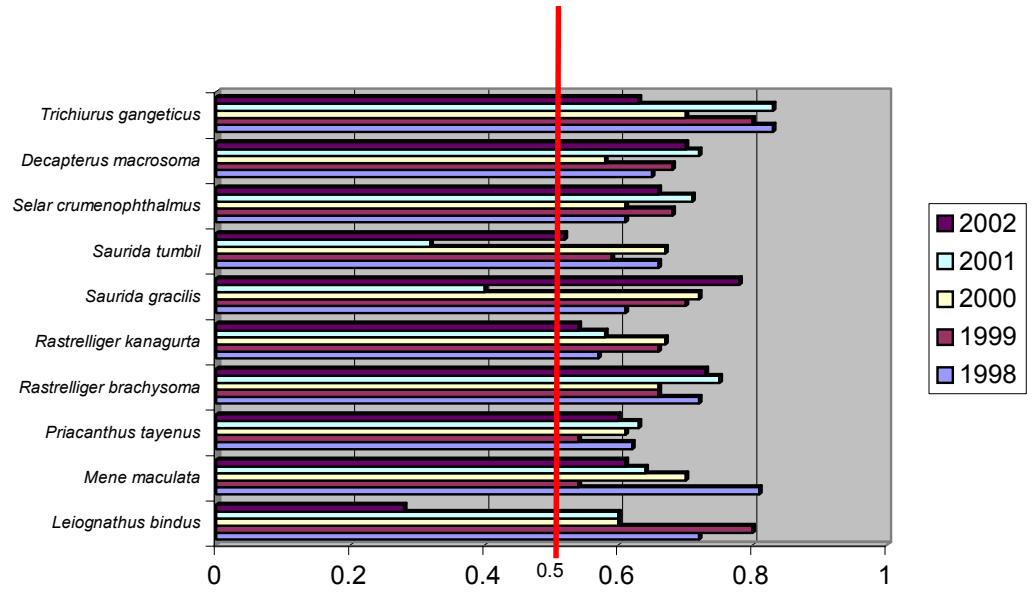
The data from the present study is consistent with findings from previous studies that Lingayen gulf is over fished even as early as 1976 (Smith. et.al, 1980).

Population Parameters and Yield per recruit analysis

From the result of the population parameters (Appendix 5), computations proceeded to probabilities of capture and on to the Yield per recruit analysis.

Among the top 10 species caught regardless of the gear used, *Mene Maculata evidently* has the highest Exploitation rate (E value) at 0.81, followed by *Leiognathus bindus* at 0.80. *Saurida gracillis reached* the E value of 0.79 while *Trichirus gangeticus reached* up to 0.73 indicating high exploitation rates (Fig 24-a).

Fig. 24a. Exploitation Rate of top 10 species 1998 - 2002

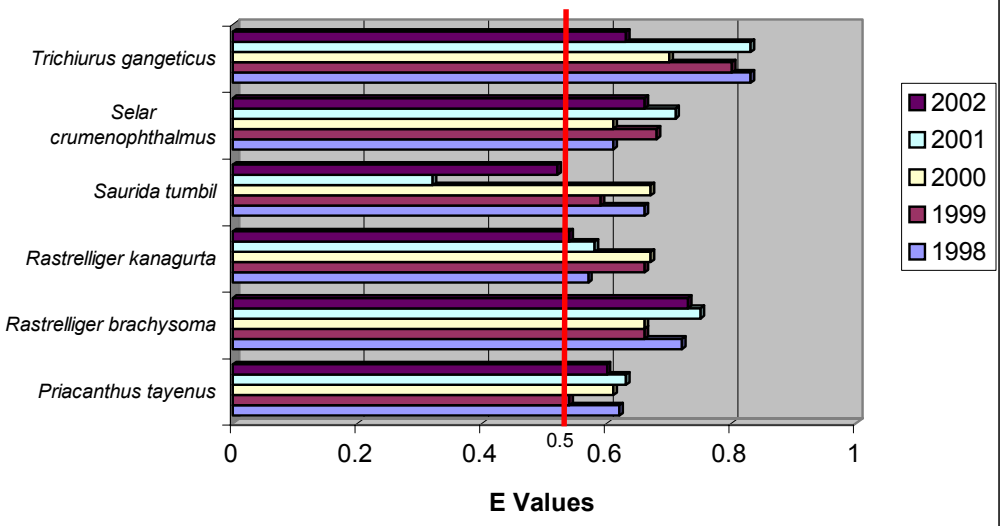


For the past five years of the study, all of the top ten species have values more than 0.5 levels even reaching up to 0.81 levels indicating that they are over exploited. Previous studies have stated that the fisheries resources of the gulf are already over exploited. This is further reiterated as a result of this study showing that the top ten species which are most abundant and commonly caught have very high exploitation rates.

