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Fish Stock Assessment in Northern Zambales Coast

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National Stock Assessment Program

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ABBREVIATIONS, ACRONYMS AND SYMBOLS

BAS	-	Bureau of Agricultural Statistics
BFAR	-	Bureau of Fisheries and Aquatic Resources
cm	-	centimeter
CPUE	-	cath per unit effort
CY	-	current year
E	-	exploitation rate
ELEFAN	-	electronic length frequency analysis
E_{opt}	-	optimum exploitation rate
F	-	fishing mortality
FAD	-	fish aggregating device
FAO	-	Food and Agriculture Organization of the United Nations
Fig.	-	figure
FISAT	-	FAO-ICLARM stock assessment tools
Fish.	-	fisheries
FL	-	fork length
FRMD	-	Fishery Resource Management Division
ICLARM	-	International Center for Living Aquatic Resources Management
J.	-	journal
K	-	growth rate
kg	-	kilogram
L_{25}	-	length at 25 percent probability of capture
L_{50}	-	length at 50 percent probability of capture
$L\infty$	-	length infinity, asymptotic length
m	-	meter
M	-	natural mortality
mt	-	metric ton
NFRDI	-	National Fisheries Research and Development Institute
NSAP	-	National Stock Assessment Program
p.	-	page/s
Philipp.	-	Philippines
PMED	-	Planning, Management and Economics Division
PY	-	potential yield
RA	-	Republic Act
Res.	-	research
TL	-	total length
VBGF	-	von Bertalanffy growth function
yr	-	year
Z	-	total mortality
Ø’	-	growth performance index
%	-	percent

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ABSTRACT

This study was carried out to document the catch per unit effort (CPUE) of different types of fishing gear, number of boats and gear, distribution of fishermen, species composition, population parameters of selected species, potenial yield (PY) and optimum effort in Northern Zambales. The study concentrated in the areas of Masinloc, Sta. Cruz and Candelaria.

Based on a five-year fishery assessment, from 1998 to 2002, production of Northern Zambales was dominated by purse seine with a share of 63 percent of the total recorded catch. The average CPUE of purse seine was 408.19 kg/day. The municipal fishing gear - gillnet and handline - recorded a CPUE of 4.40 kg/day and 9.58 kg/day, respectively.

Population parameter estimates showed that three commonly caught marine species (*Decapterus macrosoma, Selaroides leptolepis, Rastrelliger kanagurta*) in the Northern Zambales coast are overexploited, with an average exploitation rate (E) value of 0.68. On the other hand, *Pterocaesio tile* and *Myripristis adusta* recorded E values of 0.24 and 0.43, respectively, indicating underexploitation of these species.

Potential yield (PY) and optimum effort were computed using the Schaefer and Fox models. The PY for Northern Zambales area is about 5,021.69 mt, with an effort of 7,854.50 (standard gear) using the Schaefer model. Using the Fox model, the PY is lower (4, 935.08 mt) at an optimum effort of 8,657 (standard gear). The PY values obtained, using the two models, were already exceeded in 1999 and 2000 (with a yield of 5,408.88 mt and 5,071.90 mt, respectively).

INTRODUCTION

The Study Area

Northern Zambales Coast is located in Region 3 (Central Luzon) which lies at the heart of Luzon Island. Region 3 is composed of seven provinces, namely, Aurora, Bataan, Bulacan, Nueva Ecija, Pampanga, Tarlac and Zambales (Fig. 1). The region has a narrow coastline of more than 192 km along Manila Bay, 110 km along the Zambales Coast and 332 km along the Aurora coastline. Based on fisheries statistics, Central Luzon has a total fish production of 182,253 mt (BAS 2002). Almost 16 percent (29,708 mt) was contributed by municipal and commercial sectors of the region. Of the 29,708 mt of fish produced, the share of the municipal sector was 61 percent; the commercial sector, 39 percent.

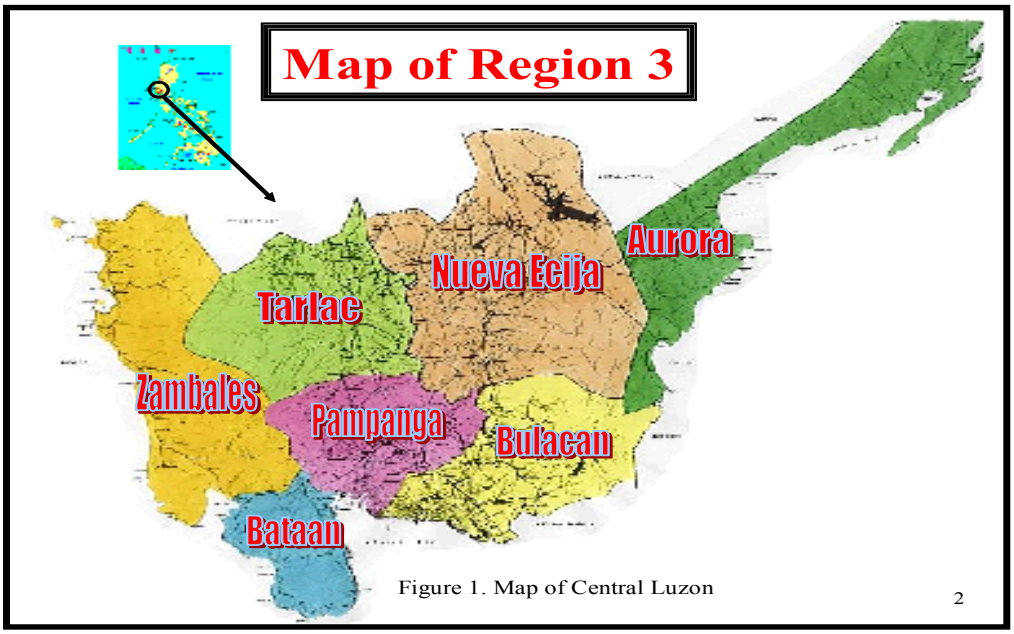


Figure 1. Map of Central Luzon.

