

# 2008

## THE PRELIMINARY REPORT ON FISHERY RESOURCES EXPLORATION ON THE CONTINENTAL SLOPES IN THE LINGAYEN GULF, THE PHILIPPINES

M/V DA-BFAR, The Philippines  
11-25 May 2008



SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER

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## **Preparation and distribution of this document**

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## **MESSAGE**

Like many fishing nations, the Philippines struggles with sustaining fisheries in traditional fishing grounds especially in the coastal and nearshore waters where many of our fishermen depend for their livelihood and income. While it is well recognized that the level of fishing needs to be moderated in these areas, alternative livelihoods and substitute fishing areas are important in achieving the objective of sustainable use of fisheries resources.

It is for this reason that our initiative to assess the potential of our deep sea resources is important in optimizing the use of available resources in deep sea areas. It is ironic that in the Philippines, while 88% of our marine waters are considered deep water zones, yet we do not know much about their potentials. Neighboring countries like Taiwan, Japan and other more advanced fishing countries with relatively limited deep water areas have developed fisheries that are based on deep sea fish species.

It is in this light that I recognize the value of this collaborative survey between BFAR and SEAFDEC on “Deep Sea Fisheries Assessment Along the Continental Slopes of Lingayen Gulf.” The survey resulted with interesting findings particularly the presence of deep sea shrimp species that are potentially valuable to fisheries. However, as we put forward our interest and efforts in developing the deep sea resources, we should also be cognizant with the high vulnerability of the resources to overexploitation.

This endeavor yet again highlighted the importance of collaboration between BFAR, SEAFDEC and its member countries in addressing fisheries matters that are of common interest in the region.

  
MALCOLM I. SARMIENTO, JR.

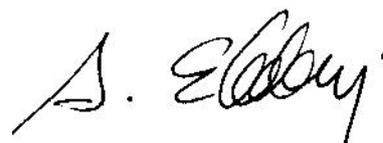
BFAR Director  
And SEAFDEC Council Director for the Philippines

## **FORWARD**

In the point of view of fishery policy maker or government searching of new fishing ground as a consequence of the depletion of the inshore/coastal fisheries resources in the Southeast Asian Countries. Those depletion was also reduces the supply of sea food materials to many fish processing industries in the region and reduces the food supply for the global level. Therefore, the deep-sea sea fishery resources survey in the EEZ of the Southeast Asian Region in order to investigate the status and potential were existed.

Though there is a great continental shelf of almost 50% occupies the area of South China Sea, the continental slope and the deep basin down to nearly 1,000 to 5,000 m are the largest habitat around the Philippines, Taiwan, Indonesia, and part of the Andaman Sea areas of Thai and Myanmar Waters. Within the 100 m depth, the fishery resources have been intensively exploited by trawling and the shallow-water fishes in the region have been well documented, but the deep-sea fauna are yet fully investigated. The known deep sea pelagic resources are those of tunas, billfishes, and sharks, which are already being exploited but the unexploited resources available in the Exclusive Economic Zone (EEZs) of the countries in the Southeast Asian Region especially the demersal resources beyond 100 meter on the continental shelf and slope are only little or no information available. Besides, there were no surveys have been specifically directed at the deep-sea demersal and mesopelagic resources in the region.

We are also faced with the challenge of sustainable managing the deep sea resources. As we are all aware of, poor management of the deep sea resources can lead to over fishing. As responsible citizens of the region, we do not want to lose the deep fisheries resources as what has happened to our coastal areas. Therefore, we need to understand the deep sea ecosystem and its resources as well as the impact to such resources from fisheries.



DR. SIRI EKMAHARAJ  
SECRETARY GENERAL  
SOUTHEAST ASEAN FISHERIES DEVELOPMENT CENTER

## **Outline of the Survey:**

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## **An outline of the Deep Sea Fishery Resources Exploration on the Continental Slopes in the Lingayen Gulf, the Philippines during 11-25 May 2008**

### **1. INTRODUCTION**

Consideration of the geographic features in the Southeast Asia Waters, more than 50% of the sea areas are identified as deep sea whereas utilization of those resources have not been initiated yet. This is due to lack of information on the species composition and how potential of the resources. In addition, it is clear that research vessel of deep sea survey seems to be one of the main factors that many countries in the region are facing. Not many research vessels in the region can conduct the deep sea resources survey due to the lack facilities, scientific instruments, type of fishing gear for fish sampling, and expertise. To encourage the SEAFDEC member countries to initiate on the deep sea resources exploration in their EEZ waters, therefore, investigation on the potential fisheries resources in the deep sea areas were commence.

### **2. RESEARCH TEAM AND PARTICIPANTS**

The ASEAN-SEAFDEC program on the Deep Sea Fisheries Resources Exploration in the Southeast Asian Waters for 2008 which was endorsed in the 30th SEAFDEC Program Committee Meeting in Iloilo, the Philippines, one of the aims is to encourage member countries conducting the deep sea fishery resources survey in their EEZ by reason of investigation for the status and how potential of deep sea fisheries resources existing in the region. SEAFDEC/TD in collaboration with the Bureau of Fisheries and Aquatic Resources (BFAR) plan to conduct the deep sea fisheries resources on the continental shelf slopes where depth ranged between 200 and 1,000 m at Lingayen Gulf which located on the northwestern Luzon of the Philippines with the aim to investigate the existing fisheries resources and searching for potential fisheries resources in her EEZ. The survey, using three main sampling gears, there are bottom trawl, deep-sea beam trawl and deep-sea trap, respectively. The survey was conducted using the training and research vessel M/V DA-BFAR during the period from 11 to 25 May 2008. Regarding this, to obtain the most benefit of using DA-BFAR to other member countries SEAFDEC/TD in cooperation with BFAR was conducted the Shipboard Training Workshop on Deep Sea Fisheries Resources Research and Survey aboard M/V DA-BFAR during the mentioned period. Lists of scientists, participants, and organizations are as follows;

#### **Bureau of Fisheries and Aquatic Resources (BFAR)**

Mr. Rafael Ramiscal (Scientist and participant)  
Mr. Pierre Esther Velasco (Scientist and participant)  
Mr. Remar Asuncion (Scientist and participant)  
Ms. Rhoda Servidad (Scientist and participant)  
Ms. Jenny Viron (Scientist and participant)  
Ms. Riczyneth Ampoyos (Scientist)  
Ms. Che-che Salcepuedes (Scientist)  
Mr. Roger Fortaliza (Scientist)  
Mr. Marlo Demo-os (Scientist)

#### **Department of Fisheries, Brunei Darussalam**

Mr. Abdul Hamid Haji Zainin Brunei (Participant)

#### **Research Institute for Marine Fisheries, Indonesia**

Mr. Muhammad Taufik (Participant)

#### **Tokyo University of Marine Science and Technology, Japan**

Dr. Tsuchiya Kotaro (Resource person)

#### **Department of Fisheries, Malaysia**

Mr. Mohammad Faisal bin Md. Saleh (Participant)

#### **Department of Fisheries, Thailand**

Mr. Montri Sumontha (Resource person)  
Mr. Narupon Darumas (Participant)

**Research Institute for Marine Fisheries, Vietnam**

Mr. Pham Quoc Huy (Participant)

**Southeast Asian Fisheries Development Center/Marine Fisheries Resources Development and management Department/Malaysia**

Mr. Mohamed Azmi bin Abdullah (Participant)

**Southeast Asian Fisheries Development Center/Training Department/Thailand**

Dr. Worawit Wanchana (Scientist)

Mr. Sayan Promjinda (Scientist)

Mr. Nakaret Yasook (Scientist)

Mr. Tossaporn Sukhapindha (Scientist)

Dr. Natinee Sukramongkol (Scientist)

**3. SAMPLING METHODS**

M/V DA-BFAR is an oceanographic training research and fisheries management vessel in the 200 miles EEZ of the Philippines Waters. She is 60 meters in length and 1,156 gross tons which belong to the Philippines government since 1999. The survey was conducted using three main fishing gears, there are beam trawl, otter trawl, and deep-sea traps. The map and details of survey stations are shown in Figure 1 and Table 1.

