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Municipal Marine Fisheries Assessment of Batanes Island, Philippines (2009-2013)

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ABSTRACT

Fishery resource assessment in the municipal waters of Batanes, Philippines was conducted from January 2009 to December 2013 to generate information vital for policy formulation for the management of the fishing ground. Standardized materials and methods of the National Stock Assessment Program was used in the collection of fisheries data. Population parameters were processed using the FAO-ICLARM Fisheries Stock Assessment Tools II.

There were 1,178 fishermen operating in the fishing ground using 18 types of fishing gears. The annual fish production fluctuated with an aggregate volume of 4,923.607 MT. Some of the noted reasons for the fluctuating production are frequent occurrence of typhoon, unstable weather condition and livelihood shifting. The most dominant fishing gear was Drift Gill Net with a catch of 47.84%.

Sixty six families were identified in the fishing ground dominated by pelagic species. Families of Exocoetidae, Scombridae, and Coryphaenidae dominated the species of vertebrates while Family Octopididae, Sepiidae, and Palinuridae dominated the invertebrate species. *Cheilopogon suttoni* ranked first of all the species caught in Batanes. Top fifteen species are usually abundant during summer season (March-May).

Fishing mortality values of *Tylosurus crocodilus* (3.47yr $^{-1}$) and *Cheilopogon unicolor* (2.17 yr^{-1}) is higher than natural mortality values of 0.99yr^{-1} and 1.4 yr^{-1}, respectively which is an indication that the species is experiencing high fishing pressure. *Kyphosus vaigiensis* has low fishing mortality (0.11 yr^{-1}) and high natural mortality (0.45 yr^{-1}) which is an indication that the species die more due to natural death. The exploitation values of the *T. crocodilus* (0.89), *C. unicolor* (0.508), and *K. vaigiensis* (0.504) already exceeded the 0.5 optimum level of exploitation.

Though Maximum Sustainable Yield (MSY) is not yet established, the obtained mortality values of the top commercially important species is already high, thus it is suggested that appropriate management of the fishery is required. Along this, biological studies should also be conducted mainly on their growth and reproduction. Likewise, massive information dissemination of the results should be done to policy working bodies for the formulation of policies and regulations for the sustainable management, conservation, and protection of the fishery resources in the municipal waters of Batanes.

INTRODUCTION

The waters of Batanes is one of the major fishing grounds in the country where different types of gears suitable for the topography of the area have been used to catch multiple stocks of demersal, pelagic, and oceanic fish species. Fishing is the major livelihood of Batanes inhabitants who fashioned simple traditional gears in spite of modern technology. They rely

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heavily on fishing to generate domestic income. However, with the water resources of the Province, foreign poaching is still an unabated problem that causes the stocks to be heavily harvested which eventually contributes to catch depletion and overfishing. Armada (2004) mentioned that the status of overfishing can be determined if the catch and catch rate is declining, increasing effort, increasing mortalities and exploitation rates, changes or shift in species composition, levelling of marine landings, and concentration of fishing effort within a small area.

Hence, this study was undertaken to provide additional documentation and information on the catch and effort, species composition, seasonality, and population parameters of top commercially important species in Batanes waters to determine the status of the fishing ground.

Objectives:

The study aims to generate information on the status of fishery resources vital for policy formulation, management and conservation of the aquatic resources in municipal waters of Batanes.

Specifically, it aims to determine the following:

- annual fish catch estimates;
- types of fishing gear operating in the area;
- catch per unit effort of various gears;
- seasonality of the commercially important species;
- relative abundance and species composition caught by major gears; and
- population parameters of some commercially important species.

Limitations of the Study

The data used in this study were mainly from the municipal fisheries data collected from the established six (6) National Stock Assessment Program (NSAP) sites covering the Batanes waters. The study only covers a six-year period, from January 2009 to December 2013.

Analysis on the population parameters were only applied to top commercially important species in Batanes waters exhibiting a steady state population.

METHODOLOGY

Study Area

Batanes is the smallest province that consists of tiny islands that form the northernmost frontier of the country. It lies at 121° 53' East longitude and 22° 20' North latitude. The islands are surrounded by the Pacific Ocean on the East, West Philippine Sea on the West and Bashi Channels on the south and north, respectively (Aragon et al. 2008).

The fishing ground of Batanes is estimated at 23,000 hectares (230 square kilometers) surrounded with marine waters, with approximately 45,000 hectares of territorial waters around the islands and islets which are a source of abundant fishery resources (DA-BFAR R02, 2006). It extends by 160 territorial kilometers to the South China Sea and on the West from the center, by 200 territorial kilometers to the Pacific Ocean on the East and by 112 kilometers to the North in the Bashi Channel midway to Taiwan and Mavudis Island. The fishing ground is an open sea which is often visited by inclement weather condition having a type IV climate that has no pronounced wet or dry seasons. Rainfall occurs every month with a minimum of 8.5 days and a maximum of 21.2 days on the average (Provincial Government of Batanes, 1993).

The study was carried out in Batanes waters where12 landing sites within the six landing centers (Basco, Itbayat, Uyugan, Sabtang, Ivana, andMahatao) were established (Fig. 1). Established landing sites are located in Valugan Bay and Baluarte Bay in Basco, Paganaman Port and Chinapoliran Port in Itbayat, Centro Port and Itbud Port in Uyugan, Sumnanga and Nakanmuan in Sabtang, Radiwan and San Vicente in Ivana and Centro and Diura in Mahatao.

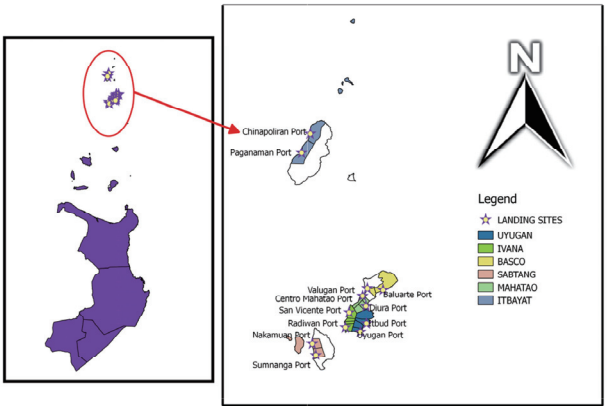


Fig. 1. Map of Batanes Waters indicating the twelve monitoring sites covered by the study.

Data Collection

Enumerators collected data from the six (6) landing centers in the Province of Batanes. Data collection and sampling techniques used were the standard NSAP method. The data were collected every other two days regardless of Saturdays, Sundays, and Holidays. The information gathered include the total number of fishing boats landed per sampling day, type of gear, total catch and effort per fishing operation, number of fishing days, number of hauls, length measurements, and species composition. Sampling of catch

was done by taking fish samples randomly from the fish holds/tubs/styrofoam, sorted by species and weighed each species component to determine the total weight of each species from the catch. All these information were recorded on the prepared NSAP forms and submitted for collation, encoding, and processing at the BFAR Regional Office 02.

Data Processing and Analysis

Fishing Boat and Gear Inventory

Municipal fishing boats were inventoried for reliable fish catch estimation in the fishing ground. To come up with the average tonnage of all fishing boats, total tonnage was divided by the number of boats landed. The latest data for the boat and gear inventory was based on C.Y. 2013 data.

Production Estimate

Raised catch data per month was obtained following the procedure of Aragon et al. (2008). To derive the raised catch per month, the following equation was used:

$$\text{Ave. catch/boat} = \text{Monitored monthly production/total boat landings} \quad (1)$$

The result was then multiplied to fifty percent of the total number of fishing boats during lean season and sixty percent of the total number of fishing boats during peak season, and then multiplied with the total number of fishing days for the month, to come up with the estimated catch for the month. Number of fishing days for the month, during peak season (i.e. March to May) was estimated at twenty fishing days and during lean season (i.e. June to February) at ten fishing days (Aragon et al., 2008).

Catch Per Unit Effort (CPUE)

Monthly CPUE per gear was computed and standardized as kilogram/boat. The annual CPUE was obtained by summing all the total monthly harvest (in kilograms) divided by the total number of fishing boats landed for the whole year.