The province of Zambales covers a large fishing area for both municipal and commercial fishing industry. The province is composed of 13 municipalities; 11 of these lie along the coastline of Zambales, geographically comprising the Zambales Coast.

Zambales Coast is an important marine fishing ground of the region, aside from Manila Bay, both for pelagic and demersal fishery resources. It lies on the northwestern part of the region and is part of the South China Sea. The marine environment of Zambales Province includes reefs, coves and bays that are rich in finfishes and aquatic invertebrates. The Bureau of Agricultural Statistics reported the fish production of Zambales for CY 2002 at

9,939 mt. Almost 65 percent is shared by the commercial and municipal sectors of the province.

The northern coast of Zambales is composed of four coastal municipalities with 63 barangays, 43 of which lie along the coast of Zambales. Pelagic and demersal fish species are landed at some selected fish landing sites of the barangays along the coast. In spite of the vast potential of the fishery resources of Zambales Coast and its share in capture fisheries production, there are no published studies and available related information on the fishery resources of the whole coast. Hence, this program was undertaken not only to assess the status of fish stocks, but to provide as well production data which are useful as basis for imposing catch ceiling limitations and establishment of closed season in the area (in accordance with RA 8550, Chapter II, Sections 8 and 9). This will aid in promoting the proper utilization, management and conservation of fishery and aquatic resources.

Importance and Objectives of the Study

The study was undertaken to provide first documentation on the catch and effort, species composition and population parameters of fish stocks in Northern Zambales. This is a component study under the National Stock Assessment Program (NSAP) with the following objectives:

General

- To give relevant information and baseline data on the marine fishery resources vital for policy formulation, management and conservation of the marine aquatic resources of Zambales Coast.

Specific

- To evaluate the catch per unit effort (CPUE) of dominant fishing gear in Northern Zambales;

- To determine the species composition and some commercially important fish species landed in Northern Zambales;

- To generate first-hand data and information on the estimated annual yield of marine species caught by observed fishing gear in the northern part of Zambales;

- To establish estimates on some population parameters of selected dominant species in Northern Zambales; and

- To determine the potential yield (PY) and optimum effort in Northern Zambales.

Limitations of the Study

- The study concentrated on the northern part of Zambales; five out of the six observed sampling sites are located thereat.

- Some of the results presented deal with the observed fishing gear used in the sites monitored during the study.

- The fish landing sites are not multi-geared type sampling stations.

METHODOLOGY

Fish Landing Sites/Sampling Stations

Figure 2 shows the established fish landing sites for the National Stock Assessment Program (NSAP) in Central Luzon. Three major fish landing sites along Zambales Coast (located in Subic, Masinloc and Sta. Cruz) and one minor fish landing site (at Candelaria) were established as sampling stations.

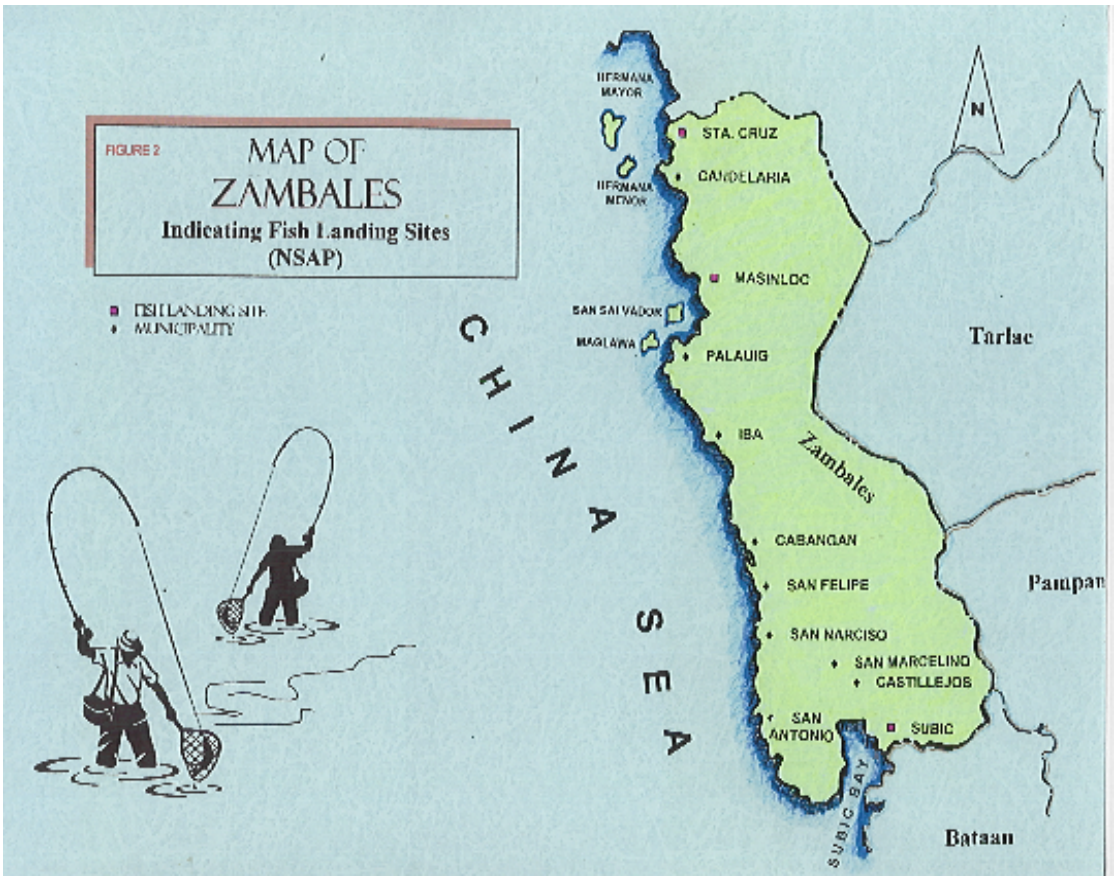


Figure 2. Map of Zambales showing the NSAP fish landing sites.