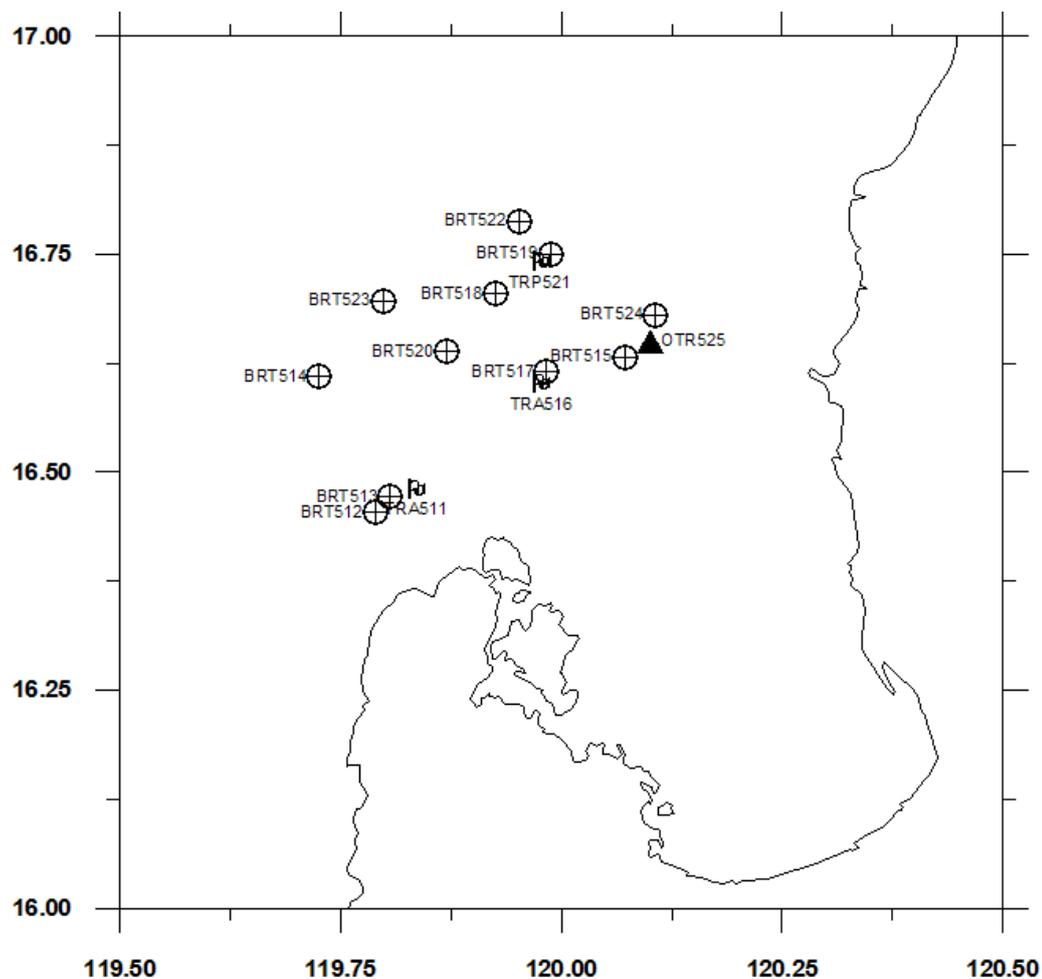


Figure1. Map of Lingayen Gulf and survey stations.

(●) TRA= Deep-Sea Trap; (⊕) BTR= Beam Trawl; (▲) OTR= Otter Trawl).

Table 1. Summary of the survey station<sup>1</sup> at Lingayen Gulf

Date	Station Code	Fishing Gear	Fishing			Hauling						Depth (m)
			Time Start	Position		Time Start	Position		Time Finished	Finished Position		
				Latitude	Longitude		Latitude	Longitude		Latitude	Longitude	
13 May 08	TRA 511	Deep Sea Trap	-	-	-	07:49	16_29.30N	119_49.90E	08:45	16_28.60N	119_49.60E	405
13 May 08	BTR 512	Beam Trawl	15:50	16_27.25N	119_47.36E	16:20	16_26.39N	119_47.19E	16:50	16_26.30N	119_47.25E	464-484
13 May 08	BTR 513	Beam Trawl	17:30	16_28.30N	119_48.38E	18:00	16_29.27N	119_48.93E	18:20	16_29.98N	119_49.38E	440-452
14 May 08	BTR 514	Beam Trawl	10:55	16_36.61N	119_43.54E	11:25	16_37.59N	119_43.39E	12:00	16_38.23N	119_43.27E	1,227-1,318
15 May 08	BTR 515	Beam Trawl	12:15	16_37.95N	120_04.28E	12:50	16_37.52N	120_05.36E	13:05	16_37.34N	120_05.60E	249-283
19 May 08	TRA 516	Deep Sea Trap	-	-	-	14:45	16_36.54N	119_59.17E	15:50	16_36.86N	119_59.52E	289
20 May 08	BTR 517	Beam Trawl	06:05	16_36.95N	119_58.99E	06:35	16_37.88N	120_00.08E	06:50	16_38.15N	120_00.24E	302-362
20 May 08	BTR 518	Beam Trawl	08:20	16_42.26N	119_55.49E	08:55	16_42.98N	119_56.76E	09:15	16_43.33N	119_56.91E	568-571
20 May 08	BTR 519	Beam Trawl	10:10	16_45.03N	119_59.28E	10:40	16_45.57N	120_00.43E	11:00	16_45.87N	120_00.52E	607-687
20 May 08	BTR 520	Beam Trawl	12:40	16_38.30N	119_52.17E	13:10	16_37.69N	119_51.39E	13:30	16_37.92N	119_51.32E	587-628
20 May 08	TRA 521	Deep Sea Trap	-	-	-	18:45	16_45.07N	119_59.31E	10:15	16_45.97N	119_59.58E	648
20 May 08	BTR 522	Beam Trawl	18:40	16_47.27N	119_57.11E	19:10	16_47.91N	119_58.74E	19:30	16_48.50N	119_58.90E	722-749
21 May 08	BTR 523	Beam Trawl	06:35	16_41.80N	119_47.90E	07:05	16_43.20N	119_48.39E	07:35	16_43.90N	119_48.50E	869-877
21 May 08	BTR 524	Beam Trawl	11:25	16_40.85N	120_06.39E	12:00	16_41.06N	120_07.82E	12:20	16_41.29N	120_08.24E	489-529
22 May 08	OTR 525	Otter Trawl	07:00	16_40.86N	120_05.42E	07:30	16_40.84N	120_03.03E	08:20	16_41.45N	120_01.33E	464-570

<sup>1</sup> TRA= Deep-Sea Trap; BTR= Beam Trawl; OTR= Otter Trawl

### Beam trawl

The beam trawl is a glides wooden beam in 50 cm high and 420 cm long with iron runners at both ends of its bar. A collecting net with 30 mm stretched-mesh cod end and the tickler chain at the footrope of the net. The beam trawl was towed with single cable using the port side trawl winch of the vessel for 30 minute on the bottom at depth from 250 m to 1,300 m (Table 1).

### Otter trawl

The bottom otter trawl with lead line 15 m in length. Mouth opens by two otter-boards and vertically by the weight of footrope and buoyancy of the floats at the headrope. The floats withstand pressure at 500-600 m. The net was towed for 30 minutes (Table 1).

### Deep-Sea Trap

A deep-sea trap is a polyethylene screen in cylindrical formed with two funnels on both ends in 65 cm long and 30 cm diameter covered by green polyethylene screen (Amazon brand) with ½ cm mesh size. Forty (40) traps were hung on 18 mm rope at 30 m interval to form a longline that was carried out using one of the astern trawl winches of the vessel. The baited using in this survey is *Sardinella* sp. (frozen).

### Sample Treatment onboard and Depository

After removed large organisms such as rocks and sunken wood, samples collected from the beam trawl were screened on 10.0, 5.0, 2.5, 1.0, and 0.5 mm mesh sieves with running seawater. The specimens were sorted on deck into fishes, crustacean, holothurians, mollusks, cephalopods. All the specimens were spread out in the plastic boxes with ice until there were brought to a temporary laboratory onboard. Those of sunken wood, rock and other organisms which contained hydrozoa, mollusks, polychaets were also kept for the later examination. In the laboratory aboard the vessel, the sorted specimens were measured on the total length (mm), body weight (g) and recorded on number

of fish specimens. Carapace length (mm), number, group weight (g), and average individual weight (g) were recorded for shrimp specimens. Other benthic invertebrates included mollusks and cephalopods were count the number and recorded mantle length (mm), group weight (g) and individual weight (g) where necessary. The specimens were identified to the lowest taxonomic level as possible and photograph. Shrimp specimens were immersed in 80% ethanol labeled, sealed and stored in a plastic drum container. Fish specimens were placed in punctured plastic bags and submerge in 10% formalin solution in plastic drum containers. All specimens from this survey and used for taxonomic study were deposited at Bureau of Fisheries and Aquatic Resources (BFAR-NMFDC).