Dominant Species

Fish species caught by municipal fishing boats were ranked from highest to lowest, which is summing all the total catch of each species from the pooled gear types from January 2009 to December 2013 to determine the 15 top commercially important fish species in the area. The result was compared with other literatures.

Seasonality of Commercially Important Species

Monthly catch (in kilograms) was used to determine the relative abundance and seasonality of some commercially important species. The data used in the estimation of the seasonality and relative abundance were the monitored raw production values.

Population Parameters

Population parameters were obtained using the FAO-ICLARM Stock Assessment Tools (FISAT) software (Gayanilo et al. 1996).

Mortality and Exploitation Rates

Length frequency data of the species from all gears were pooled to simulate a steady state population. Total mortality coefficient (Z) was estimated by length converted catch curve procedure of ELEFAN II. Natural mortality was calculated using Pauly's empirical equation.

$$Z = M + F \quad (2)$$

where Z is the instantaneous total mortality, M is the instantaneous natural mortality due to predation, aging and other environmental causes, and F is the instantaneous fishing mortality caused by fishing. The total mortality was obtained from the slope (b) of the descending limb of the catch curved with the sign changed.

Instantaneous natural mortality (M) was estimated using Pauly's (1984) empirical formula of:

$$\text{Log } M = 0.654 \text{ Log } k - 0.28 \text{ Log } L\infty + 0.463 \text{ Log} T \quad (3)$$

where $L\infty$ and K are the Von Bertalanffy Growth Function (VBGF) growth parameters and T was the annual mean habitat temperature (28℃) taken as annual average temperature of the area.The asymptotic length ($L\infty$) and the growth constant (K) value of the species were already provided by the software. However, the value obtained was compared with the value listed on the fishbase.org and other published references to have a confident K scan value for particular species.

The ratios of the coefficients of mortality and growth (Z/K) were estimated using the Powell-Wetherall plot (Powell, 1979; Wetherall, 1986; Gayanilo and Pauly, 1997). Natural mortality (M) was estimated using the M-empirical equation of Pauly (1984) which eventually was used in the computation of exploitation rate.

$$E = F/(F + M) \quad (4)$$

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

Results and Discussion

Fishing boats and gear inventory

The fishery resource of Batanes waters is shared by six municipalities with twenty nine (29) coastal barangays. Fig. 2 showed the distribution of municipal fishing boats in the Province of Batanes for C.Y. 2010 and 2013. A total of 468 fishing boats were noted to be operating in 2010 with slight increase to 476 fishing boats in 2013. The increase in the number of boats and gears could be attributed to the expansion and capitalization of municipal fishing operations in all coastal municipalities of the Province.

In terms of fishing gear distribution, the municipality of Basco (the Province Capital) has the highest distribution share (38.87%), followed by Sabtang (21.64%), Mahatao (13.45%), Itbayat (10.29%), Ivana (8.61%), and Uyugan (7.14%).

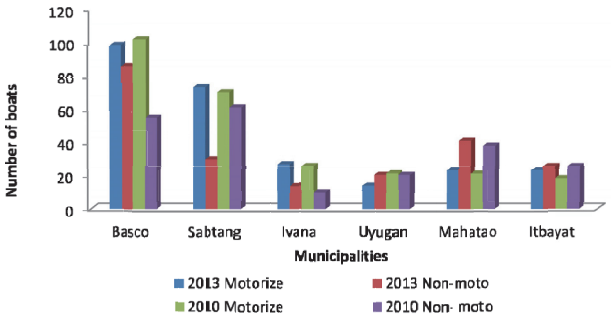


Fig. 2. Fishing boats inventory by type C.Y. 2010 and 2013.

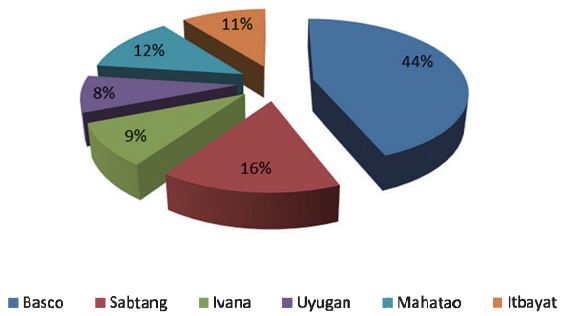


Fig. 3. Distribution of fisherfolk by municipality C. Y. 2013.

There were eighteen (18) kinds of fishing gears used by fisherfolk in Batanes (Table 1). Though there was a slight increase in the total number of fishing boats registered, there was also a slight decrease in 2013 on the type of fishing gear used compared to 24 types of fishing gears recorded in 2005 and 2010 . The decrease in number of fishing gears was due to high cost of fishing paraphernalia thus, that the fishermen could no longer afford to buy a new set of fishing gear or replace their old gear. Stop seine; crab lift net, gaff hook line, vertical longlines, and drift longlines were no longer used. Notably, troll line has the highest percentage distribution (18. 97%) followed by multiple hand line (17.75%), simple hand line (17.50%), and spear gun (14.92%). These gears were the most commonly used due to their easy operation and maintenance. The fisherfolk in the area prefer to use non textile devices rather than textile devices. Textile devices were seldom used due to its high operating and maintenance cost.

Estimated annual harvest in Batanes Water

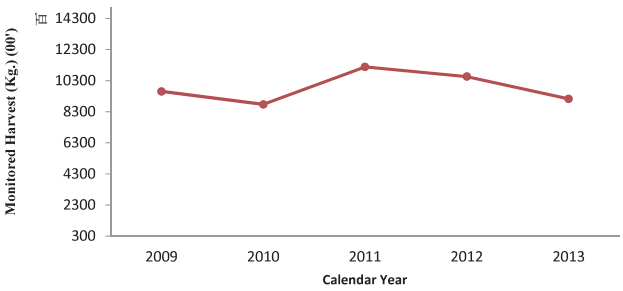


Fig. 4. Estimated annual harvest along municipal waters of Batanes (January 2009 – December 2013).

Fig. 4 shows the estimated volume of harvest in Batanes municipal waters during the five-year study period. The trend is fluctuating with a slight decrease in 2010, 2012, and 2013 except in 2011 where slight increase was observed. The production decrease in 2010, 2012, and 2013 could be attributed to frequent occurrence of typhoon, and unstable weather conditions especially changes and fluctuations of wave and winds, and the national campaign period in 2010. Likewise, a number of fisherfolk shifted from fishing to construction works in private and development projects in the province, resulting to decrease in fishing activities. Further, the fluctuating production could be aggravated by variation of monthly water temperature, phytoplankton abundance, salinity and other agro-climatic factors that affect fish distribution and abundance.

Table 1. Distribution of fishing gears used in Batanes Province C.Y. 2013.

Fishing Gears	Basco	Sabtang	Ivana	Uyugan	Mahatao	Itbayat	Total	(%)
	Number of Units	Number of Units	Number of Units	Number of Units	Number of Units	Number of Units		
Drive-In Net	36	10	16	10	3		75	1.60%
Bottom Drive-in Gill Net	66	0	0	0			66	1.40%
Bottom Set Gill Net	78	35	32	24	9	3	181	3.85%
Bottom Set Long Line	11	0	0				11	0.23%
Drift Gill Net	61	33	18	23		27	162	3.45%
Drift Line	176	0	0	1	265		442	9.41%
Troll Line	318	181	59	17	293	23	891	18.97%
Multiple Hand Line	405	75	69	68	63	154	834	17.75%
Jigger	49	0			35		84	1.79%
Pole Held Cast Net	9	14	49	29	35		136	2.89%
Pole and Line	11	0					11	0.23%
Reel and Rod	97	0					97	2.06%
Surface Drive-in Gill Net	20	0		1	6		27	0.57%
Stick Held Dip Net	12	0	19	11	17		59	1.26%
Spear Gun	338	132	59	58	47	67	701	14.92%
Simple Hand Line	391	183	65	12	100	71	822	17.50%
Scoop Net	45	0	15		30	6	96	2.04%
Surface Set Gill Net	3	0					3	0.06%
Total	**2126**	**663**	**401**	**254**	**903**	**351**	**4698**	100%