In combining the catch of the two commercial gears (Danish seine and trawl) and the top municipal gear (bottom set gill net) the most commonly caught species *Saurida tumbil* & *Priacanthus tayenus* have reached the E

value of 0.66 even during the first year of the study, while *Trichiurus gangeticus* and *Selar crumenophtlamus* have reached E values of 0.80 levels which are very high during the fifth year.

Fig. 24b. Exploitation Rate of top species commonly caught by all gears 1998 - 2002



Based on the computed E value, most of the top 10 species caught by Danish Seine, Gillnet and Trawl fisheries are heavily exploited as shown by most of the numbers computed which is beyond 0.5 levels (Fig 24 b).

Length Frequency Distribution and Probability of Capture Analysis

One possible area where management measures can be done is to look at the data from the probability of capture and the length frequency distribution. For most of the species caught by Danish Seine, Gillnet and Trawl fisheries the length at first capture of the top 10 species is already at 12 cm. As they reach 15 cm about 50% are already caught and at 16 cm almost 75% are caught.

For this study, length frequencies of *Decapterus macrosoma* which is the top species caught by trawl indicate that the species is caught before it matures. However the probability of capture indicates that it matures before the 50% level of stock is reached (length at maturity as determined by other studies is about 15 cm). *Rastrelliger brachysoma,* however, which is the top species caught by Danish seine, is more exploited since based on the probability of capture 75% of the stock are already caught before it reaches maturity at 17 cm.

As for *Rastrelliger kanagurta* data shows that more than 75% of the stock is already caught before it matures. *Selar crumenopthalmus* is the most vulnerable of the species caught since the length at maturity is way beyond the length where almost 90 % of the stocks are captured (Fig. 25 a-e).

Mesh size regulation can be done so that the stock is allowed to mature and can reproduce before they are caught.

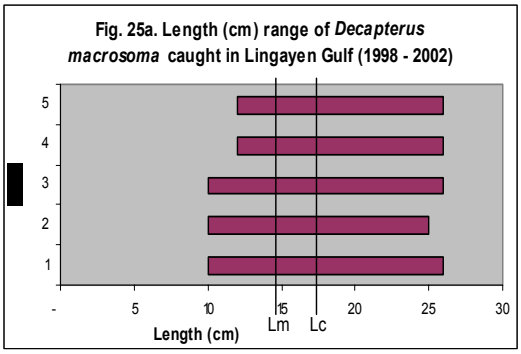
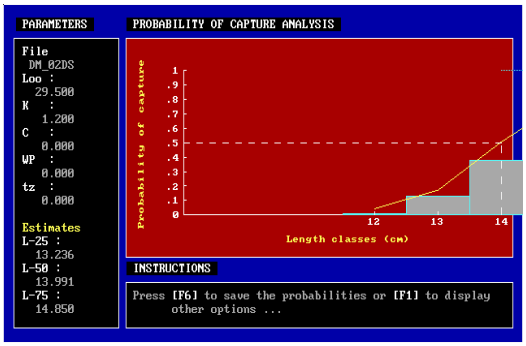


Fig. 25a. Length (cm) range of *Decapterus macrosoma* caught in Lingayen Gulf (1998 - 2002)