#### **4. ACKNOWLEDGEMENTS**

The authors wish to acknowledge the cooperation between the DA-BFAR and SEAFDEC/TD. We would also like to express our sincere thanks to the captain and crews of the M/V DA-BFAR for their help during the surveys. We also acknowledge the support of the Fisheries Agency of Japan (Japanese Trust Fund) for funding this project.

## **Results from the Survey:**

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## Preliminary Assessment of Deep Sea Fisheries Resources along the Continental Slopes of Lingayen Gulf, Philippines

Alma C. Dickson<sup>1</sup>, Jonathan O. Dickson<sup>2</sup>, Rafael V. Ramiscal<sup>1</sup>, Robin Escriba<sup>1</sup>, Joeren Ylleana<sup>1</sup>, Che-che Salcepuedes<sup>1</sup>, Rhoda Servidad<sup>1</sup>, Jenny Viron<sup>1</sup>, Roger Fortaliza<sup>1</sup>, and Riczineth Amposyos<sup>1</sup>

<sup>1</sup>National Marine Fisheries Development Center, Bureau of Fisheries and Aquatic Resources, Quezon City, Philippines

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### 1. ABSTRACT

Deep sea fisheries survey was conducted along the continental slopes of Lingayen Gulf on May 11-26, 2008 using beam trawl and traps to determine composition and abundance of species that are important to fisheries. Among the crustaceans, pandalid shrimps were found dominant and perhaps the most significant to fisheries mainly *Heterocarpus dorsalis*, *H. woodmasoni*, *H. hayashii* and *H. laevigatus* that were caught at sampling depths between 200 m and 800 m but were most abundant at 400-600 m.

Using swept area method, the catch-per-unit-area (CPUA) and biomass based on beam trawl tows were computed according to depth range for various species groups including crustaceans (shrimps and pandalid shrimps) and fish (family Macrouridae and Colocongridae). The CPUA for fish and crustaceans particularly pandalid shrimps was highest at 400-600 m. The total biomass for fish and crustaceans was estimated to be about 819 tons which include about 46 tons of pandalid shrimps in an area of about 2,567 km<sup>2</sup> with depths between 200 m and 1,500 m that is located at the entrance of Lingayen Gulf. Embarking on a fishery based on above deep-sea species should be done carefully following thorough feasibility and assessment studies.

### 2. INTRODUCTION

The Philippine continental shelf which involves the marine water area from the shoreline to a depth of 200 meters approximates to 254,547 km<sup>2</sup>. It constitutes only about 11.6% of the country's territorial waters of 2.2 million km<sup>2</sup> and it is in this shallow and coastal water where declining catch and over fishing of stocks are of serious concern. Beyond the continental shelf area is the deep water region that includes the continental slope with depths beyond 200 meters up to a depth of 1,500 m and where the bottom is normally sloping and upwelling is taking place. Fishing activities at these depths are not common primarily due to lack of information as regards to available fish resources and perhaps technological restraints to harvest the resources from the deeper regions. Nonetheless, the deep waters are potentially important to fisheries considering its extent that is comparable in size with the continental shelf area (Figure 1).

In 2005 and 2007, deep-sea benthic fauna surveys were conducted jointly by the French National Museum of Natural History, the Philippines National Museum, the Philippines Bureau of Fisheries and Aquatic Resources (BFAR), University of San Carlos Cebu and National Fisheries Research and Development Institute (NFRDI) onboard M/V DA-BFAR. The surveys revealed incidence of interesting species with fisheries importance particularly deep-water shrimps and lobsters. The expeditions were however focused on the collection of specimens for taxonomic studies and catalogue of deep-water biodiversity rather than evaluation for fisheries purposes.

Several deep water shrimps and lobster species with fisheries potential have also been mentioned to be found in the Philippines (FAO, 1998). Interestingly, some of these species form important fisheries in countries like Taiwan and Australia (FAO, 1998; T.Y Chan, pers. comm.). A deep-water trap fishery for deep-sea shrimps is existent in the Davao Gulf area at 200-400 m (Flores, 2004). M/V DA-BFAR initial trials of deep-sea traps at 700-800 m in the Celebes Sea also caught some of the important deep-sea shrimp species (M/V DA-BFAR, 2007). Given these accounts, the M/V DA-BFAR has included in its program the survey of deep sea fisheries resources.

Similarly, the Southeast Asian Fisheries Development Center, Training Department (SEAFDEC/TD) initiated the ASEAN-SEAFDEC Program on the Deep Sea Fisheries Resources Exploration in the Southeast Asian Waters. The main purpose of this regional project is to encourage member countries to conduct deep sea fishery resources survey in their respective Exclusive Economic Zone (EEZ) and investigate the potential of deep sea fisheries resources that exist in the region.

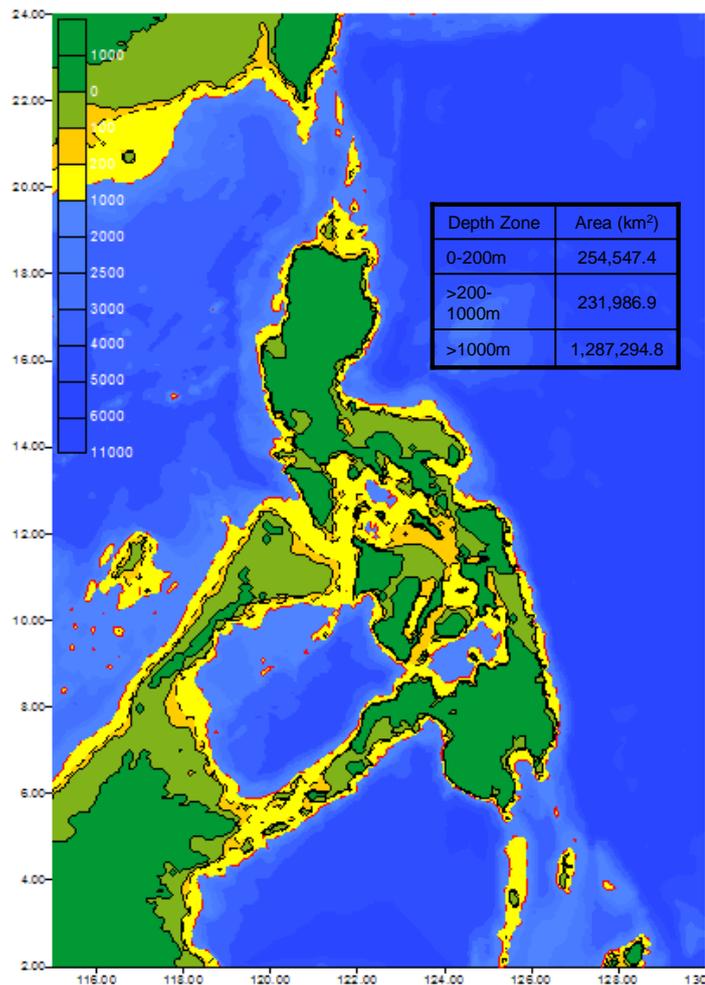


Figure 1. The deep water areas of the Philippines.

The Philippines, as one of the SEAFDEC member country and with the experience gained from preceding deep water benthic surveys, had expressed to take the lead role in the ASEAN-SEAFDEC Program. With SEAFDEC/TD proposing for collaboration, the initial survey in Philippine waters was conducted along the entrance of Lingayen Gulf on May 11-26, 2008. Hands-on onboard training of deep sea fisheries survey was simultaneously conducted onboard M/V DA-BFAR with attending participants coming from the SEAFDEC member countries like Brunei Darussalam, Indonesia, Malaysia, Thailand, Vietnam and the Philippines.