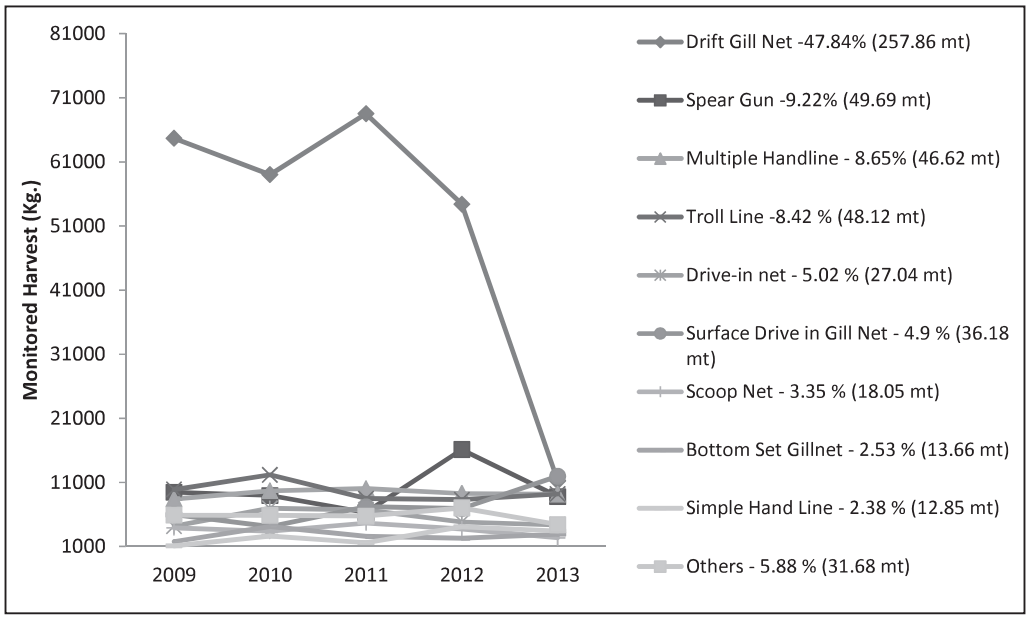


Fig. 5. Estimated annual harvest and catch contribution of major fishing gears in Batanes waters (January 2009 – December 2013).

Drift gill net has the highest estimated annual harvest during the study period with a percentage share of 47.84% followed by Spear gun (9.22%), Multiple hand line (8.65%) and the rest of the gears (Fig. 5.) Other gears only contributed 5.88% of the total harvest in the municipal waters of Batanes. These are the Bottom set gill net (1.75%), Surface gill net

(1.30%), Pole held cast net (0.91%), Jigger (0.66%), Drift long line (0.51%), Bottom set long line (0.22%), Beach seine (0.16%), Reel and rod (0.08%), Drift long line (0.04%), Crab lift net (0.02%), Gaff hook (0.01%), Pole and line (0.003%), and Stick held dip net (0.002%). The fluctuating harvest of each gear can be associated with the frequent unfavorable weather condition in the area because of its demographic location. Likewise, the increasing and decreasing total catch per unit effort (CPUE) of each gear and the number of fishing boats operated per year due to social, environmental and economic reasons were also some of the reasons for the fluctuating production of each gear.

Estimated harvest and annual average CPUE (kg/boat) of major fishing gears

The increasing and decreasing total harvest with the corresponding increase and decrease of CPUE of the top five municipal fishing gears in the municipal waters of Batanes was observed (Fig. 6). Drift gill net has the highest catch and CPUE observed in 2011 with 68,504.4 kilograms and 86.94 kilograms per boat, respectively. On the other hand, the lowest harvest and CPUE was observed in 2013 with only 11,259.5 kilograms and 31.99 kilograms per boat, respectively (Fig. 6a).

Spear gun, the second major type of fishing gear used in the municipal waters of Batanes was observed to have a decreasing fish catch and CPUE in year 2010 to 2011 and sudden increase in 2012 (Fig. 6b). However, in 2013 both the fish harvest and the CPUE abruptly decreased. The highest catch of Spear Gun was observed in 2012 with 16, 149 kilograms and CPUE of 20.7 kilograms per boat. Conversely, lowest total fish harvest was observed in 2011 with 6, 286.95 kilograms and CPUE of 12.47 kilograms per boat.

Multiple hand line is the third major type of fishing gears used targeting large oceanic or pelagic species. Lowest CPUE (8.33 kg/boat) was observed in 2011 yet it has the highest catch (10, 056 kilograms) recorded (Fig. 6c). This could possibly due to the abundance of species in that period since the gears targeted large oceanic species which are migratory in nature.

Troll line is the fourth major type of fishing gear used that also targets large oceanic and pelagic species specifically *Coryphaena hippurus* (Common dolphinfish). The highest total catch was observed in 2010 with 11,701.55 kilograms and the lowest was observed in 2012 with 7,653.2 kilograms (Fig. 6d). On the other hand, the highest CPUE was observed in 2013 with 19.88 kilograms per boat and the lowest was observed in 2011 with 8.27 kilograms per boat.

Drive-in net is the fifth major type of fishing gear used to catch flying fish in the area. Highest total catch was observed in 2010 with 6, 945. 83 kilograms and CPUE of 70. 16 kilograms per day (Fig. 6e). On the other hand, the lowest total catch was observed in 2009 with 4,187.5 kilograms and a CPUE of 55.1 kilograms per boat.

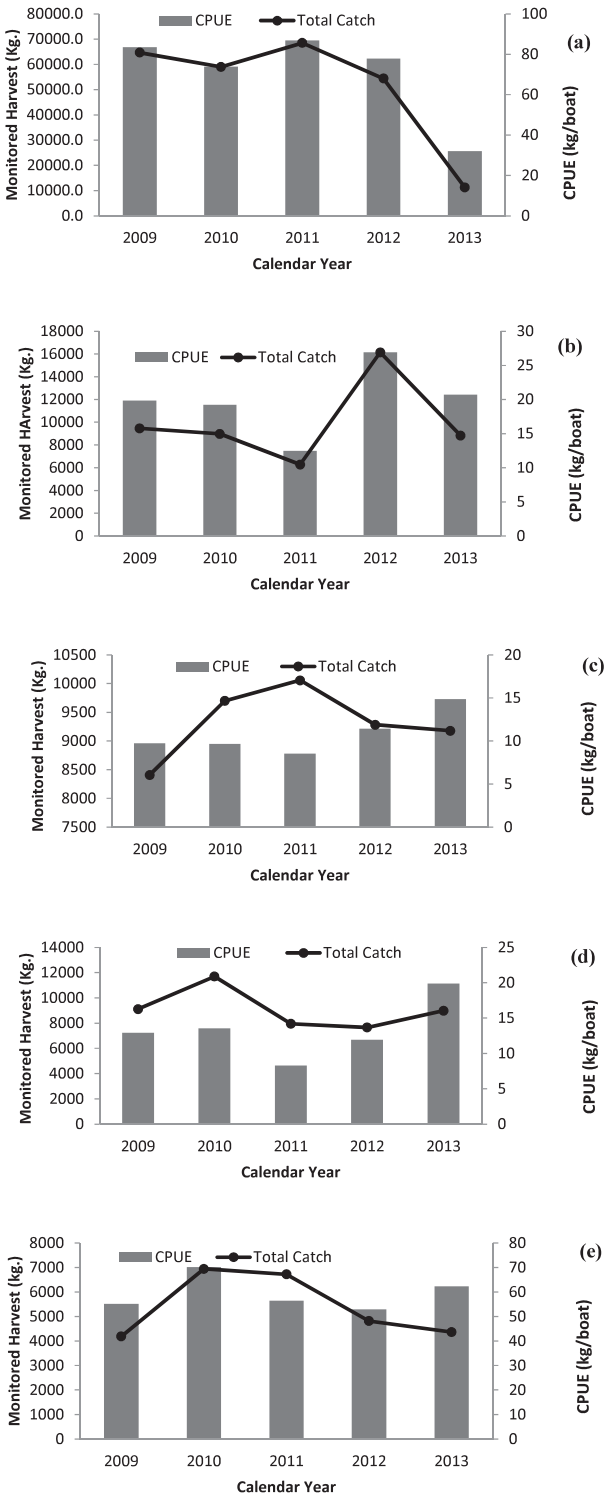


Fig. 6. Estimated harvest and annual average CPUE (kg/boat) of a) Drift Gill Net b) Spear Gun c) Multiple Hand Line d) Troll Line and e) Drive-in Net in Batanes Waters (January 2009 - December 2013).