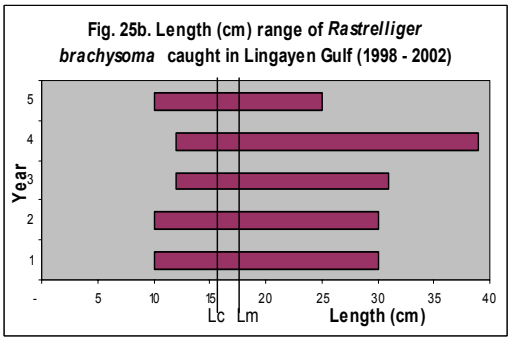
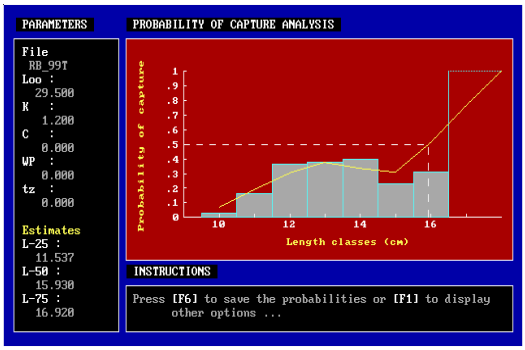


Fig. 25b. Length (cm) range of *Rastrelliger brachysoma* caught in Lingayen Gulf (1998 - 2002)



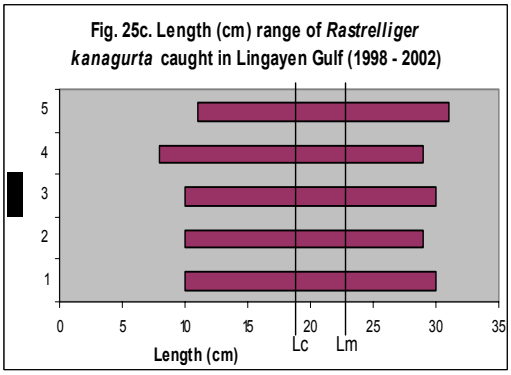
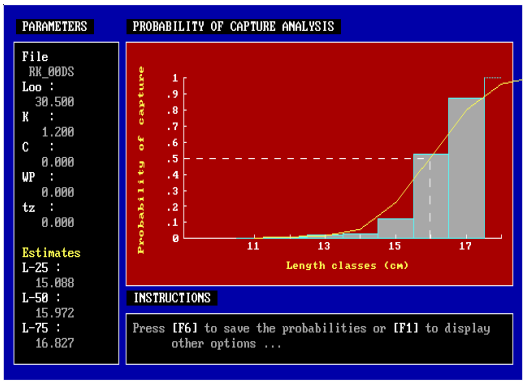


Fig. 25c. Length (cm) range of *Rastrelliger kanagurta* caught in Lingayen Gulf (1998 - 2002)



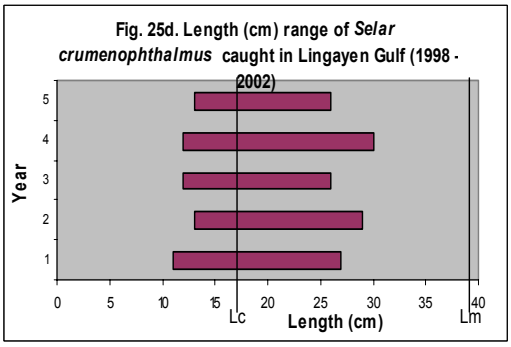
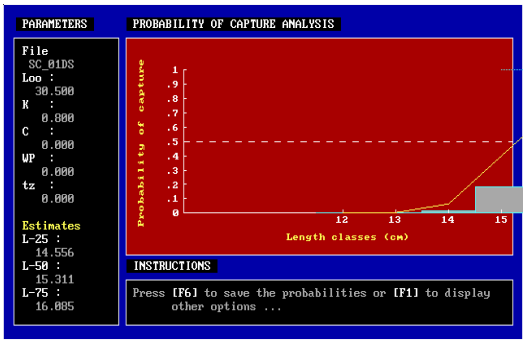
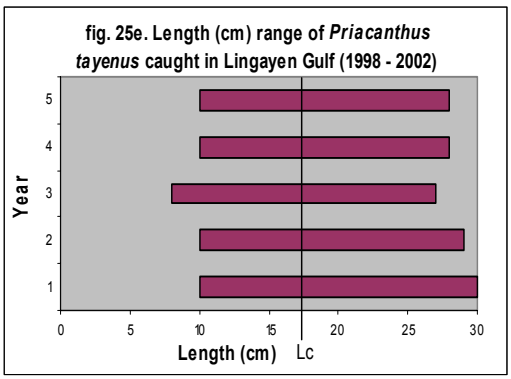
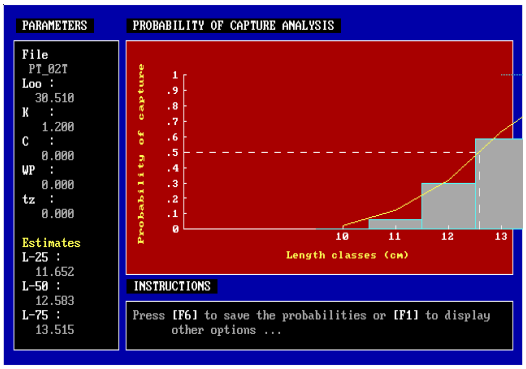