Lingayen Gulf is a semi-enclosed body of water located in the northwestern Philippines between latitude 16.02° and 16.67° N, and longitude 119.89° and 119.90° E. It is a large (2,100 km<sup>2</sup>) embayment which wraps around 18 municipalities and cities in the provinces of Pangasinan and La Union. The Gulf is a chief fishing ground for the Ilocos Region for both municipal and commercial fisheries. The total marine fish production of the Ilocos Region1 2006 was 38,465 mt.

Like most of shallow coastal waters in the country, Lingayen Gulf is beset with declining catch and increasing concern for the continuing deterioration of fisheries resources (Padilla, 1995; BFAR-RFO1, 2006). In addition to fishing pressure from small scale municipal fisheries, the Gulf is also host to about 74 units of commercial fishing vessels, mainly modified Danish and bottom trawls. Commercial fishing is restricted within 15 km from shore, however, breach of this regulation is not uncommon apparently due to insignificant catch in a very limited area that is left for commercial fishing within the Gulf.

The continental slope along the approaches of the Gulf is the most significant along the western coast of Luzon. Deep sea resources when found to be available in the area could provide as

alternative resource to reduce current fishing effort within the Gulf. For this reason, the deep sea resources survey was conducted to determine species caught and indices of abundance like catch-per-unit-area (CPUA) and biomass using beam trawl and catch-per-unit-effort (kg/trap/hr) for deep-sea traps. The survey also intended make use of bottom trawl, however major gear damage on its 1st operation discontinued its deployment.

### 3. MATERIALS AND METHODS

#### Beam Trawl

The sampling stations were selected at random and allowed sampling at various sampling depth ranges and suitable topography. A total of 11 beam trawl stations were covered at various depths at about 30 minutes per tow. Only 10 tows were utilized in the analysis since the bridle line was cut in station BTR 512 (Figure 2) (Table 1).

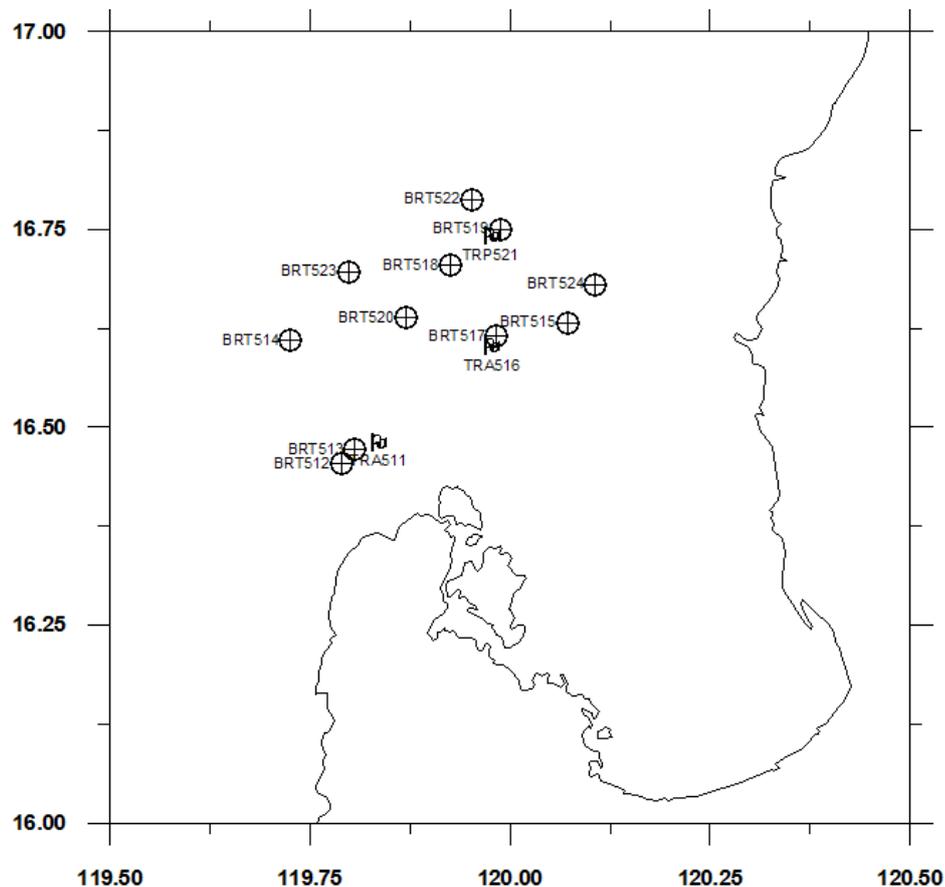


Figure 2. Beam trawl and deep-sea trap sampling stations.

(⊕ BTR= Beam Trawl; ⊞ TRA= Deep-sea Trap)

#### Deep-Sea Trap

Three (3) trap operations were completed at 40 traps per set. Setting was done in the afternoon and hauled the following morning. Depth of operation was 200-600 m and an average of 15.7 hours immersion time (Figure 2) (Table 1).

#### Sampling and Data Management

All organisms caught by the collecting gears after washing and sieving were sorted into groups (i.e. fish, crustaceans, mollusk, and other invertebrates). After the initial sorting on deck, specimens were brought to the laboratories for identification, measurements, photography and preservation.

All shrimp and fish caught were identified according to family and species level whenever possible. Carapace length (carapace to end of rostrum) (mm), number, group weight (g) and body weight (g) were also recorded. Shrimps were immersed in 80% ethanol labeled, sealed in plastic bag and stored in a plastic drum container. Fish samples were placed in punctured plastic bags and submerge in 10% formalin solution in plastic drum containers. All samples were deposited at the BFAR-NMFDC Center for further handling, storage and studies.

Table1. Summary of the survey station<sup>1</sup> at Lingayen Gulf

Date	Station Code	Fishing			Hauling				Fishing Depth (m)	Remarks		
		Time Start	Position		Time Start	Position		Time Finished			Finished Position	
			Latitude	Longitude		Latitude	Longitude				Latitude	Longitude
13 May 08	TRA 511	-	-	-	07:49	16_29.30N	119_49.90E	08:45	16_28.60N	119_49.60E	405	
13 May 08	BTR 512	15:50	16_27.25N	119_47.36E	16:20	16_26.39N	119_47.19E	16:50	16_26.30N	119_47.25E	464-484	Bridle line was cut
13 May 08	BTR 513	17:30	16_28.30N	119_48.38E	18:00	16_29.27N	119_48.93E	18:20	16_29.98N	119_49.38E	440-452	
14 May 08	BTR 514	10:55	16_36.61N	119_43.54E	11:25	16_37.59N	119_43.39E	12:00	16_38.23N	119_43.27E	1,227-1,318	
15 May 08	BTR 515	12:15	16_37.95N	120_04.28E	12:50	16_37.52N	120_05.36E	13:05	16_37.34N	120_05.60E	249-283	
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21 May 08	BTR 523	06:35	16_41.80N	119_47.90E	07:05	16_43.20N	119_48.39E	07:35	16_43.90N	119_48.50E	869-877	
21 May 08	BTR 524	11:25	16_40.85N	120_06.39E	12:00	16_41.06N	120_07.82E	12:20	16_41.29N	120_08.24E	489-529	

<sup>1</sup> TRA= Deep-sea Trap; BTR= Beam Trawl

## Data Treatment and Analyses

For beam trawl, the swept area method was used to estimate the catch-per-unit-area (CPUA). The distance (d) was estimated as the distance between the coordinates between finished setting and start of hauling, thus the swept area was computed as;

$$A = d \cdot BL \quad \text{where } BL = \text{length of the beam} = 4.15 \text{ m}$$

And the catch-per-unit-area (CPUA) in kg/km<sup>2</sup> for shrimps in each tow was computed as;

$$CPUA = C/A \quad \text{where } C \text{ is the total catch for the particular station}$$

The fraction of the biomass in the effective path swept which was actually retained by the beam trawl was estimated as CPUA\*0.5 which is commonly used in trawl surveys in Southeast Asia. Attempt was made to stratify CPUA and biomass according to depth, to account difference of distribution according to depth.

For the traps, the catch-per-unit-effort, expressed in kg/trap/hour, was used an index of abundance. Soaking time was determined as the time between setting was finished and hauling started.

For the purpose of biomass estimation, the total survey area along the entrance of Lingayen Gulf was estimated. Using the soundings navigational chart (NAMRIA chart), the isobaths to separate the various depth ranges were plotted in a Google Map. The area of each depth range was then approximated by overlaying a 1 km<sup>2</sup> grid.