Generally, the increase and decrease of monitored harvest could be attributed to the increase or decrease of monitored boat landings. Factors like shifting of fishing to agricultural activities coupled with the frequent occurrence of bad weather and several typhoons in the area contributed to the decrease in harvest. The increase of harvest observed was due to favorable weather condition for fishing and abundance of large oceanic species in a certain year due to their migration activities.

A total of 580 species of fish belonging to 66 families were identified during the entire study period (Table 2). Vertebrate species comprised 96.8% of the total landed catch wherein 54.9% of this is pelagic and 41.9% are demersal species. On the other hand, invertebrate species comprised 3.1% and 0.05% of Elasmobranch species was observed.

Table 2. Catch composition in the municipal waters of Batanes (January 2009 − December 2013).

Habitat	Family	Common Name	Monitored Harvest (kg.)	% Abundance
Vertebrates				
Pelagic				
	Sphyrnidae	barracudas	1920.62	0.360
	Clupeidae	herrings, shads, sardines,	1160.05	0.220
	Coryphaenidae	dolphinfishes	24415.4	4.560
	Engraulidae	anchovies	7895.38	1.470
	Exocoetidae	flying fishes	243380.9	44.460
	Hemiramphidae	halfbeaks	38.1	0.007
	Istiophoridae	billfishes, marlins	2319.75	0.002
	Mugillidae	mullets	123.65	0.020
	Cyprinidae	carps	2.5	0.001
	Scombridae	mackerels, tunas, bonitos	20135.85	3.800
	Antherinidae	silverside fishes	2.6	0.001
Sub total			***301394.8***	***54.9***
Demersal	Acanthuridae	surgeonfishes, unicornfishes,	34331.36	6.000
	Belonidae	needlefishes	63041.93	10.780
	Bothidae	large-eye flounders	0.68	0.000
	Caesionidae	fusiliers	3731.15	0.700
	Carangidae	jacks and pampanos	29810.57	5.500
	Balistidae	triggerfishes	3189.182	0.600
	Chaetodontidae	butterfly fishes	973.062	0.180
	Labridae	wrasses	4573.94	0.850
	Diodontidae	porcupine fishes	55.88	0.010
	Elopidae	tenpounders	14.84	0.003
	Ephippidae	spadefishes	5.55	0.001
	Gerridae	mojarras	110	0.021
	Polynemidae	threadfins	169.88	0.032
	Haemulidae	Grunts	7.04	0.001
	Holocentridae	squirrelfish	1447.81	0.270
	Pomacanthidae	angelfish	209.49	0.040
	Kyphosidae	sea chubs	7524.491	1.410
	Pomacentridae	damsel fishes	1009.45	0.190
	Pempheridae	sweepers	115.513	0.002
	Lethrinidae	emperors	13509.88	2.520
	Zanclidae	morish idols	124.8117	0.023
	Lutjanidae	snappers	13881.159	2.590
	Fistularidae	cornet fishes	23	0.004
	Monocanthidae	leatherjacks	400.62	0.070
	Mullidae	goatfishes	2844.31	0.530
	Muraenidae	moray eels	990.26	0.190

	Nemipteridae	threadfin and whiptail breams	268.58	0.050
	Latidae	perch like fishes	5.7	0.001
	Paralichthyidae	flounders	7.85	0.002
	Priacanthidae	bigeyes, catalufas	611.92	0.110
	Malacanthidae	tile fishes	184.26	0.034
	Opichthidae	snake eels	1.5	0.000
	Scaridae	parrotfishes	8077.38	1.500
	Ostraciidae	boxfishes	195.11	3.640
	Serranidae	sea bass	12453.125	2.330
	Siganidae	Siganids	8992.908	1.680
	Scatophagidae	Scats	3.65	0.001
	Ephinephelidae	Grouper	17.7	0.003
	Sparidae	Breams	142.72	0.030
	Synodontidae	lizardfishes	3.45	0.001
	Teraponidae	teraponids	14.61	0.003
Sub total			***213076.3217***	***41.9***
Invertebrates				
	Raninidae	frog crabs	65.65	0.010
	Loliginidae	Squids	1278	0.240
	Palinuridae	Lobsters	3772.53	0.700
	Scyllaridae	Crabs	103.1	0.020
	Octopididae	Octopus	5170.74	0.970
	Sepiidae	cuttlefish	8671.65	1.200
	Hydrophiinae	coral reef snakes	9.2	0.002
	Grapsidae	shore crabs	11.45	0.002
Sub total			***19082.32***	***3.1***
Elasmobranchs	Dasyatidae	Rays	42.6	0.010
	Scyliorhinidae	catsharks	47.35	0.009
	Carharhinidae	requim sharks	177.64	0.030
	Hexanchidae	cow sharks	23	0.004
	Hemigalidae	tooth shark	7.04	0.001
Sub total			***297.63***	***0.05***
Grand total			**533851.0717**	**100.000**

Pelagic fishes were represented by 11 families of fish. Demersal fishes were represented by 41 families of fish, 4 families of crustaceans, 3 families of cephalopods, and 1 family of reptiles. The Elasmobranch species were represented by 5 families of sharks. As observed, Family Exocoetidae (flying fishes) has the highest percentage abundance of 44. 46% followed by Family Belonidae (needle fishes), Acanthuridae (surgeon and unicornfishes), Carangidae (jacks and pampanos) and Coryphaenidae (dolphinfishes) with percentage abundance of 10. 78%, 6%, 5. 50%, and 4. 56%, respectively.

Conversely, Family Sepiidae (cuttlefish) has the highest percentage abundance of all invertebrates species. This was followed by Family Octopididae (octopus), Palinuridae (lobsters), and Loliginidae (squids) with percentage abundance of 0.97%, 0.7%, and 0.24%, respectively.

Fig. 7 shows the ranking of top fifteen dominant species caught in the municipal waters of Batanes. *Cheilopogon suttoni* (Sutton's flyingfish) ranked first with a percentage abundance of 9. 59% followed by *Cheilopogon furcatus* (Spotfin flyingfish) (9. 55%) and other species. Notably, Family Exocoetidae of the genus Cheilopogon dominated the fish catch diversity in municipal waters of Batanes. Most of the commercially important species are pelagic, oceanic, and migratory in nature. The remaining 32.73 % comprised other demersal and pelagic species.

Of the top fifteen species recorded, *Siganus argenteus* (streamlined spinefoot) has the lowest percentage abundance of 1.40% since this is only a by-catch species and most of the fishing gears used in the area is intended for flying fish and dolphinfish species.