Boat and Gear Inventory

Data on the inventory of fishing gear and boats, and distribution of fisherfolk in the coastal barangays of Northern Zambales were taken by NSAP field enumerators from the Office of the Municipal Agriculturist. There were some missing data, however, which were projected based on the available inventory data.

Data Collection

Data collection in the study area was conducted from 1998 to 2002 by trained NSAP field enumerators. The frequency of sampling was every two days, including Saturdays, Sundays and holidays. Practically all fishing boats, of whatever fishing gear, unloading their catch during the daytime were sampled for total catch and species composition. Fishing boats that were not sampled were also recorded by gear type so as to obtain a total enumeration of fishing boats for a particular sampling day. Data and other relevant information were recorded in prepared survey forms. They were summarized monthly and tabulated by species composition and gear type.

For length-frequency data sampling, the dominant and abundant species were tallied monthly. Tuna and tuna-like species were measured in fork length (FL), while other species in total length (TL). Length-frequency data of dominant species were grouped, based on the recommended class interval of the FAO Working Party on Length Measurement and Tabulation. All measurements are in centimeters.

Catch, Effort and CPUE

Catch is expressed as whole weight in kilograms. Catch per unit effort (CPUE) was determined using the standard units of effort formulated by BFAR according to the type of fishing gear used. For this study, the standardized unit of effort used is kilograms per day (kg/day). CPUE is computed by taking the quotient of the catch (in kg) over the average fishing days. CPUE of the dominant fishing gear in the monitored sites was computed using actual and raised data. Information on CPUE of minor gear in unmonitored sites were gathered through interviews with fishermen.

Production Estimates

Production data for monitored sites were sourced from the summarized monthly fish landing surveys conducted by the NSAP field enumerators. The production in the unmonitored sites was computed on the basis of CPUE obtained through interviews. Values were standardized by computing the direct relationship between CPUE, actual fishing days and units of boats landed.

Data Processing and Analysis

Catch and length-frequency data were raised, according to the procedures in recording length and catch data (Edralin *et al.* 1992).

Species composition was categorized according to family groups. Identification and grouping of the species were based on Allen and Swainston (1988) and Froese and Pauly (2000). The landed catch of the fish species was tabulated by family using the five-year (1998-2002) catch data, and the family composition was obtained by taking the percentage share in relation to

the total catch of the landed boats and of the boat catch sampled by species at the fish landing site.

Population Parameters

Population parameters presented were obtained using the FAO-ICLARM Stock Assessment Tools (FISAT) software (Gayanilo *et al.* 1996). The software includes the Electronic Length Frequency Analysis (ELEFAN) routines to estimate the parameters of the von Bertalanffy Growth Function (VBGF). The asymptotic length ($L\infty$) and the growth constant (K) value were estimated via K-scan routine of ELEFAN 1, wherein the K-value is chosen to provide the "best fit" for the available length-frequency data of a particular species. The ratios of the coefficients of mortality and growth (Z/K) were estimated using the Powell-Wetherall plot (Powell 1979, Wetherall 1986). Natural mortality (M) was estimated using the M-empirical equation of Pauly (1984). Values obtained for mortality were used for the computation of exploitation rate (E).

Probability of Capture

Probabilities of capture for the selected species were estimated from the left ascending arm of the catch curves. This involves extrapolating the right descending side of the catch curve such that fish that "ought" to have been caught are added to the curve, with the ratio of "expected" numbers to those that are actually caught being used to estimate the probabilities of capture.

Potential Yield

Potential yield (PY) and optimum effort were estimated using two models: Schaefer model and Fox model. The effort used in the computation of PY is the number of standard gear recorded in the Northern Zambales area.

Standardization was made using gillnet units with the following specification (average):

Length of *banata*	=	100 m
Number of *banata*	=	13
Depth of net	=	2 m
Mesh size	=	3 cm

Other gear types were converted/standardized into gillnet unit using the formula:

$$\frac{\text{CPUE of selected gear}}{\text{CPUE of gillnet}} \times \text{annual selected gear inventory}$$

RESULTS AND DISCUSSION

Fishing Boats

Municipal. Table 1 shows the distribution of fishing boats used by municipal fishermen of Northern Zambales. Out of 2,377 municipal fishing boats, 79.46 percent are motorized. The municipality of Sta. Cruz has the highest percentage share (47.50 percent) both for motorized and non-motorized fishing boats. Candelaria has the least number of fishing boats, with only five coastal barangays (out of 16 barangays under the municipality's jurisdiction).

Table 1. **Inventory of municipal boats in Northern Zambales, 2002.**

Municipality	Number of Boats			Percentage Share
	Motorized	Non-motorized	Total	
Palauig	360	201	561	23.60
Masinloc	382	134	516	21.71
Candelaria	134	37	171	7.19
Sta. Cruz	1,013	116	1,129	47.50
Total	**1,889**	**488**	**2,377**	
% Share	79.46	20.54		100.00

Commercial. The Bureau of Fisheries and Aquatic Resources – Region 3 has recorded and issued licenses to 20 commercial fishing boats in Northern Zambales, particularly in Masinloc and Sta. Cruz (Table 2). Majority of these boats are in Masinloc. All the commercial fishing vessels have their own light boats.

Table 2. Inventory of commercial boats in Northern Zambales, 2002*.