Fig. 25d. Length (cm) range of *Selar crumenophthalmus* caught in Lingayen Gulf (1998 - 2002)



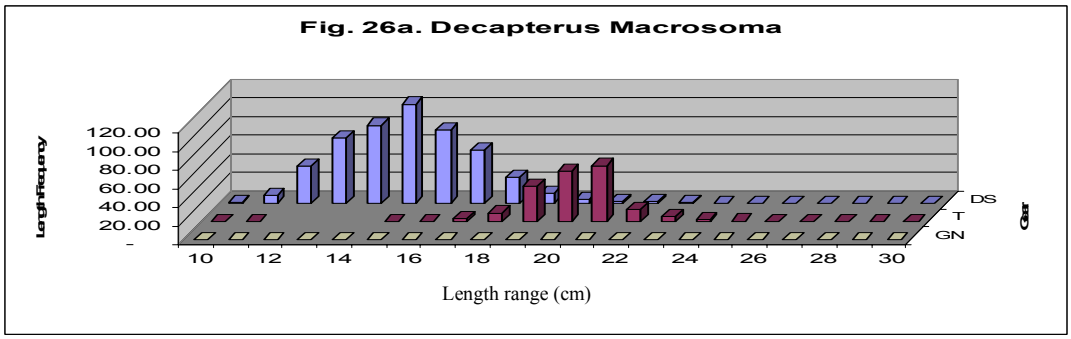


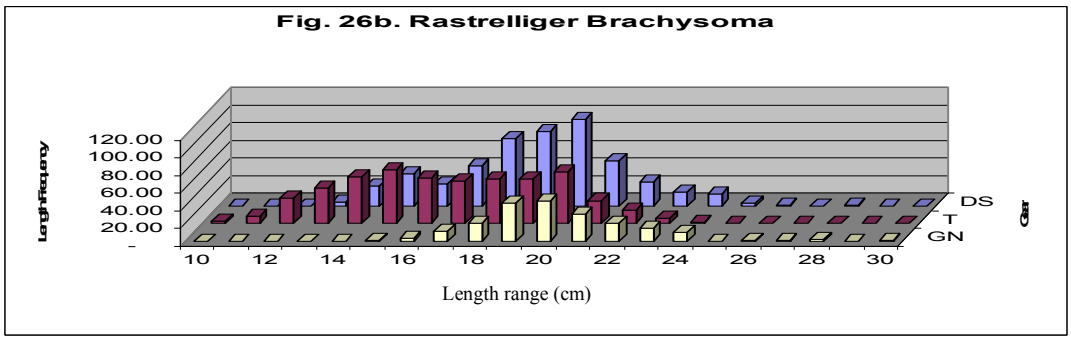


With the combined pressure of the two commercial gears and top municipal gear which is the gill net, most of the top species are really vulnerable to over exploitation. Based on the following graphs, smaller length classes for *Decapterus macrosoma*, is caught by Danish seine while the bigger length classes are caught by trawl. Gill net catch was not recorded. For *Rastrelliger brachysoma* and *Rastrelliger kanagurta*, the smaller length classes is caught by trawl while the bigger length classes are caught by both Danish seine and gill net.

As for the other top species, *Saurida tumbil* is caught by trawl and gill net for the smaller length classes while the bigger length classes are caught by Danish seine. For the rest like *Selar crumenophthalmus*, *Priacanthus tayennus* and *Trichiurus gangeticus*, same sizes are caught by the three gears (Fig 26a-g).