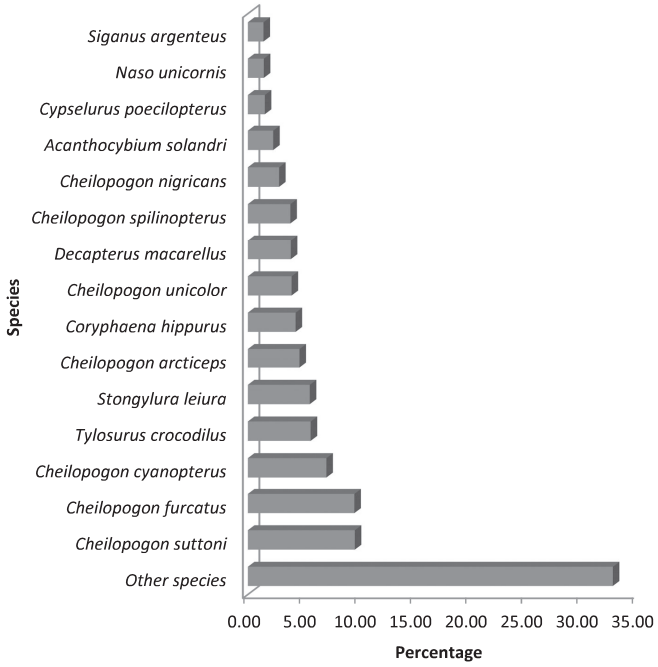
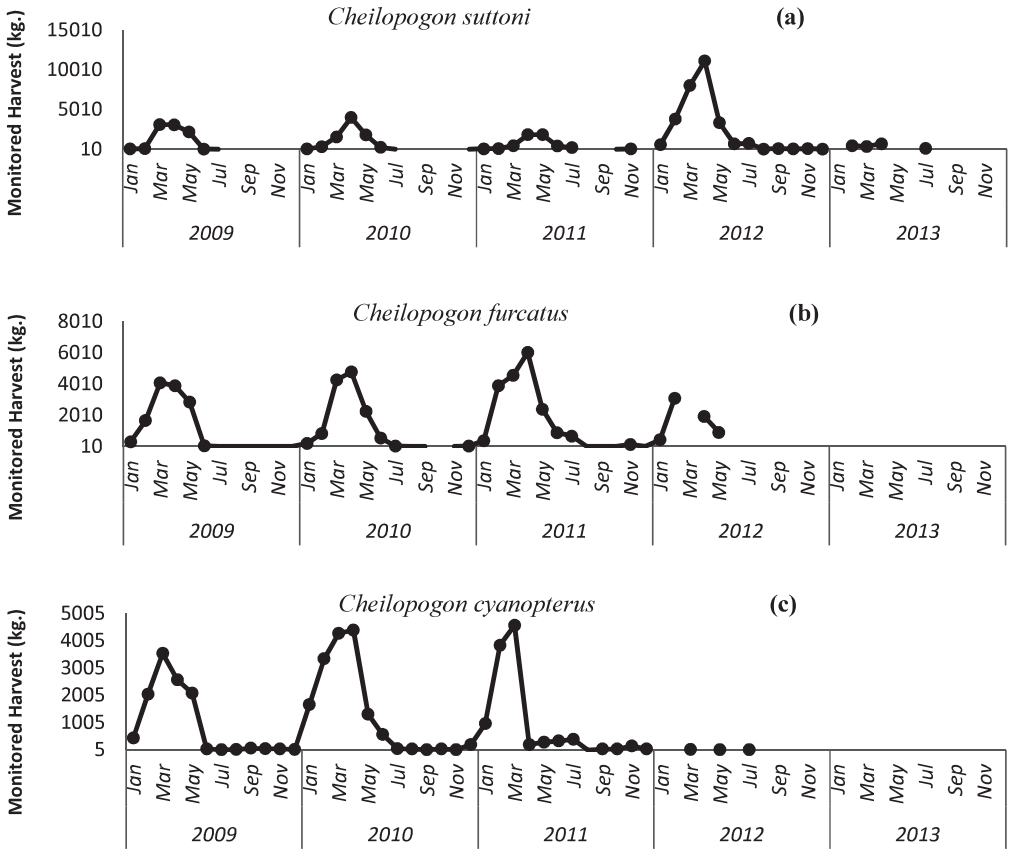
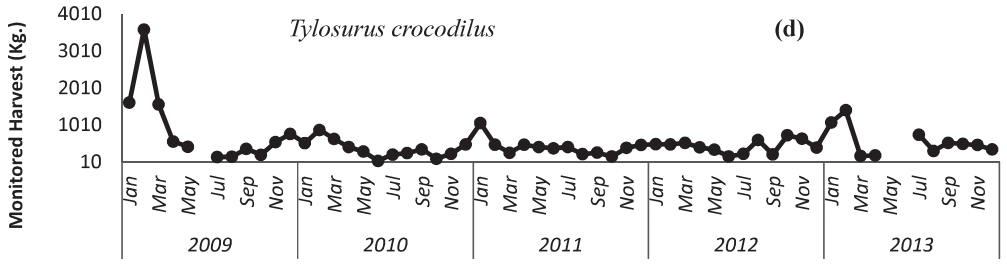


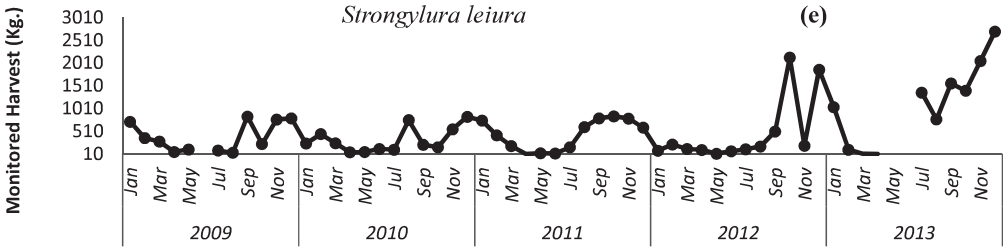
Fig. 7. Ranking of the top fifteen dominant species along Batanes waters (January 2009 - December 2013).

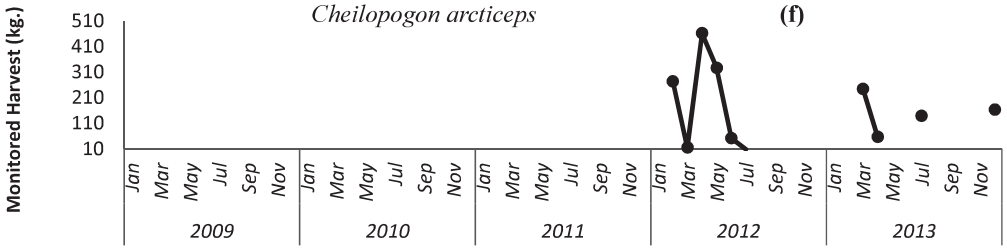
Seasonality of top fifteen commercially important species

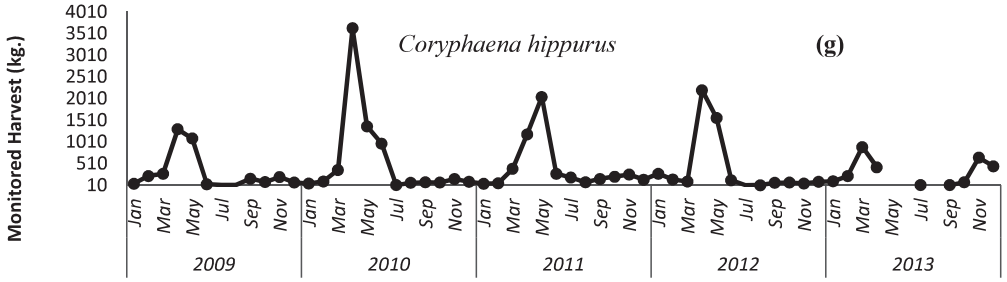
Seasonality of top fifteen commercially important species in Batanes waters were observed during the five year study period (Fig. 8).

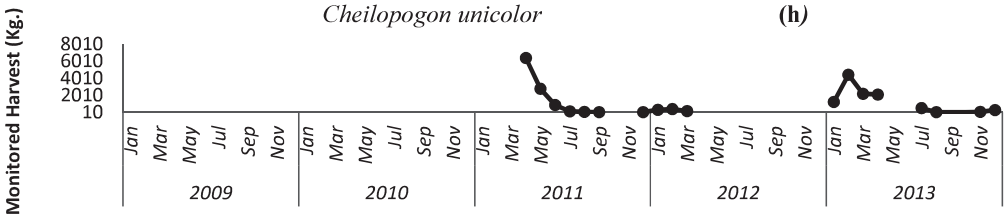


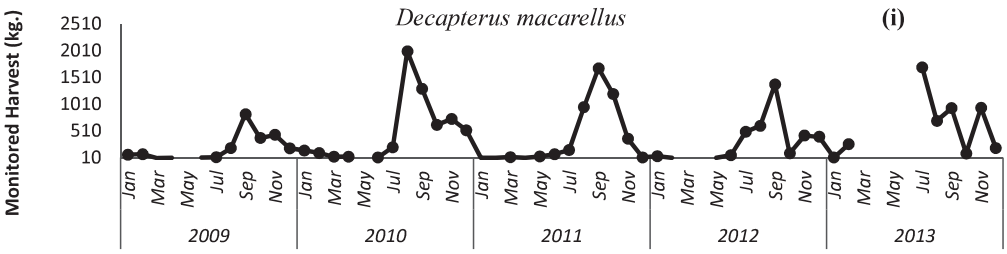

Tylosurus crocodilus
(d)
Monitored Harvest (Kg.)
4010
3010
2010
1010
10
Jan Mar May Jul Sep Nov
2009
2010
2011
2012
2013