Municipality	Number of Boats			Percentage Share
	Mother Boat	Light Boat	Total	
Masinloc	12	36	48	62.00
Sta. Cruz	8	21	29	38.00
Total	**20**	**57**	**77**	
% Share	26.00	74.00		100.00

* FRMD, BFAR 3.

Distribution of Fishermen and Fishing Gear

Municipal. A total of 4,462 sustenance fishermen were recorded in the four municipalities of Northern Zambales (Table 3). Of this, 2,788 (62.48 percent) are engaged in full-time fishing, while 1,674 (37.52 percent) are part-time fishermen. Full-time fishermen are those 100 percent fishermen with no other income aside from fishing and who purely depend on fishing as their source of income. Part-time fishermen are those who do not depend on fishing during lean season and engage in other activity, like farming and selling of goods.

Table 3. Distribution of municipal fishermen in Northern Zambales, 2002.

Municipality	Number of Fishermen			Percentage Share
	Full-time	Part-time	Total	
Palauig	715	673	1,388	31.11
Masinloc	331	244	575	12.89
Candelaria	123	48	171	3.83
Sta. Cruz	1,619	709	2,328	52.17
Total	**2,788**	**1,674**	**4,462**	
% Share	62.48	37.52		100.00

There are 15 types of fishing gear used by municipal fishermen of Northern Zambales. Table 4 shows the type and number of fishing gear distributed by municipality in Northern Zambales. A total of 6,892 fishing gear units or 89.70 percent were recorded in the municipality of Sta. Cruz. Of the 15 types of fishing gear, the gillnet has recorded the highest number with 4,142 units. Gillnet is the dominant gear in Masinloc and Sta. Cruz.

Commercial. Table 5 shows that all commercial fishermen in Northern Zambales are full-time fishermen. Masinloc accounts for 54.65 percent and the rest are in Sta. Cruz, Zambales.

Purse seine and ring net are the only types of commercial fishing gear observed in Northern Zambales (Table 6). Purse seine accounted for 75 percent and are concentrated in Masinloc, Zambales.

Composition of Catch Landed by Dominant Fishing Gear

Figure 3 illustrates the percentage share of fish production for dominant fishing gear recorded in Northern Zambales.

Gillnet

The total landed catch of gillnet during the period of study was 486,194 kg. Thirty families were recorded from catches of the gear. Yellow-striped

scad (*Selaroides leptolepis)*, shadowfin soldier fish (*Myripristis adusta*) and surgeon fish (*Ctenochaeutus strigosus*) were the dominant species.

Table 4. Distribution of municipal fishing gear in Northern Zambales, 2002.

Fishing Gear	Municipality				Total	Percentage Share
	Palauig	Masinloc	Candelaria	Sta. Cruz		
Gillnet		178	55	3,909	4,142	53.91
Handline			35	418	453	5.90
Hook and line		107	35		142	1.85
Baby bagnet		103	66		169	2.20
Long line				630	630	8.20
Squid jigger		113		609	722	9.40
Spear gun		38		470	508	6.61
Push net				51	51	0.66
Trammel line				89	89	1.16
Troll line				239	239	3.11
Lift net				209	209	2.72
Baby trawl				27	27	0.35
Traps				241	241	3.14
Beach seine	23		11		34	0.44
Round haul seine	27				27	0.35
Total	**50**	**539**	**202**	**6,892**	**7,683**	
% Share	0.65	7.02	2.63	89.7		100.00

Table 5. *Distribution of commercial fishermen in Northern Zambales, 2002.*

Municipality	Number of Fishermen			Percentage Share
	Full-time	Part-time	Total	
Masinloc	94		94	54.65
Sta. Cruz	78		78	45.35
Total	**172**		**172**	
% Share	100.00			100.00

Table 6. *Types of commercial fishing gear in Northern Zambales, 2002.*

Municipality	Fishing Gear Used (Number of Units)			Percentage Share
	Purse Seine	Ringnet	Total	
Masinloc	12		12	60
Sta. Cruz	3	5	8	40
Total	**15**	**5**	**20**	
% Share	75	25		100.00

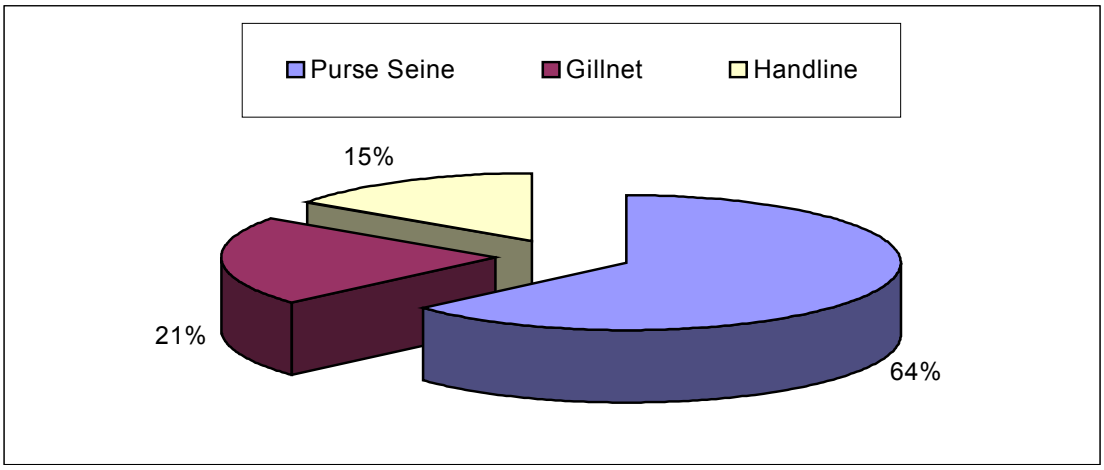


Figure 3. Production shares of the dominant fishing gear in Northern Zambales, 1998-2002.