Based on these data, management measures can be done in the form of mesh regulations and licensing of gears so that exploitation rates can be lowered and stocks can recover.





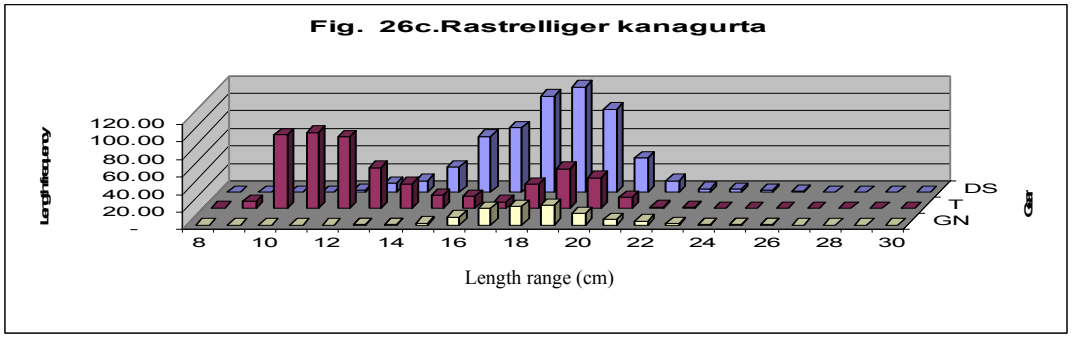


Fig. 26c.Rastrelliger kanagurta
120.00
100.00
80.00
60.00
40.00
20.00
-
8 10 12 14 16 18 20 22 24 26 28 30
DS
T
GN
Length range (cm)

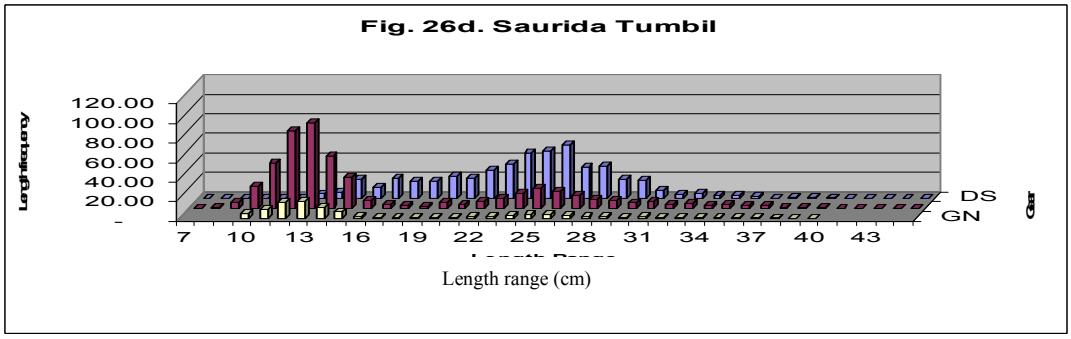


Fig. 26d. Saurida Tumbil
120.00
100.00
80.00
60.00
40.00
20.00
-
7 10 13 16 19 22 25 28 31 34 37 40 43
DS
GN
Length range (cm)

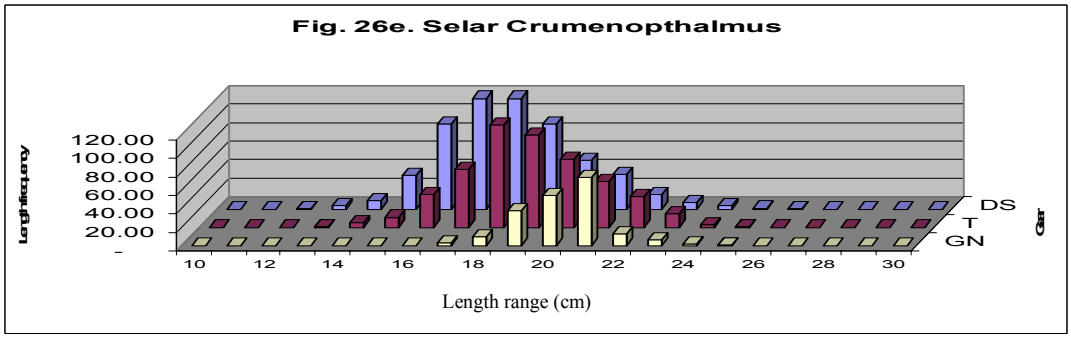


Fig. 26e. Selar Crumenopthalmus
120.00
100.00
80.00
60.00
40.00
20.00
-
10 12 14 16 18 20 22 24 26 28 30
DS
T
GN
Length range (cm)