Strongylura leiura
(e)
Monitored Harvest (Kg.)
3010
2510
2010
1510
1010
510
10
Jan Mar May Jul Sep Nov
2009
2010
2011
2012
2013


Cheilopogon arcticeps
(f)
Monitored Harvest (kg.)
510
410
310
210
110
10
Jan Mar May Jul Sep Nov
2009
2010
2011
2012
2013


Coryphaena hippurus
(g)
Monitored Harvest (kg.)
4010
3510
3010
2510
2010
1510
1010
510
10
Jan Mar May Jul Sep Nov
2009
2010
2011
2012
2013


Cheilopogon unicolor
(h)
Monitored Harvest (kg.)
8010
6010
4010
2010
10
Jan Mar May Jul Sep Nov
2009
2010
2011
2012
2013


Decapterus macarellus
(i)
Monitored Harvest (kg.)
2510
2010
1510
1010
510
10
Jan Mar May Jul Sep Nov
2009
2010
2011
2012
2013

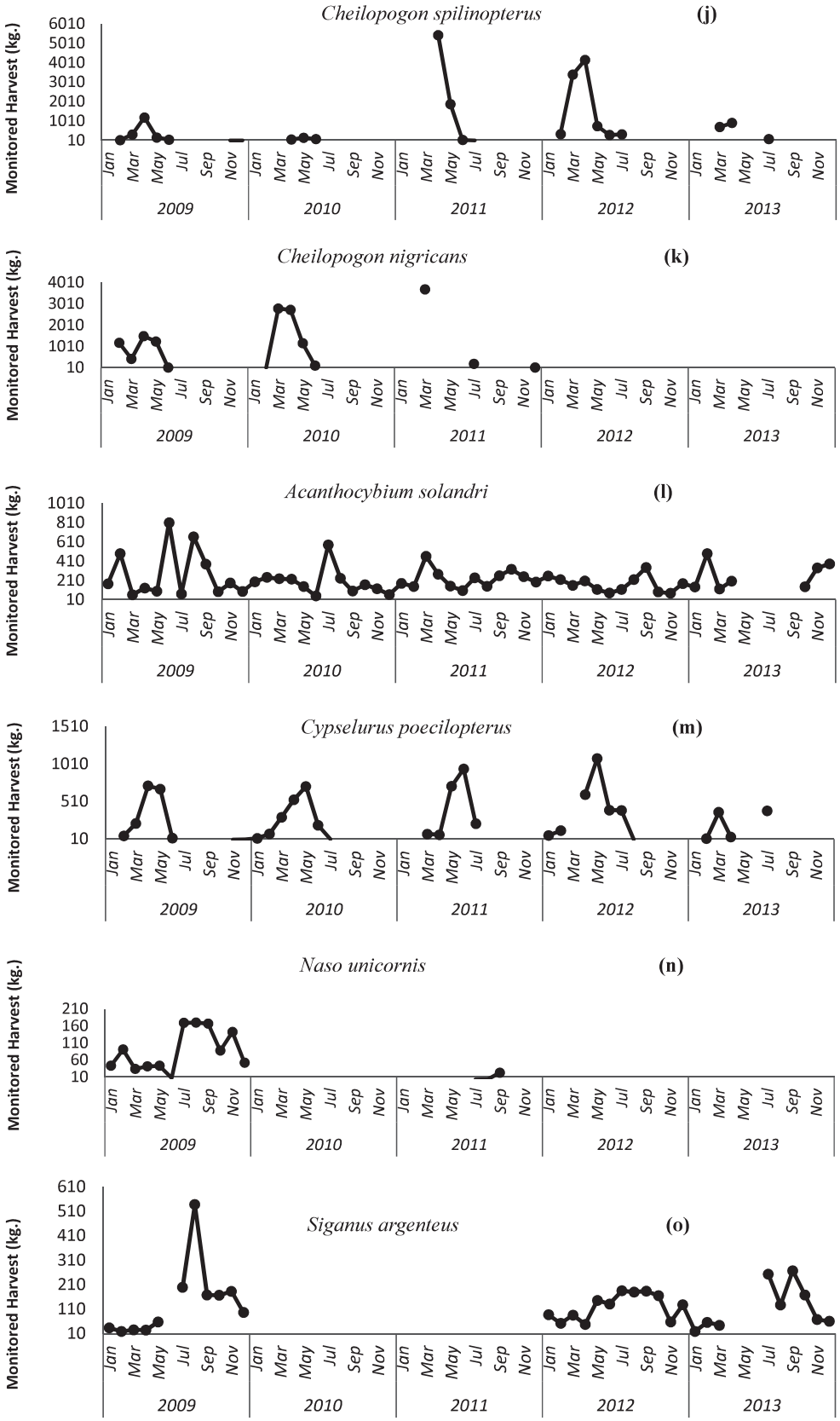


Fig. 8. Seasonality of top major commercially important species. a) *C. suttoni* b) *C. furcatus* c) *C. cyanopterus* d) *T. crocodilus* e) *S. leiura* f) *C. arcticeps* g) *C. hippurus* h) *C. unicolor* i) *D. macarellus* j) *C. spilinopterus* k) *C. nigricans* l) *A. solandri* m) *C. poecilopterus* n) *N. unicornis* o) *S. argenteus.*

As noted, the top fifteen species are highly seasonal with a production peak during summer. Same trend of seasonality of the species under genus Cheilopogon was also observed in the study of Aragon et al. (2008).

Cheilopogon suttoni (Sutton's flyingfish) locally known as "Patawen", the most dominant species has an observed total harvest of 51, 325. 68 kilograms (Fig. 8a) followed by *Cheilopogon furcatus* (Spotfin flyingfish) with 51, 133. 02 kilograms (Fig. 8b), and *Cheilopogon cyanopterus* (Margined flyingfish) with 37,710.27 kilograms (Fig. 8c). There was no recorded catch for *C. suttoni* during monsoon seasons that usually starts from August to December. Likewise, *C. furcatus* and *C. cyanopterus* were not observed to appear during the last two years of the study. The variation and seasonal occurrence of this species could be highly attributed to biological (phytoplankton abundance, predation) and oceanographic (temperature, sunshine duration, ocean current etc.) factors. The peak season for these species is from March to May wherein peak of fishing activities also takes place in the area.

Tylosurus crocodilus (Hound needlefish) locally known as "Hahay/Xaxay", the fourth dominant species caught in Batanes waters. As observed, the species is observed throughout the year with peaks from January to March (Fig. 8d). A total harvest of 30, 150. 37 kilograms was observed during the entire period of the study. The study of Olaňio et al., (2009) in Lagonoy Gulf confirmed that the species are abundant during transition winds (January to April).

Strongylura leiura (Banded needlefish) locally known as "Macknay", the fifth dominant species was observed all year round with peaks in August to September and December to January (Fig. 8e). Notably, S. leiura are abundant after the southwest and northeast monsoon. Aragon et al. (2008) observed that the species is gradually increasing in numbers during the months of August to February with peaks in October and November.

Cheilopogon arcticeps (White finned flyingfish) locally known as "Liit", the sixth dominant species was only observed during the latter part of the study with peaks in March to May. A total harvest of 24,791.92 kilograms was monitored during the entire study period (Fig. 8f).

Coryphaena hippurus (Common dolphinfish) locally known as "Arayo", the seventh commercially important species observed in the waters of Batanes has its peak from March to May with a monitored harvest of 22,912.5 kilograms during the study (Fig. 8g). Notably, dolphinfish is generally observed year round with pronounced seasonal variations in abundance specifically during summer which coincides with the abundance of flying fish as the favorite prey of dolphin fish. In the stomach content analysis conducted by Rose (1966) cited by (Palko et al., (1982), 24% of food intake of dolphinfish is composed of Exocoetidae. The species is highly migratory, commercially important, and widely distributed. It has been reported that the species were also found in the Philippine Islands (Herre, 1945; Palko et al., 1982) and in the waters adjacent to eastern Taiwan and the north-eastern part of Batan Islands (Wang, 1979, Palko et al., 1982). The observed abundance of *C. hippurus* in the coast of East Africa coincided with the time of high surface temperature and low salinity, that the southwest monsoon season and its variation influenced plankton growth (Williams and Newell, 1957, Palko et al., 1982). Hence, the peak of dolphinfish in the area could be due to migration season where the species is present in large numbers for short period (March to May) of time while they pass in the waters of Batanes.