Purse Seine

Purse seine recorded a total catch of 1,438,752 kg, comprising of 12 species. The tuna species dominated the catch with skipjack (*Katsuwonus pelamis*) having the highest catch of 598,570 kg or 42 percent of the total catch. Yellowfin tuna (*Thunnus albacares*) and shortfin scad (*Decapterus macrosoma)* ranked second and third in the catch composition of purse seine, with a total catch of 577,363 kg and 106,386 kg, respectively.

Handline

Family Scombridae, composed of yellowfin tuna (*Thunnus albacares*), skipjack (*Katsuwonus pelamis*) and big-eyed tuna (*Thunnus obesus)*, comprised the biggest bulk of handline catch. The recorded total catch of this type of fishing gear was 348,730 kg, 95 percent of which (or 330,874 kg) were species belonging to the Family Scrombridae.

Species Composition

A total of 121 species belonging to 33 families were identified from the catches recorded during the study period (1998-2002). Figure 4 shows the most abundant family groups: Scombridae (tuna/mackerel), Carangidae (threadfish/ trevally/ roundscad), Holocentridae (soldierfish/ squirrelfish), Siganidae (rabbitfish) and Mullidae (goatfish).

Figure 5 shows the species composition of the landed catch from Northern Zambales. Family Scombridae dominated the catch, with yellow fin tuna (*Thunnus albacares*) contributing the highest catch at 48 percent and skipjack (*Katsuwonus pelamis*) with a share of 42 percent.

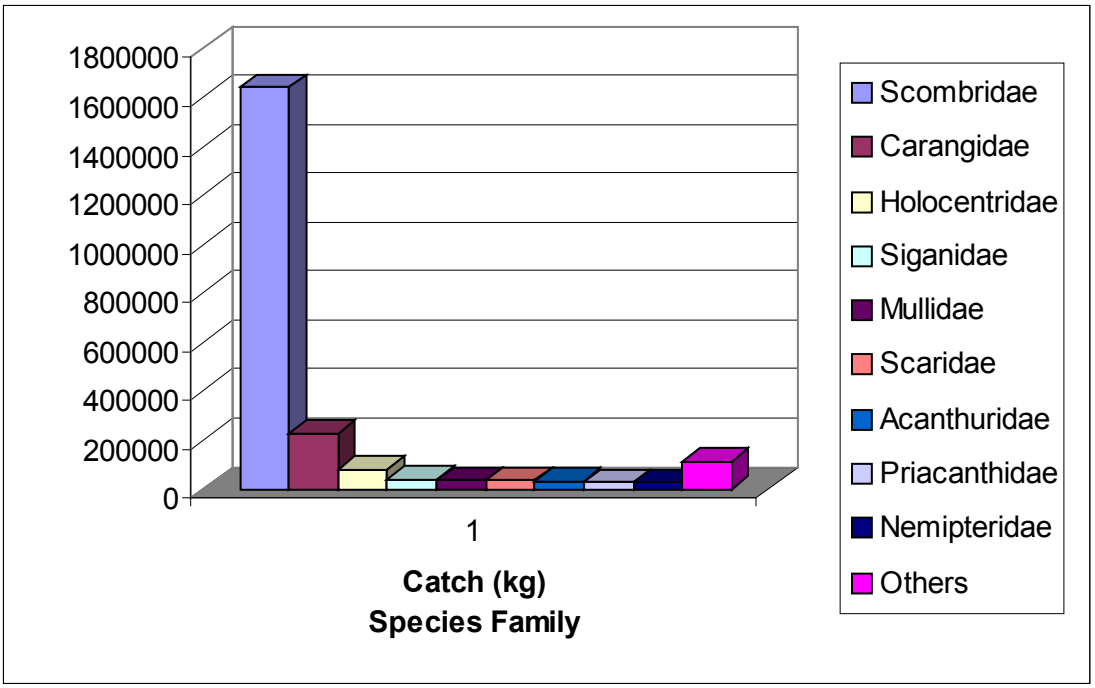


Figure 4. Composition (by family) of landed catch in Northern Zambales, 1998–2002.

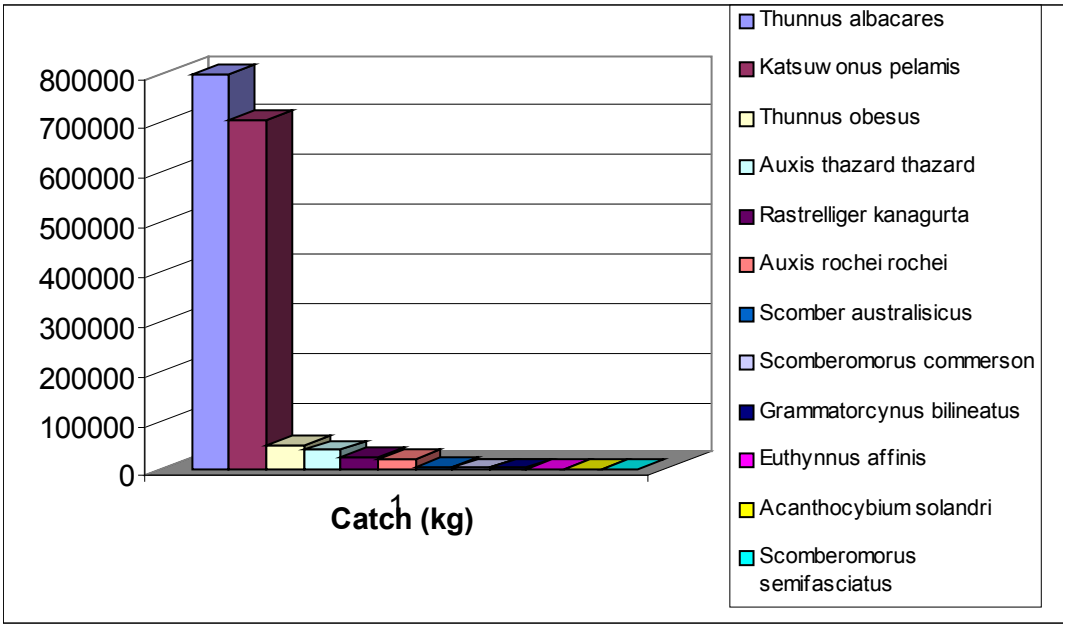
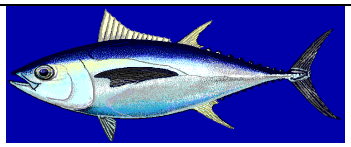


Figure 5. Species composition of the landed catch from Northern Zambales, 1998-2002.