## 4. RESULTS

### Catch Composition

As expected, catch by beam trawl was more diverse than traps due to obvious reasons of different selectivity and efficiency of the fishing gears. For example, more than fifty shrimps, lobsters and crabs species belonging to 18 crustacean families and 41 fish families were identified from beam trawl catch. In traps, 10 crustacean species belonging to five families and five families of fish were initially identified.

Total catch for crustaceans and fishes from the operations of both gears amounted to about 38.73 kg (Table 2). Beam trawl catch was 24.7% crustaceans of which 43% were deep-sea shrimps largely pandalid shrimps. Crustaceans were 32% of the catch from traps dominated by pandalid shrimps (29%). There were 9 shrimp species identified belonging to genus *Heterocarpus*. The predominant species in beam trawl were *H. dorsalis*, *H. woodmasoni*, *H. hayashii* and *H. laevigatus* which of particular interest to fisheries.

More than fifty percent of 41 fish families caught during the survey were belongs to Macrouridae, Colocongridae and Sternoptychidae, respectively. About 32% of Macrouridae, 11% of Colocongrida and 10% of Sternoptychidae of the fish were caught by beam trawl.

Table 2. Total catch by gear, station and group

Fishing Gear	Station Code	Total Catch (kg)	
		Crustacean	Fish
Beam Trawl	BRT 513	0.60	3.11
	BRT 514	0.04	0.70
	BRT 515	0.85	0.77
	BRT 517	0.35	0.16
	BRT 518	0.47	1.78
	BRT 519	0.57	0.80
	BRT 520	0.61	2.18
	BRT 522	0.07	0.68
	BRT 523	0.09	1.18
	BRT 524	1.20	3.10
<i>Subtotal</i>		<i>4.83</i>	<i>14.43</i>
Deep Sea Trap	TRA 511	2.35	7.63
	TRA 516	0.10	1.96
	TRA 521	3.81	3.63
<i>Subtotal</i>		<i>6.26</i>	<i>13.21</i>
<b>Grand Total</b>		<b>11.09</b>	<b>27.64</b>

### Catch-Per-Unit-Effort (CPUE) and Catch-Per-Unit-Area (CPUA)

Computed indices of abundance (CPUE, CPUA) according to depth range indicated interesting distribution of the potential deep sea fisheries resources. The average CPUE for all fish and crustacean species for beam trawl was about 3.62 kg/hour and 10 g/hr/trap for the trap operations.

The pooled average CPUA for all crustacean and fish in beam trawl tows was 207.1 kg/km<sup>2</sup> and magnitude was observed to be highest at depth range of 200-400 m at 347.6 kg/km<sup>2</sup>. The same was observed on CPUA when categorized as fish, shrimp and Pandalidae shrimps. The CPUA for pandalid shrimps was 32 kg/km<sup>2</sup> at this depth range. However, this is not true on the most dominant fish group (Colocongridae) which was caught only between 400 and 800 m but higher catch was realized at depth between 600 and 800 meter deep (Figure 3-6).

The composition and abundance of *Heterocarpus* shrimps also indicates distribution according to the depth. The higher number of species and abundance at 400-600 m perhaps suggests optimum at this depth. Largest in size among the pandalus shrimps is *H. laevigatus* at an average of 17.5 g apiece. Relatively bigger size of *H. hayashii*, *H. laevigatus* and *H. dorsalis* were caught between 600 and 800 m. It can also be noted that those species were not observed beyond 800 m (Table 3.).

Table 3. Average CPUA of *Heterocarpus* species caught by beam trawl according to depth

Depth Range (m)	Species	Weight (g)	Count (tails)	Average weight (g/tail)	Average of CPUA3.2_kg/km <sup>2</sup>
>1000	<i>Heterocarpus</i> 1	10	1	10	1.3
	<i>Heterocarpus</i> 2	2	1	2	0.26
	<i>Heterocarpus</i> 3	4	1	4	0.52
200-400	<i>H. hayashii</i>	100	23	4.3	5.39
	<i>H. woodmasoni</i>	3	3	1	0.28
	<i>Heterocarpus</i> 1	20	5	4	1.85
400-600	<i>H. dorsalis</i>	142	24	5.9	12.12
	<i>H. gibbosus</i>	80	10	8	3.98
	<i>H. hayashii</i>	75	19	3.9	4.44
	<i>H. laevigatus</i>	135	9	15	6.27
	<i>H. woodmasoni</i>	330	168	2	38.68
600-800	<i>H. dorsalis</i>	165	25	6.6	6.05
	<i>H. hayashii</i>	10	1	10	1.36
	<i>H. laevigatus</i>	40	1	40	5.42
	<i>Heterocarpus</i> sp.	15	7	2.1	0.88

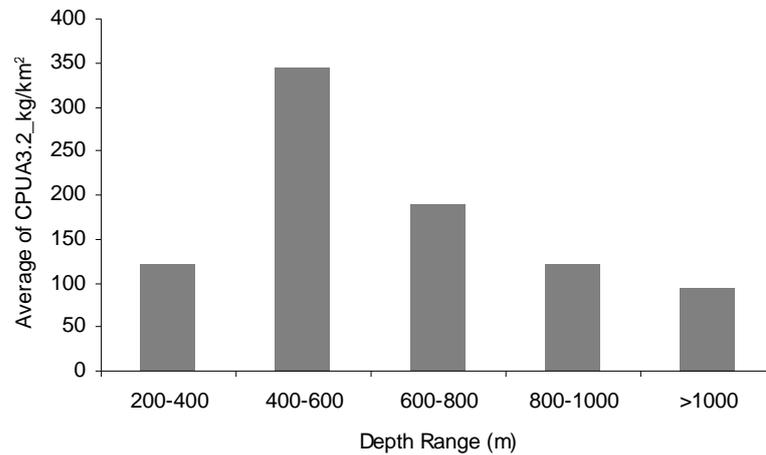


Figure 3. Average CPUA of all species caught (crustaceans and fishes) by depth.

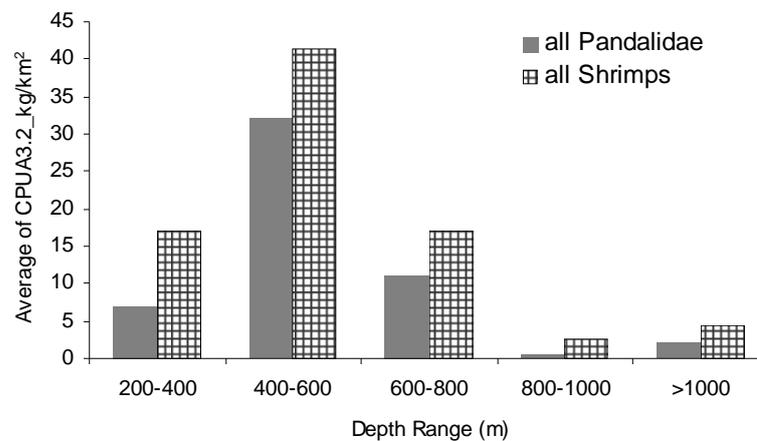


Figure 4. Average CPUA of all species of shrimps and Pandalidae shrimps by depth.

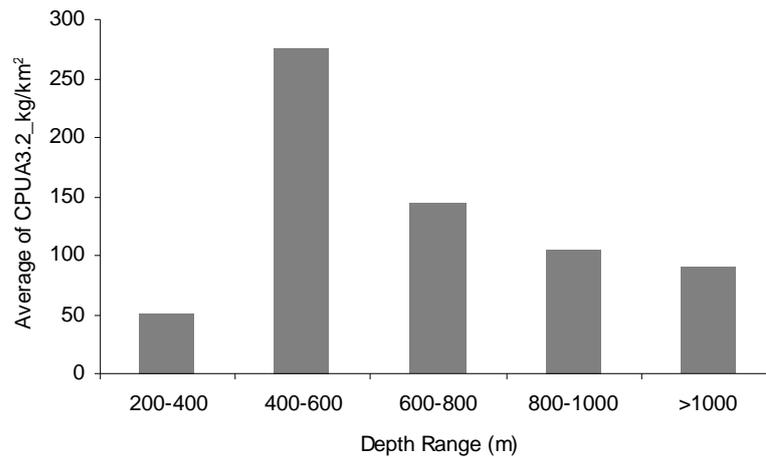


Figure 5. Average CPUA of all fish species by depth.