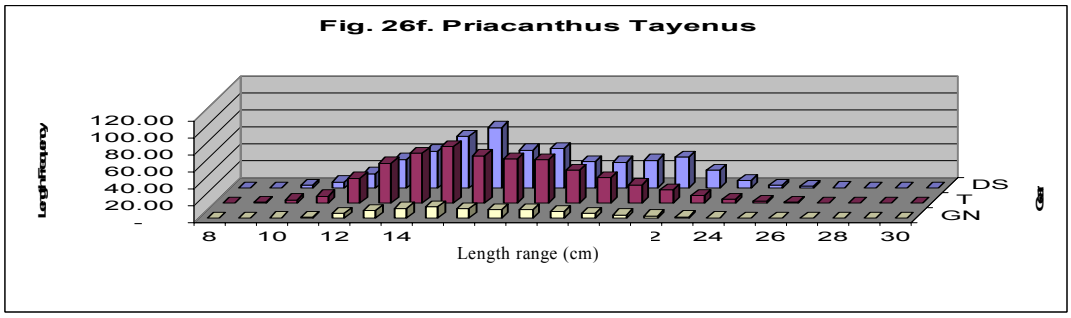


Fig. 26f. Priacanthus Tayenus
120.00
100.00
80.00
60.00
40.00
20.00
-
8 10 12 14 24 26 28 30
DS
T
GN
Length range (cm)

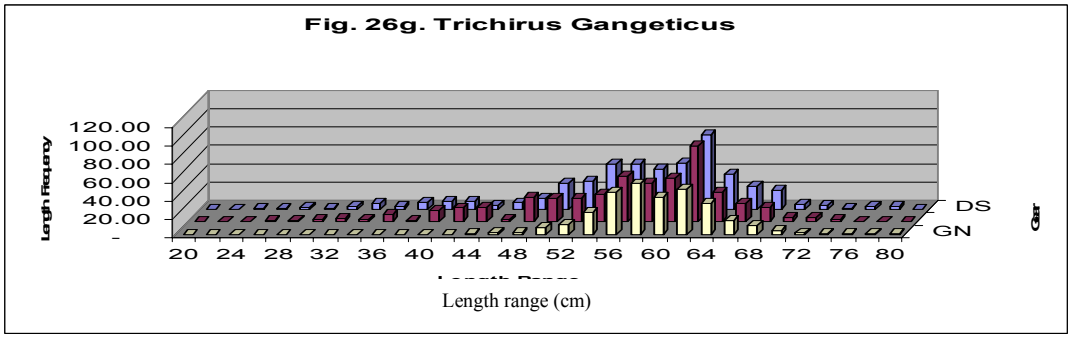
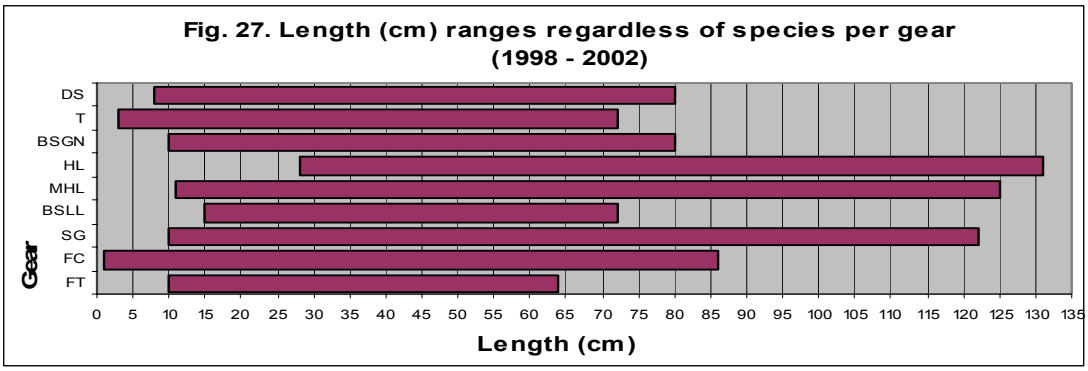