Table 7 shows the 10 dominant fish species in Northern Zambales. The yellowfin tuna (*Thunnus albacares*) tops the list, followed by skipjack (*Katsuwonus pelamis*) and shortfin scad (*Decapterus macrosoma*).

Table 7. Ten dominant fish species in Northern Zambales.

Rank	Species	Family	Raised Catch (kg)
1	 *Thunnus albacares*	Scombridae	796,056
2	 *Katsuwonus pelamis*	Scombridae	702,851
3	 *Decapterus macrosoma*	Carangidae	107,718
4	 *Thunnus obesus*	Scombridae	47,142
5	 *Selaroides leptolepis*	Carangidae	41,069
6	 *Auxis thazard thazard*	Scombridae	38,086
7	 *Myripristis adusta*	Holocentridae	34,787
8	 *Abalistes stellaris*	Balistidae	30,397
9	 *Elagatis bipinnulata*	Carangidae	27,265
10	 *Ctenochaetus strigosus*	Acanthuridae	25,899

Tuna Production

Results of the survey indicate that tuna resources were primarily caught by both municipal and commercial fishing activities (Table 8). Tuna species were captured mostly by purse seine with almost 80 percent of the total production of tuna, followed by handline. They were fished out near fish aggregating devices (FADs) locally known as "payao".

Table 8. Tuna production (in kg) in Northern Zambales, 1998-2002.

Species	Gillnet	Handline	Purse Seine	Total	% Share
Thunnus albacares		218,693	577,363	796,056	49.63
Katsuwonus pelamis		104,281	598,570	702,851	43.82
Thunnus obesus		4,739	42,403	47,142	2.94
Auxis thazard thazard	759	457	36,870	38,086	2.38
Auxis rochei rochei	361	68	18,214	18,643	1.16
Euthynnus affinis		319	736	1,055	0.07
Total	**1,120**	**32,8557**	**1,274,156**	**1,603,833**	
% Share	0.07	20.49	79.44		100.00

Six species of tuna were caught in Northern Zambales. These were yellowfin tuna (*Thunnus albacares*), skipjack (*Katsuwonus pelamis),* big-eyed tuna (*Thunnus obesus*), frigate tuna (*Auxis thazard thazard*), bullet tuna (*Auxis rochei rochei*) and mackerel tuna (*Euthynnus affinis*).

Tuna production was about 1,603,833 kg or 71 percent of the total landed catch recorded in Northern Zambales.

Catch Per Unit Effort

Table 9 shows the catch per unit effort (CPUE) of the different types of fishing gear in the Northern Zambales area. Based on data gathered for a five-year period, from 1998 to 2002, purse seine and ring net had an average CPUE of 408.19 kg/day and 199.2 kg/day, respectively. For municipal fishing gear, the average catch was only 4.40 kg/day for gillnet, and 9.58 kg/day for handline.

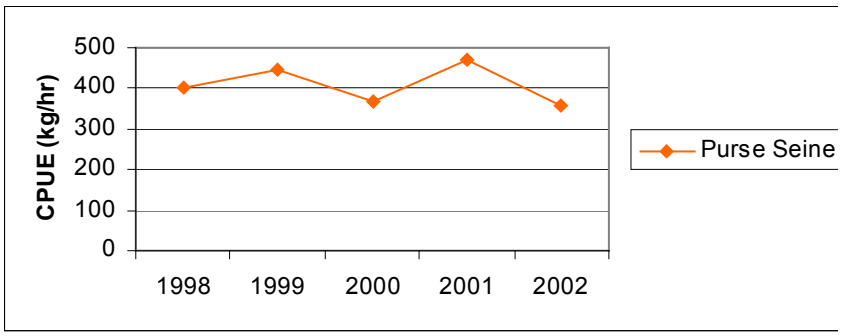
The CPUE of the three dominant fishing gear in Northern Zambales showed a fluctuating trend both for purse seine and gillnet, and a decreasing trend for handline (Fig. 6).

Population Parameter Estimates

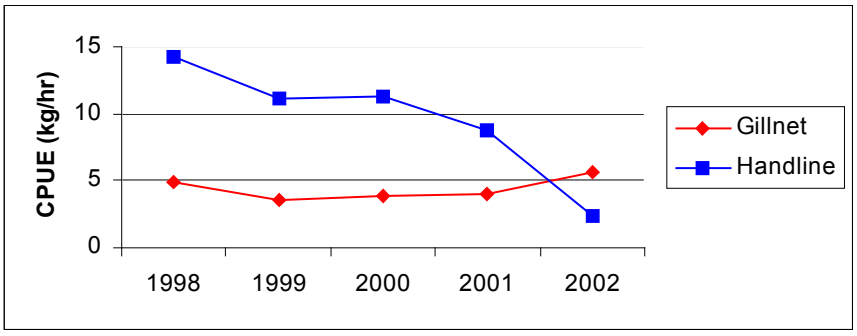
Table 10 shows the population parameter estimates of five selected species in Northern Zambales.

Table 9. Catch per unit effort of the different types of fishing gear in Northern Zambales coast, 1998-2002.