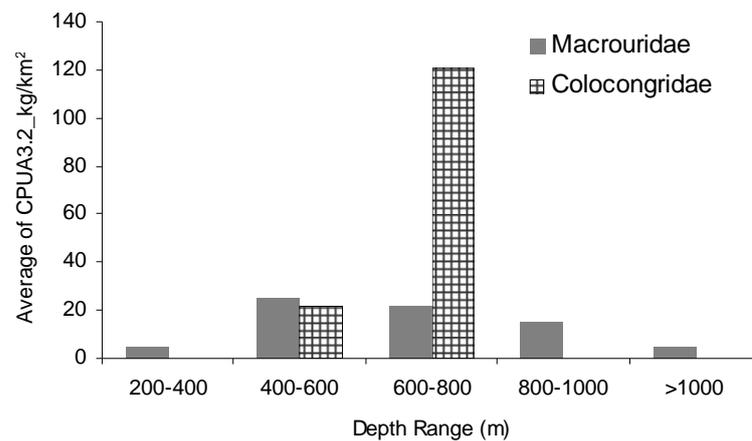


Figure 6. Average CPUA of dominant fish family (Macrouridae and Colocongridae) by depth.

### Deep-Sea Traps

The average catch-per-unit-effort was 10.1 g/trap/hr when crustaceans and fishes are combined. Catch of shrimps was observed to be higher at 400-600 m with 3.4 g/trap/hr compared to 1.7 g/trap/hr at 200-400 m (Table 4). Fish caught from the shallower depth was observed to be higher (Figure 7). The catch rate is considered low which could be due to low efficiency of current trap design.

Table 4. Average CPUE of *Heterocarpus* species caught by deep-sea trap according to depth

Depth Range (m)	Species	Weight (g)	Count (tails)	Average weight (g/tail)	Average of CPUE (g/trap/hr)
200-400	<i>H. hayashii</i>	2,330	340	7	1.71
	<i>H. woodmasoni</i>	60	9	7	0.09
400-600	<i>H. dorsalis</i>	1,250	76	16	1.17
	<i>H. hayashii</i>	300	22	14	2.05
	<i>H. laevigatus</i>	500	17	29	0.49

In Mariana Islands, deep-sea traps deployed at 4,001-838 m were catching 97.5% *H. laevigatus* and catch rates peak in the 640 to 660 m depth (Ostazesky, 1997), however gear loss was also observed to be high at 3.5% per day. Catch-per-unit-effort was high at 1.1 kg/trap-night.

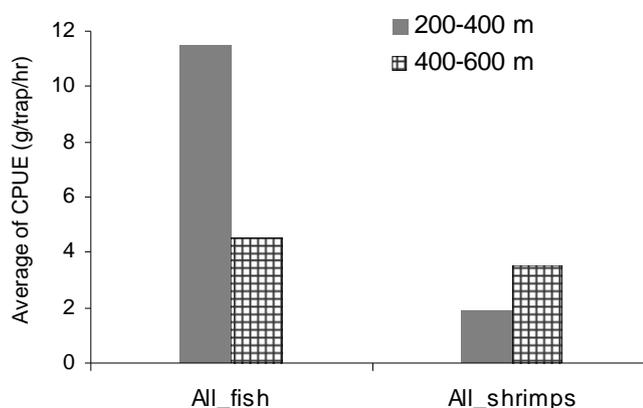


Figure 7. Average CPUE of fish and shrimps caught by deep-sea trap by depth.

## Biomass

The total area of the continental slope up to depths from 200 to 1,500 m in the entrance of Lingayen Gulf was estimated at 2,567 km<sup>2</sup> (Figure 8) (Table 5).

Table 5. The estimated biomass of deep sea resources according to depth

Depth Range (m)	Total area (km <sup>2</sup> )	BIOMASS (Tons)						
		Crustacean and Fish	All Crustacean	All Fish	Pandalid	All Shrimps	Macrouridae	Colocongridae
200-400	253.81	60.24	33.65	26.60	3.69	8.68	1.92	0
400-600	604.52	339.92	76.54	263.39	29.68	43.34	28.12	30.04
600-800	395.47	153.46	39.25	114.21	8.62	13.45	16.70	95.41
800-1000	408.84	92.69	6.56	86.13	0.51	2.04	11.30	0
>1000	905.15	172.65	8.95	163.70	3.77	8.48	9.42	0
<b>Total</b>	<b>2,567.80</b>	<b>818.97</b>	<b>164.94</b>	<b>654.02</b>	<b>46.27</b>	<b>75.99</b>	<b>67.45</b>	<b>125.45</b>

The biomass estimated by depth based on CPUA and area estimates along the continental slope area in entrance of Lingayen Gulf can thus be estimated as shown in Table 5. Based on these estimates, fisheries can be initiated targeting species with commercial potential particularly the pandalid shrimps.

## Other Resources

### Cephalopods

In this survey, there were 11 lots of cephalopods collected under Class Cephalopoda belonging to 8 families (Family Octopodidae, Ctenopterygidae, Sepioliidae, Ommastrephidae, Mastigoteuthidae, Octopoteuthidae, Histioteuthidae and Pyroteuthidae). Family Ommasrephidae was observed dominant which consisted of 2 species (*Ornithoteuthis volatilis* and *Sthenoteuthis eualaniensis*). A total of 9 species of cephalopods were identified namely: *Pyroteuthis* sp., *Sthenoteuthis eualaniensis*, *Octopoteuthis* sp., *Ornithoteuthis volatilis*, *Ctenopteryx sicula*, *Histioteuthis meleagroteuthis*, *Mastigoteuthis cordiformis*, *Heteroteuthis* sp. and *Octopus* sp.). Among the cephalopod species identified, 5 families were collected during the unsuccessful otter trawl operation indicating its relatively higher efficiency for cephalopods as compared to beam trawl and traps.

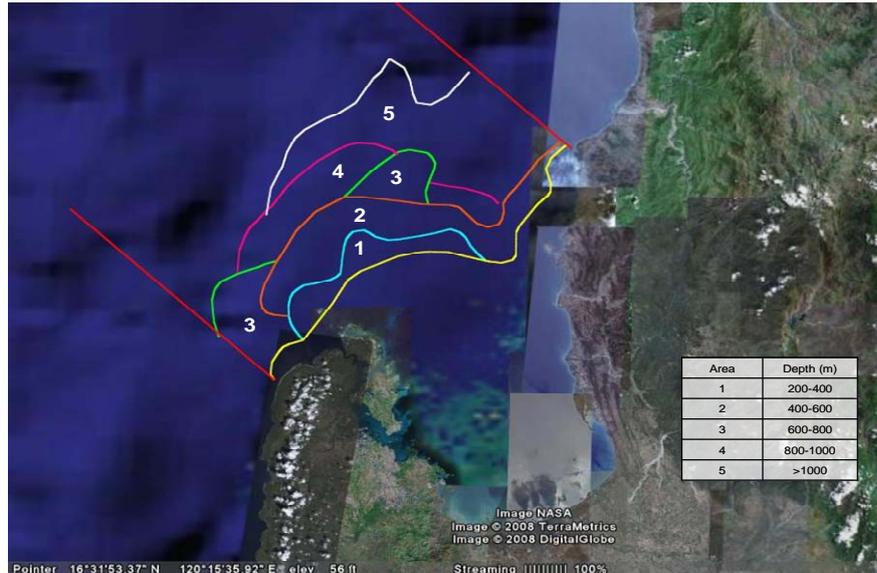


Figure 8. Survey area according to depth ranges.

### Shelled mollusks

At least 64 species belonging to 35 families of shelled mollusks were initially identified from 475 individuals caught by the beam trawl. There are 3 polyplacophorans, at least 43 gastropods, 5 scaphopods, and 13 bivalves. Gastropods were over 67% of total species composition and 70% of total count of specimens. Most of them were recorded alive, but few in worn shells. Gastropods were comprised of 6 species in 2 families of vetigastropods, 7 species in 5 families of sorbeoconchs, over 30 species in 11 families on neogastropods, and 2 heterobranchs. Vetigastropod families have rhipidoglossate radula, and usually herbivore or grazer in shallow water, but detritus feeder or grazing bacteria mat or organic matter derived from such as sunken woods (e.g. *Fissurella* sp.) in deep sea. Sorbeoconch species are usually filter feeder (e.g. *Capulus* sp.) or carnivore (e.g. *Natica* sp.). It was known naticid fed other mollusks, and cassid fed echinoderms. Neogastropoda is a divergent group, and mainly carnivore. No species of herbivore-dominant group such as turbinids, haliotids occurred.