Cheilopogon unicolor (Limpid wing flyingfish) locally known as "Suhuhen" is the eight commercially dominant species in the area with an observed harvest of 21, 001. 25 kilograms during the study period (Fig. 8h). Like other flying fish species, *C. unicolor* has its peak from March to May. However, there are years that the species was absent. All the flying fish species serve as prey for the dolphinfish during the season.

Decapterus macarellus (Mackerel scad) locally known as "Galunggong" is the ninth commercially important species caught in the area. The species was observed to be present throughout the year with major peaks from March to May (Fig. 8i). It has an observed harvest of 20,631.67 kilograms during the study period.

Cheilopogon spilinopterus (Spotfin flying fish) and *Cheilopogon nigricans* (Blacksail flyingfish) locally known as "Dibang" the top ten and eleven dominant species, respectively caught in the area with its peak from March to May. The recorded harvest of these two species during the entire study period was 20,378.34 kilograms and 14,998.14 kilograms, respectively (Fig. 8j and Fig. 8k). However, there are some parts of the year or even the whole year that the species are not present.

Acanthocybium solandri (Wahoo) locally known as "Tanigi", the top twelve dominant species has its peak from April to June with an observed harvest of 12,169.21 kilograms (Fig. 8l) during the study period. The species is highly migratory in nature.

Cypselurus poecilopterus (Yellow-wing flying fish) locally known as "Anak", the top thirteen species observed has its peak from March to May with a noted harvest of 8,145.06 kilograms during the study and can be rarely seen during the rest of the months (Fig. 8m).

Naso unicornis (Blue spine unicornfish) locally known as "Parayan" and *Siganus argenteus* (Streamlined spinefoot) as "Manayri", the fourteen, and fifteen commercially dominant species in the area were only observed in certain parts of the

year. The peak season for *N. unicornis* (Fig. 8n) and *S. argenteus* (Fig. 8o) started from July to September with a monitored harvest of 7, 658. 98 kilograms and 7, 501. 503 kilograms during the study period, respectively.

Olañio et al., (2009) reported that the highest volume of annual settlement of *S. argenteus* occurs at new moon since they are lunar spawners and the major factors that influence siganids juvenile recruitment are production, habitat, and oceanographic conditions. Same seasonal pattern was also observed by Aragon et al., (2008) in Batanes waters.

Meanwhile, family Exocoetidae and Coryphaenidae are abundantly caught during summer specifically from March to May. The species under these families are called the "fish of summer" in Batanes waters because of their abundance. They are biologically migratory in nature; therefore it is only in a certain season that the species enter the near shore waters of a given area in significant numbers.

Generally, the southwest monsoon, northeast monsoon, and transition winds regularly observed throughout the year along with biological (predation, food availability), environmental (monsoon winds), and oceanographic conditions (temperature, salinity, wind, etc.) were considered to be the major factors influencing the seasonality of the species in the fishing ground. Hence, environmental, biological and oceanographic factors in varying degrees contribute in the seasonal occurrence of certain species as these factors are interlinked with each other.

Catch contribution of major fishing gears operating in the municipal waters of Batanes

Drift gill net is the most commonly used by fisherfolk and the top contributor to bulk of harvest in the fishing ground. There were twenty dominant fish species caught by Drift Gill Net during the study period. The gear recorded a total catch of 257, 857. 60 kilograms comprising of 44 species during the study period. *Cheilopogon furcatus* (18.91%) dominated the catch of the said gear closely followed by *Cheilopogon cyanopterus* (13.95%), and *Cheilopogon suttoni* (11.28%).

The remaining species comprised the 9.54 % of the gear total catch (Table 3). Notably, most of the catch was dominated by pelagic species especially flying fishes of Family Exocoetidae.

Table 3. Dominant species caught by Drift Gillnet in the municipal waters of Batanes (January 2009 − December 2013).

Species	Total Catch (kg.)	% Abundance
Cheilopogon furcatus	48773.21	18.91
Cheilopogon cyanopterus	35981.16	13.95
Cheilopogon suttoni	26730.66	10.37
Cheilopogon unicolor	26197.95	10.16
Cheilopogon astrisignis	22841.27	8.86
Tylosurus crocodilus	18470.52	7.16
Cheilopogon nigricans	13470.49	5.22
Cheilopogon spilinopterus	8219.26	3.19
Cypselurus poecilopterus	6577.35	2.55
Cheilopogon spilonotopterus	6153.41	2.39
Cypselurus naresii	4425.82	1.72
Stongylura leiura	3651.35	1.42
Hirundichthys coromandelensis	1961.93	0.76
Cheilopogon katopron	1836.83	0.71
Cypselurus opisthopus	1794.94	0.70
Cheilopogon nigricans	1599.7	0.62
Cheilinus furcatus	1509.6	0.59
Cheilinus cyanopterus	1366.35	0.53
Cheilopogon arcticeps	881.48	0.34
Cypselurus poecilopterus	809.48	0.31
Other Species	24604.837	9.54
Total Catch	***257,857.597***	***100***

Spear gun is the second top most fishing gear used to catch different demersal species in the waters of Batanes. The gear has a total catch of 49, 685.10 kilograms comprised of 300 different species of demersal vertebrates and invertebrate fish species. *Sepia lycidas* (9. 79%) was the most dominant species caught by this gear followed by *Sepia pharoanis* (8. 33%) and *Naso unicornis* (6. 48%). The remaining species comprised the 31.95% of the gear total catch (Table 4).

Table 4. Dominant species caught by Spear Gun in the municipal waters of Batanes (January 2009 − December 2013).

Species	Total Catch (kg.)	% Abundance
Sepia lycidas	4862.12	9.79
Sepia pharaonis	4139	8.33
Naso unicornis	3217.45	6.48
Panulirus penicillatus	2850.84	5.74
Kyphosus vaigiensis	1905.22	3.83
Octopus vulgaris	1652.69	3.33
Acanthurus dussumieri	1488.37	3.00
Siganus argenteus	1353.24	2.72
Scarus ghobban	1191.78	2.40
Gymnothorax javanicus	1159.65	2.33
Acanthurus guttatus	1134.74	2.28
Naso lituratus	1120.19	2.25
Acanthurus lineatus	873.8	1.76
Panulirus ornatus	869.38	1.75
Cetoscarus bicolor	844.12	1.70
Variola louti	755.19	1.52
Lutjanus gibbus	667.23	1.34
Naso tuberosus	614.36	1.24
Octopus macropus	508.1	1.02
Scarus rivulatus	506.08	1.02
Other Species	17971.548	36.17
Total Catch	***49,685.098***	***100.00***

Multiple hand line is the third top most fishing gear used to catch different demersal and pelagic species in the waters of Batanes. During the entire study period, the gear has a total catch of 46, 624. 72 kilograms comprised of 279 different species of demersal fishes. *Decapterus macarellus* (26.02%) was the most dominant species caught by this gear followed by *Lethrinus rubrioperculatus* (9.99%), and *Paracaesio xanthurus* (6.74%). The remaining species comprised the 18.80% of the gear total catch (Table 5).

Table 5. Dominant species caught by Multiple Handline in the municipal waters of Batanes (January 2009 − December 2013).

Species	Total Catch (kg.)	% Abundance
Decapterus macarellus	12133.85	26.02
Lerhtinus rubrioperculatus	4658.09	9.99
Paracaesio xanthurus	3143.66	6.74
Variola louti	2875.00	6.17
Variola albimarginata	2010.34	4.31
Lerhtinus lentjan	1848.63	3.96
Gnathodentex aurolineatus	1229.05	2.64
Lutjanus gibbus	1186.17	2.54
Cephalopholis urodeta	1130.66	2.43
Epinephelus fasciatus	1036.44	2.22
Etelis copruscans	1009.60	2.17
Etelis carbuncullus	1009.41	2.16
Lutjanus kasmira	775.46	1.66
Lethrinus harak	767.62	1.65
Parupeneus multifasciatus	582.03	1.25
Aprion virescens	575.46	1.23
Priacanthus macracanthus	569.46	1.22
Lutjanus quinquelineatus	542.55	1.16
Pristipomoides filamentosus	409.22	0.88
Cephalopholis sonnerati	366.96	0.79
Other Species	8765.06	18.80
Total Catch	**46,624.72**	**100.00**

The estimated total production for Troll Line is mostly contributed by *Coryphaena hippurus* (42.80%), followed by *Acanthocybium solandri* (25.66%) and *Katsuwonus pelamis* (7.29%). The remaining species comprised the 0.78% of the gear total catch (Table 6). The gear has a total catch of 48,120. 28 kilograms during the study period comprised of 45 species of pelagic and some demersal species. Particularly, Family Scombridae, Istiophoridae, and Coryphaenidae dominated the catch of Troll Line.