Fishing Gear	CPUE (kg/day)					
	1998	1999	2000	2001	2002	Average
Commercial						
Purse seine	400.13	445.52	370.02	469.67	355.62	408.19
Ring net	300	270	243	122	61	199.2
Municipal						
Gillnet	4.97	3.54	3.82	4.07	5.59	4.4
Handline	14.28	11.18	11.34	8.79	2.32	9.58
Multiple hook and line	8.3	7.5	6.8	6.2	5.6	6.88
Baby bagnet	52	47	43	39	35	43.2
Longline	20	18	16	8	4	13.2
Squid jigger	15	13	12	6	3	9.8
Spear gun	5	4.5	4	2	1	3.3
Push net	2	1.8	1.6	0.8	0.4	1.32
Trammel line	50	45	40	20	5	32
Troll line	5	4.5	4	2	1	3.3
Lift net	20	18	16	8	4	13.2
Baby trawl	10	9	8	4	2	6.6
Trap	2	1.8	1.6	0.8	0.4	1.32
Beach seine	50	45	40	20	5	32
Round haul seine	2	1.8	1.6	0.8	0.4	1.32



(a)



(b)

Figure 6. Catch per unit effort of (a) purse seine and (b) handline and gillnet in Northern Zambales, 1998-2002.

Table 10. Estimates of population parameters for selected species caught in Northern Zambales, 1998-2002.

Family	Species	Parameter	Value	Literature
Scombridae	*Rastrelliger kanagurta*	L∞ (cm)	27	24.7 – 39.0
		Length Type	TL	FL – TL
		K (yr^{-1})	1.0	0.72 – 2.0
		∅'	2.86	2.84 – 3.08
		Z (yr^{-1})	4.15	2.36 – 8.27
		M (yr^{-1})	1.84	1.68 –2.43
		F (yr^{-1})	2.31	-
		E	0.56	0.71
Caesionidae	*Pterocaesio tile*	L∞ (cm)	26	-
		Length Type	TL	-
		K (yr^{-1})	0.56	-
		∅'	2.58	-
		Z (yr^{-1})	1.73	-
		M (yr^{-1})	1.27	-
		F (yr^{-1})	0.46	-
		E	0.26	-
Carangidae	*Decapterus macrosoma*	L∞ (cm)	41	21.4 – 33.0
		Length Type	TL	FL – TL
		K (yr^{-1})	2.40	0.60 – 2.30
		∅'	3.61	2.74 – 3.02
		Z (yr^{-1})	12.90	-
		M (yr^{-1})	2.90	-
		F (yr^{-1})	10	-
		E	0.78	-
Carangidae	*Selaroides leptolepis*	L∞ (cm)	22	18.2 – 29.0
		Length Type	TL	FL – TL
		K (yr^{-1})	5.40	0.53 – 1.32
		∅'	3.42	2.32 – 2.95
		Z (yr^{-1})	19.36	2.76 – 8.64
		M (yr^{-1})	5.87	1.56 – 2.11
		F (yr^{-1})	13.49	-
		E	0.70	0.44 – 0.76
Holocentridae	*Myripristis adusta*	L∞ (cm)	25	
		Length Type	TL	
		K (yr^{-1})	0.39	
		∅'	2.39	
		Z (yr^{-1})	1.79	
		M (yr^{-1})	1.01	
		F (yr^{-1})	0.77	
		E	0.43	

Rastrelliger kanagurta. The computed asymptotic length (L∞) and growth constant (K) values for *R. kanagurta* are 27 cm and 1.0 $year^{-1}$, respectively. Previous studies on the species showed that L∞ ranges from 24.7 cm to 39.0 cm and K, from 0.72 to 2.0 $year^{-1}$. Natural mortality (M) of the species is estimated at 1.84 $year^{-1}$, fishing mortality (F) at 2.31 $year^{-1}$, and instantaneous rate of total mortality (Z) at 4.15 $year^{-1}$ which is within the range of computed Z values of other studies. However, the estimated exploitation

rate (E) value is 0.06 which is higher than the optimum E value (E_{opt}) of 0.50. For the probabilities of capture using running average for selection analysis, the length of *R. kanagurta* at 25 percent captivity (L_{25}) is 16.41 cm; at L_{50}, 17.07 cm; and at L_{75}, 17.60 cm.

Pterocaesio tile. The estimated L∞ and K of *P. tile* are 26 cm and 0.56 year^{-1}, respectively. M is estimated at 1.27 year^{-1}, F at 0.46 year^{-1}, and Z at 1.73 year^{-1}. The E value obtained for the species is 0.26 which is much less than the E_{opt} value of 0.50. This indicates that *P. tile* is not yet an exploited species. For the probabilities of capture using running average for selection analysis, the length of *P. tile* at 25 percent captivity (L_{25}) is 14.98 cm; at $L_{50,}$ 15.61 cm; and at L_{75}, 17.37 cm.

Decapterus macrosoma. The L∞ and K values for this species are estimated at 41 cm and 2.40 year^{-1}, respectively. Values from literature for L∞ range from 21.4 cm to 33.0 cm; for K, from 0.60 to 2.30 year^{-1}. M is estimated at 2.90 year^{-1}, F at 10 year^{-1}, and Z at 12.90 year^{-1}. The E value obtained for *D. macrosoma* (0.78) exceeded the E_{opt} value, which means that the species is overexploited. For the probabilities of capture using running average for selection analysis, the length of *D. macrosoma* at 25 percent captivity (L_{25}) is 26.87 cm; at $L_{50,}$ 27.76 cm; and at L_{75}, 28.64 cm.