Most abundant family in count is Turridae which was 71% of the total gastropods. Xenophoridae and Fascioliariidae were at 5% each. It seemed that there was a large gap of biomass among these families. Turridae also showed highest species diversity among gastropods, over 15 species were recorded including unidentified species. Turridae is considered to be an active hunter with toxoglossate radula, which whole swallowing feeding habitat is adaptive for soft sediment deep sea bottom.

Summarized by vertical distribution, species diversity was highest around 500 m, mollusca fauna shifts around 600 m. Especially in *Xenophora* and *Fusinus* species, the distribution was limited shallower than 600 m. It was surmised that for estimating the species diversity there was a bias of fishing gear selectivity for large sized (e.g., Buccinidae spp.) and micro-species, as fishing target and majority of deep sea floor, respectively. Species identification was not finished onboard. It is necessary that further study on detailed taxonomy be undertaken.

### Other Invertebrates

Invertebrates collected from Lingayen Gulf using Beam Trawl, Deep-Sea Trap, and Otter Trawl were categorized into four groups: Echinoderms (sea cucumber, sea urchin, sea feathers, brittle stars and sea stars), Anthozoans (soft corals, hard corals and sea anemones), Sponges, and Other Invertebrates (Annelids, other Cnidarians, and sea grasses were also included in this group).

The organisms collected were sorted, photographed, and recorded. A total of 2,861 lots of invertebrates were gathered from the survey. Echinoderms dominated (1,540 pieces) the collection followed by Sponges (511 pieces), Anthozoans (505 pieces), and other invertebrates (305 pieces). Among the gears used, Beam Trawl has the most abundant and diverse group of invertebrates

collected. Anthozoans and Sponges were not present in the deep-sea trap collection since most in these groups are not mobile.

The abundance of organisms were also evaluated into two levels of depth strata which are <500 m and >500 m. The result showed that invertebrates (Echinoderms, Sponges, and other invertebrates) collected were abundant at <500 m. Anthozoans group however were found high at >500 m.

## 5. SUMMARY

The deep sea exploratory survey of the continental slopes of Lingayen Gulf covered a total of 15 sampling operations consisting of 11 beam trawls, 3 deep-sea traps and 1 otter trawl operation. The activities were badly hampered by typhoon Cosme, reducing the accomplished stations (target: 11 beam, 4 traps and 6 otter trawl). Four oceanographic stations were also not pursued due to lost platform and rough weather that restricted safe deployment of oceanographic equipment.

Beam trawl catch samples indicated high diversity, however fish and shrimp catch are possibly biased considering the low vertical opening and slow towing speed of the gear. Increasing the size of the shoes to increase vertical opening and increasing the towing speed should be considered in future surveys.

The survey confirmed the prevalence of pandalid shrimp species in deep sea areas particularly 400-600 m and that their distribution beyond 800 m deep maybe limited. The pandalid shrimps can be considered as the most promising for developing a deep sea based fisheries. However, the vulnerability of deep-sea species to overexploitation should be taken into account so that an in-depth feasibility study and stock assessment are necessary prior to opening the fishery to fishermen. As a start, a pilot operation of traps could be implemented to further evaluate the extent of the resource and develop its utilization and markets. Current trap design should also be modified to include introduction of cover to improve efficiency.

The current bottom trawl net of MV DA-BFAR has limited application for deep sea surveys. Besides restrictions due to present buoy capacity for deployment beyond 600m, its large size makes it susceptible to snags and damage when operated on narrow flat bottom strips that are expected in continental slope areas. Since the bottom trawl is still considered the best sampling gear for demersal fisheries assessment, a smaller shrimp trawl net towed by one cable wire is recommended in future surveys.

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## **Fishing Trial on Deepwater Trawl during the Workshop on the Deep Sea Fishery Resources Exploration on the Continental Slopes in the Lingayen Gulf, the Philippines during 11-25 May 2008**

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### **1. INTRODUCTION**

Regarding the ASEAN-SEAFDEC Program on the Deep Sea Fisheries Resources Exploration in the Southeast Asian Waters for 2008 was endorsed in the 30th SEAFDEC Program Committee Meeting at Iloilo, Philippines last November 25 to December 1, 2007 (SEAFDEC, 2008). The purpose of which is to encourage member countries in conducting deep sea fishery resources survey in their respective EEZ and investigate its status to determine the potential deep sea fisheries resources existing in the Region. SEAFDEC/TD in corporation with the Bureau of Fisheries and Aquatic Resources (BFAR) agreed to conduct Shipboard Training on Deep Sea Fisheries Resources Research and Survey on board National Vessel, M/V DA-BFAR to be attended by the representatives from the SEAFDEC member countries. This paper presents the information on the results of the bottom trawl survey and the topographic survey aboard M/V DA-BFAR from 11 to 25 May 2008.

### **2. MATERIALS AND METHODS**

The deep-sea fauna around Lingayen Bay was collected by otter trawl conducted by M/V DA-BFAR. From a total of 14 fishing operations (11 beam trawl operations and 3 deep-sea traps) one operation of otter trawl was made. The net was towed for 30 minutes on the bottom at depth between 358 and 882 meter.

After net hauling, all of the samples were sorted and identified to the lowest taxonomic level as possible. In the laboratory aboard M/V DA-BFAR, the size and weigh, of fish was measured and recorded. Specimens were photography and fixed in 10% formalin. The specimens obtained in this survey and used for taxonomic study was deposited at DA-BFAR.

The literature sources for deep-sea fishes (occur at waters deeper than 200 m) identification was followed Carpenter and Niem (1998, 1999, and 2001), Matsui and Rosenblatt (1984), and the report of Japan-Indonesia Deep Sea Fishery Resources Joint Exploration Project (2006).

The sea floor mapping was conducted using the color video sounder (Furuno FCV-292) equipped aboard M/V DA-BFAR. The depth and position were recorded every one minute before the trawl operation to obtain the seafloor bathymetry and a transect lines during the trawl operation.

### **3. RESULTS**

#### **Seafloor mapping**

Lingayen Gulf is located on the northwestern Luzon of the Philippines (Figure 1). The bay is shallow as the continental shelf extends from 30 to 35 nautical miles from the shore to the outer part of the bay. At the survey area, just out side of the bay, is rather gentle with depths of 300-400 m and surrounded by the isobath of 500 m before falling to the deepest isobath of 1,000 m of the topographic survey.

The survey track of otter trawl in the present study was shown in Figure 2. The otter trawl start conducted at latitude 16° 40.8' N, longitude 120° 09.8' E and finished at latitude 16° 41.5' N, longitude 120° 01.3'E. According to the irregular substrate as shown in Figure 3, the trawl net was damaged beyond repair. Besides, work was limited to several stations in the present survey. Although nine operations of the otter trawl survey was planned to conduct, most of the operations were cancelled due to the approach of typhoon COSME (HALONG).