Table 6. Dominant species caught by Troll Line in the municipal waters of Batanes (January 2009 − December 2013).

Species	Total Catch (kg.)	% Abundance
Coryphaena hippurus	20593.71	42.80
Acanthocybium solandri	12347.41	25.66
Katsuwonus pelamis	3506.8	7.29
Elagatis bipinnulata	2302.39	4.78
Thunnus albacares	1850.55	3.85
Coryphaena equeselis	1468.7	3.05
Istiomplax indica	1235.6	2.57
Euthynnus affinis	980.85	2.04
Auxis rochei	911.79	1.89
Istiophorus platypterus	746.25	1.55
Aprion virescens	422.85	0.88
Gymnosarda unicolor	288.1	0.60
Caranx sexfasciatus	242.65	0.50
Sphyraena barracuda	224.21	0.47
Caranx speciosus	176.15	0.37
Caranx tile	120.25	0.25
Sarda orientalis	118.29	0.25
Caranx ignobilis	97.79	0.20
Cybiosarda elegans	56.82	0.12
Auxis thazard	53.95	0.11
Other Species	375.17	0.78
Total Catch	**48,120.28**	**100.00**

Population parameters of some commercially important species

Studies conducted in the nearby fishing grounds were used as reference in the estimation of population parameters. But, in the case where studies are not yet conducted, results of studies conducted in other nearby countries were used in comparing the parameters obtained in this study.

The L_{max} of *Tylosurus crocodilus, Cheilopogon unicolor*, and *Kyphosus vaigiensis* were 64.97 cm, 35.78 cm, and 26.21 cm, respectively. Base on sizes range of the recorded length frequencies of the selected top commercially important species (Table 7) caught which are representative of pelagic and demersal species, the maximum length observed became

Table 7. Growth parameter estimates of selected commercially important species in the municipal waters of Batanes.

Species	L_{max} (cm) year^{-1}	L_{oo} (cm) year^{-1}	K value year^{-1}
Tylosurus crocodilus (TL) (Crocodilian needlefish)	64.97	79.8	0.34
Values from Fish base/literatures	**69***	**80.2***	-
Cheilopogon unicolor (TL) (Limpidwing flyingfish)	35.78	40.95	0.85
Values from literature	**36***		**0.40 – 0.62****
Kyphosus vaigiensis (TL) Brassy chub	26.21	42	0.14
Values from literature	**44***	-	-

**Source: Aragon t.al,. 2008a*
***Ame and Retamal, 2013 (unpublished)*

smaller compared to the L_{max} on previous study of Aragon et al., (2008). This shows that only smaller sizes of species are left in the fishing ground which has less contribution in the recruitment process of the said species.

The growth scan value (K) obtained for *C. unicolor* was 0.85 year^{1} which is very near to the value obtained in the study of Ame and Retamal, (2013, unpublished). *T. crocodilus* and *K. vaigiensis* obtained a K value of 0.34 year^{1} and 0.14 year^{1}, respectively. For these species, there are no available literatures or information regarding mortality and exploitation rates in nearby fishing grounds or countries that could serve as additional information in the estimation of K scan values.

Mortality and exploitation rates of some major species

The mortality of a cohort is composed of mortality due to fishing (F), and mortality (M) due to natural causes such as predations, diseases, and deaths due to aging. These factors were used to determine the exploitation rate (E) of a certain species (Guanco et al., 2002) where exploitation rate can be known using the ration of F/Z which indicates the fishing condition of a certain fishing ground. Pauly and Ingles (1984) stated that the optimum fishing mortality in an exploited stock should be approximately equal to natural mortality, or optimum exploitation rate (E) is approximately equal to 0.50. A predominance of estimates of values of $E > 0.5$ in a number of stocks should be suggestive of over exploitation.

Table 8. Mortality and exploitation rate estimates of selected commercially important species in the municipal waters of Batanes.

Parameters	*Tylosurus crocodylus*	*Cheilopogon unicolor*	*Kyphosus vaigiensis*
M (yr^{-1})	0.99	1.47	0.45
F (yr^{-1})	3.47	2.17	0.11
Z (yr^{-1})	4.46	3.64	0.56
E(yr^{-1})	0.78	0.6	0.20
E_{10}	0.75	0.408	0.41
E_{50}	0.44	0.315	0.314
E_{max}	0.89	0.508	0.504

As observed, the fishing mortality values obtained for *T. crocodylus* (3.47 yr^{-1}) and *C. unicolor* (2.17 yr^{-1}) is higher than the natural mortality values of 0.99 yr^{-1} and 1.47 yr^{-1}, respectively (Table 8). This only means these species is experiencing high fishing pressure than natural death. Conversely, one commercially important species (*K. vaigiensis*) is experiencing a low fishing pressure as indicated by the value obtained. This only means that the species die more due to natural causes like predation, old age, and other natural factors.

The obtained exploitation value for this species were already beyond the optimum level of exploitation based on the suggested sustainable exploitation level of 0.05 by Gulland (1971). Same results on the exploitation rate of these species were obtained by Aragon et al., (2008) where the exploitation rate ranges from 0.60 − 0.80

Summary and Conclusion

The data analyzed was obtained from the 12 established NSAP landing sites in the municipal waters of Batanes from CY 2009 to CY 2013 to evaluate the present status and potential of the fishing ground. The resources of the Island is shared by six (6) coastal municipalities with a total number of 1178 fishermen operating in the fishing ground. There are 4698 units of fishing gears used in the fishing ground. The trend of annual fish production in the fishing ground is fluctuating with an aggregate volume of 4923.607 MT. The fluctuating production could be due to frequent occurrence of typhoon, unstable weather condition and some social factors (i.e. livelihood shifting).

Drift Gill Net is the most dominant commercial gear in the area with the highest annual harvest during the study period with a percentage share of 47.84% followed by Spear Gun (9.22%), and Multiple Handline (8.65%).

The highest recorded CPUE for Drift Gill Net was in the year 2011 with a total harvest of 68,504.4 kilograms at 86.94 kg/boat. For the Spear Gun, the highest CPUE recorded was in 2012 with a total catch of 16,149 kilograms at 20.7 kg/boat.

There are 580 species of fish belonging to 66 families. Vertebrate species comprised 96.8% of the total landed catch wherein 54.9% are pelagic and 41.9% are demersal. The 3.1% comprised the invertebrate species and 0.05% for the Elasmobranch species.

The seasonal patterns of the species observed were found to be abundant during summer starting the months of March to May. Some of the species were observed only in a certain months or year. This could possibly be due to their migration activities along with the inclement weather conditions of the area and other environmental, biological, and oceanographic conditions that affect their seasonal pattern. The southwest monsoon, northeast monsoon, and the transition winds that are regularly observed throughout the year were also considered to be the major factors influencing the seasonality of the species in the fishing ground.

The fishing mortality values of Hound needlefish (*Tylosurus crocodilus*) *Limpid wing flyingfish* (*Cheilopogon unicolor*) was higher than the natural mortality value which is an indication that high fishing pressure is being experienced and exploitation rate of these species is already beyond sustainable optimum level.

Recommendations

Based on the results of this study, the following should be considered to address the current fisheries status of the municipal waters of Batanes:

1. Maximum sustainable yield is not yet established in this study but based on the mortality values obtained, fishing pressure is high. It is suggested that appropriate management of the fishery is required.
2. Biological studies on the top commercially important species should be conducted particularly on their growth and reproduction. These information are still lacking in the area under study.
3. Massive information dissemination of the results should be done to policy working bodies for the formulation of policies and regulations leading to the sustainable management, conservation, and protection of the fishery resources in the municipal waters of Batanes.

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