Selaroides leptolepis. The estimated L∞ of *S. leptolepis* is 22 cm, and K is 5.40 year^{-1}. Values of L∞ and K from available literature range from 18.2 cm to 29.0 cm and from 0.53 to 1.32 year^{-1}, respectively. M is estimated at 5.87 year^{-1}, F at 13.49 year^{-1}, and Z at 19.36 year^{-1}. The E value obtained is 0.70, indicating that the stock is already overexploited. For the probabilities of capture using running average for selection analysis, the length at 25 percent captivity (L_{25}) is 15.21 cm; at L_{50}, 15.66 cm; and at L_{75} , 16.10 cm.

Myripristis adusta. The computed L∞ and K values for *M. adusta* are 25 cm and 0.39 year^{-1}, respectively. M is estimated at 1.01 year^{-1}, F at 0.77 year^{-1}, and Z at 1.79 year^{-1}. The estimated E value for the species is 0.43 which is less than the E_{opt} value of 0.50, indicating that *M. adusta* is underexploited. For the probabilities of capture using running average for selection analysis, the length of *M. adusta* at 25 percent captivity (L_{25}) is 9.75 cm; at L_{50}, 10.13 cm; and at L_{75}, 10.64 cm.

Potential Yield

The Schaefer and Fox models were used in the estimation of potential yield (PY) and optimum effort. Figure 7 shows that the PY for Northern Zambales area, using the Schaefer model, is about 5,021.69 mt with an effort of 7,854 standard gear. The PY value obtained from Fox model is a little lower. The maximum effort which can be used to harvest a yield of about 4,935.08 mt is 8,657 standard gear.

Based on the computed result, the PY, using both Schaefer and Fox models, was already exceeded in 1999 and 2000 with yields of 5,408.88 mt and 5,071.9 mt, respectively. Figure 7 also shows that the area becomes

depleted as years go by, because the trend in catch decreases as the effort increases.

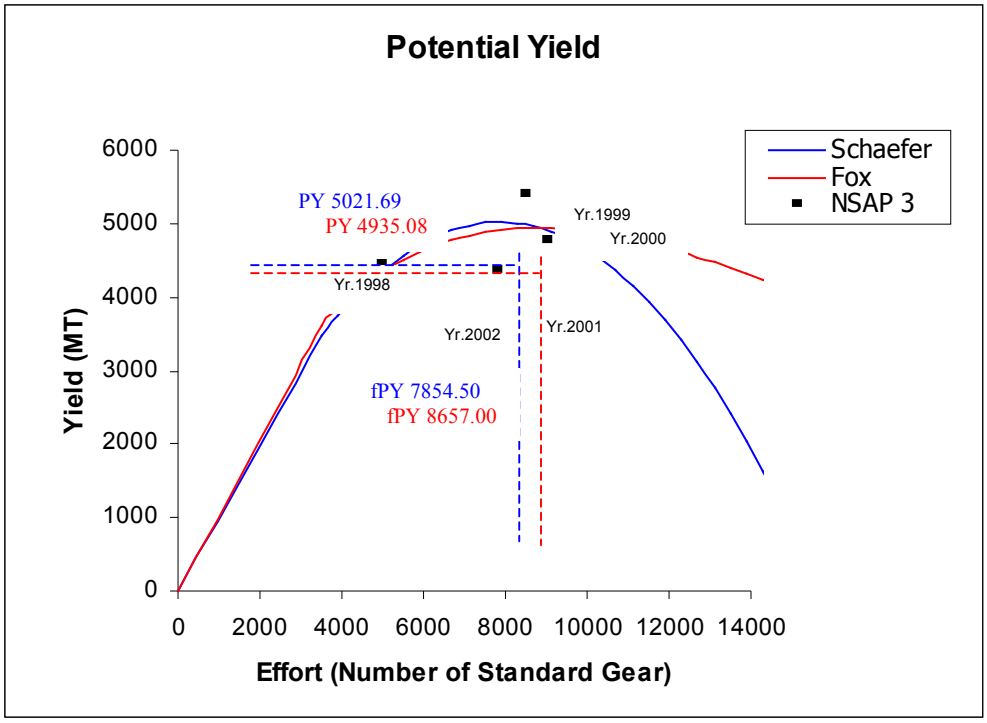


Figure 7. Potential yield (PY) of Northern Zambales coast.

SUMMARY, CONCLUSION AND RECOMMENDATION

In Northern Zambales, 79.46 percent of boats used in municipal fishing are motorized and 47.50 percent of this are found in Sta. Cruz. The commercial fishing boats are mainly found in Masinloc and Sta. Cruz.

Municipal fishermen who engage in full-time fishing comprise about 62.48 percent, while commercial fishermen are all full time.

The catch composition recorded from 1998-2002 was dominated by the Families Scombridae (tuna/mackerel), Carangidae (threadfish/ trevally/ roundscad), Holocentridae (soldierfish/squirrelfish), Siganidae (rabbitfish) and Mullidae (goatfish). The most dominant species caught were the yellowfin tuna (*Thunnus albacares*), skipjack tuna (*Katsuwonus pelamis*), and shorfin scad (*Decapterus macrosoma*).

Results on catch per unit effort (CPUE) showed that purse seine, which is a commercial fishing gear, had the highest CPUE (408.19 kg/day), followed by handline (9.58 kg/day) and gillnet (4.40 kg/day).

Population parameter estimates showed that three species, out of the five analyzed, are exploited. This means that the E value exceeded the optimum level, and the fishing area in Northern Zambales is already exploited.

Peak catch was achieved in 1999 with a value of 5,408.88 mt. This exceeded the potential yield (PY) of 5,021.69 mt (Schaefer model) and 4,935.08 mt (Fox model). An indication of overexploitation is the increase in effort resulting to decrease in catch.

It is thus recommended that proper management and conservation of marine aquatic resources must be fully implemented to protect the environment and to prevent overexploitation of stocks. Information dissemination plays a vital role in achieving this and in attaining sustainable supply of fish and fishery resources.

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