Fig. 26g. Trichirus Gangeticus
120.00
100.00
80.00
60.00
40.00
20.00
-
20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80
DS
GN
Length range (cm)



The ranges in length (cm) of fish caught by all gears is shown in Fig 27 where fish corral catches very small sized fish at 1 cm and trawl catches fish as small as 3 cm indicating that the nets used by these gears have very small mesh sizes. Danish seine, bottom set gill nets, spear gun and fish traps catch bigger fishes starting at 8 cm and 10 cm, respectively. Multiple hand line and bottom set long line fishery catch bigger sized fish starting from 11 cm and 15 cm, while hook and line catch the tuna, tuna like and other big species. Appendix 6.

SUMMARY AND CONCLUSION

1. Commercial fisheries is contributed by both modified Danish seine and trawl while municipal fisheries consist of gill net fishery, handline, fish traps, fish corrals, pots, seines and other minor gears. An average of 83 boats (commercial) and 5000 municipal boats surveyed are fishing in the gulf. The municipal fisheries are dominated by gill net and handline fishery. Fishermen shift from one gear to another depending on the season.

2. The species composition is dominated by demersal species over the pelagic species since most of the gears target both demersal and pelagic species. Commercial gears have wider mouth opening as shown in the species composition where both catch demersal and pelagic species.

3. The short fin scad is the most dominant species caught by Danish seine, while short mackerel is the most dominant species caught by both trawl and bottom set gill net. Tuna and dolphin fish dominate the handline fisheries while the blue swimming crab dominates the catch of fish traps.

4. The most abundant species exhibit seasonality where annual peak and lean months are shown for the 5 year data series

5. Boat operation and production were compared for commercial and municipal fisheries. Increase in effort does not necessarily mean increase in production as shown in the computed CPUE. Danish seine contributed 65% while trawl contributed 35% of the total commercial fisheries production. However, for the five year period, the CPUE of Danish seine did not increase while trawl dropped to as much as 50% from year 1 to year 5. The CPUE for most of the municipal gears also declined from year 1 to year 5 except for fish corral and fist trap which increased during the fifth year.

6. The computation of MSY shows that gulf has reached MSY level even before the start of the study. Previous studies have shown that the resources of the gulf have been over exploited. This is confirmed by this study where commercial and municipal production were combined and effort was standardized to get the over all status of the resources.

7. Population parameters were computed for the top ten species and results show that for the past 5 years, the exploitation rates of all the species have gone beyond 0.5 levels. This further indicates that the fishery is over exploited.

8. The length frequencies indicate that most of the species are caught before they mature. This is further confirmed through the routine on probability of capture where 75% of the stocks are caught before they reach maturity. The top species are also caught by both commercial gears (Danish seine and trawl) and municipal gears using bottom set gill net. Most of the species are caught for the whole of their life cycle with different gears catching them at different sizes depending on the size of the nets.

RECOMMENDATIONS

1. From the results of this study, there is a need to reduce effort levels for all gears (commercial and municipal) so that MSY can be achieved. As per computed fMSY, a level of 100 to 113 boats at 20GT is being recommended to maintain MSY.

2. Closed season can be recommended during peak or lean months for the species as well as for gears. This is another management measure based on the seasonality of the stocks. However, biological parameters such as maturity and presence of gonads must be incorporated to support this measure.

3. Mesh size regulation is another option for management to regulate fishing activities. Fish corrals catch as small as 1 cm while trawl catch as small as 3cm. There is a need to monitor the bunt of these gears to prevent them from catching very small sized fish.

4. Selective gears must be encouraged as a fishing gear instead of gears using nets.

5. Continue promotion of resource enhancement projects where no fishing zones are delineated to allow the resources to grow, mature and reproduce.

6. Promote alternative livelihood projects which lessen fishing pressure

7. Continue the assessment of the gulf so that the fisheries can be monitored. Continued collaboration with BAS to produce more reliable results.

8. Prepare production estimates for the ILocos Coast.

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