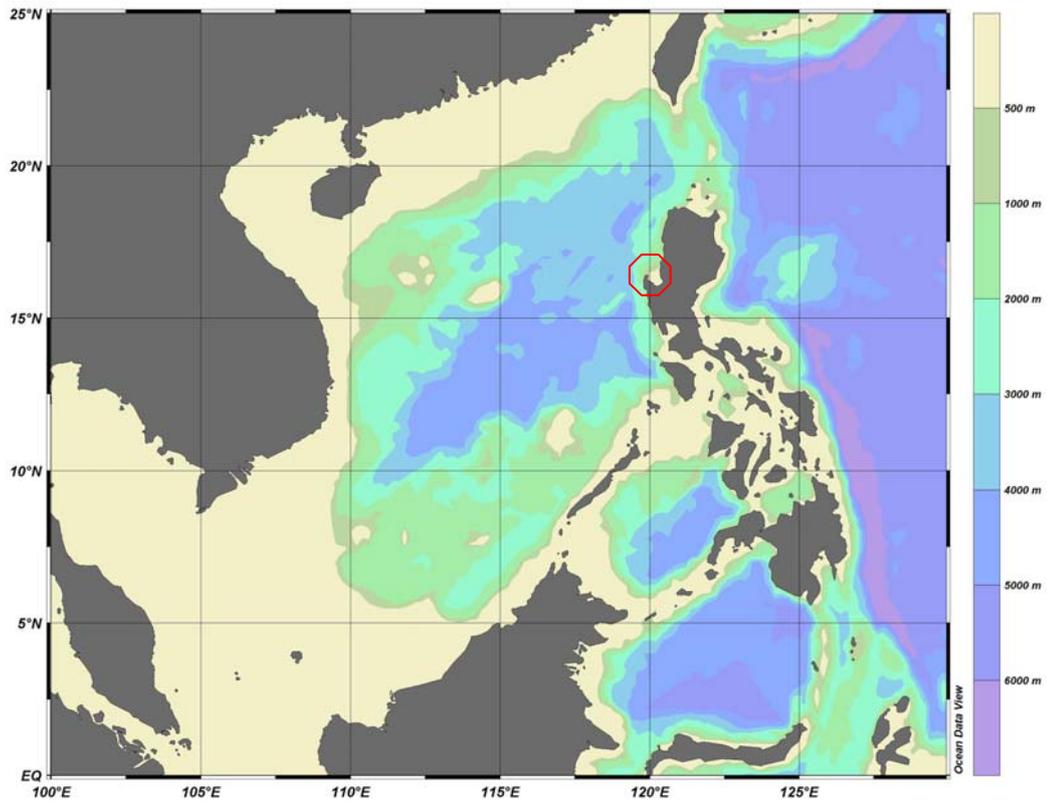


Figure 1. Map of the study area at Lingayen Gulf, the Philippines.

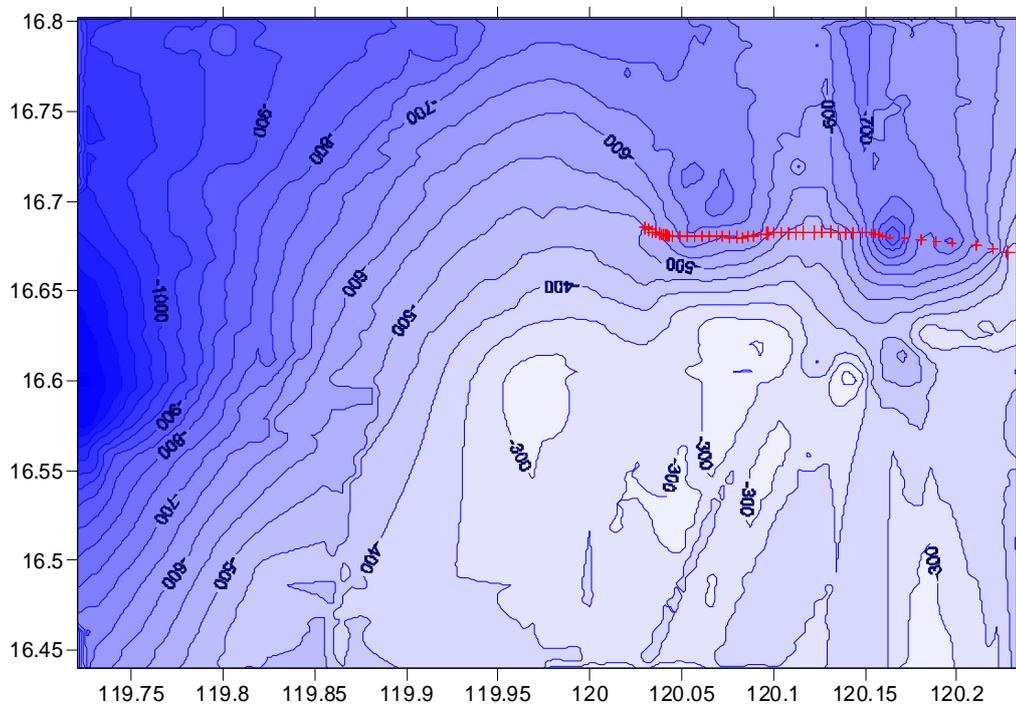


Figure 2. Sea floor topography at Lingayen Gulf and survey track of otter trawl.

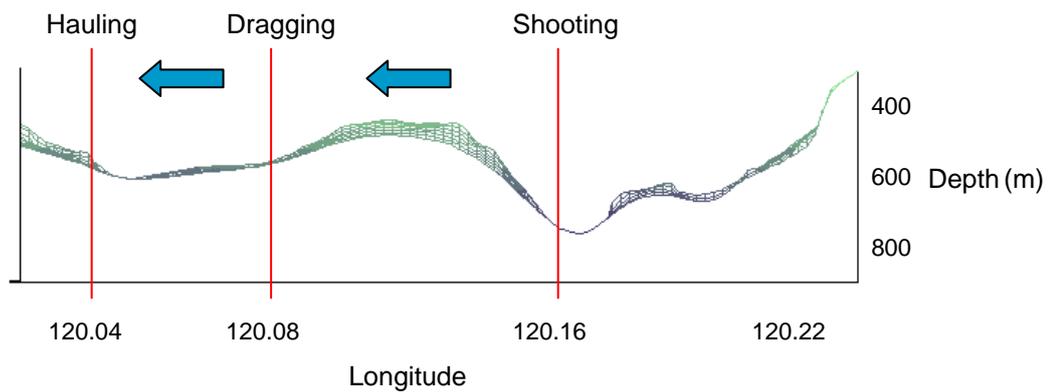


Figure 3. The transaction of survey track of otter trawl in the Lingayen Gulf.

### Species list

A total of 36 fish specimens collected from a single otter trawl station were identified into 22 species from 17 families as follows;

#### Order Anguilliformes

##### Family Congridae

*Leptocephalus* larva sp.

##### Family Nemichthyidae

*Nemichthys* sp.1

#### Order Ateleopodiformes

##### Family Ateleopodidae

*Ateleopus* sp.

#### Order Gadiformes

##### Family Macrouridae

Macrouridae sp.16

*Caelorinchus* sp. 4

#### Order Lampridiformes

##### Family Trachipteridae

Trachipteridae sp.

#### Order Lophiiformes

##### Family Ogcocephalidae

*Halieutopsis* sp.1

#### Order Myctophiformes

##### Family Myctophidae

*Lampanyctus* sp.1

#### Order Ophidiiformes

##### Family Ophidiidae

Ophidiidae sp.1

## Order Perciformes

## Family Epigonidae

*Epigonus atherinoides*

## Family A

Unidentified

## Family Nomeidae

*Cubiceps* sp.

## Family Trichiuridae

*Benthodesmus tenuis*

## Order Squaliformes

## Family Squalidae

*Deania quadrispinosa*

Squalidae sp.

## Order Stomiiformes

## Family Chauliodontidae

*Chauliodus* sp.

## Family Gonostomatidae

*Gonostoma* sp.

## Family Idiacanthidae

Idiacanthidae sp.

## Family Malacostidae

Malacostidae sp.1

Malacostidae sp.2

Malacostidae sp.3

Six species from 5 families of cephalopods was identified from 12 specimens as follows;

## Class Cephalopoda

## Order Teuthida

## Family Ctenopterygidae

*Ctenopteryx sicula*

## Family Histioteuthidae

*Histioteuthis meleagroteuthis*

## Family Octopoteuthidae

*Octopoteuthis* sp.

## Family Ommastrephidae

*Ornithoteuthis volatilis**Sthenoteuthis eualaniensis*

## Family Pyroteuthidae

*Pyroteuthis* sp.

There were other benthic invertebrate consisting of 7 individuals of crustacean, 8 individuals of echinoderm, 2 individuals of porifera, and 26 individuals of tunicate. The list of specimens collected as follows;

Subphylum Crustacia

Class Malacostraca

Order: Decapoda

Suborder: Dendrobranchia

Family Solenoceridae

*Solanocera* sp.

Suborder Pleocyemata

Family Goneplacidae

Family Pandalidae

*Heterocarpus hayashii*

Pandalidae sp.1

Family Palinuridae

Panulirus sp.

Family Polychelidae

Polychelidae sp.

Phylum Echinodermata

Subphylum Asterozoa

Class: Ophiuroidea

Brittle stars (Ophiuroid)

Subphylum Echinozoa

Class: Echinozoidea

Sea urchins (Echinoid)

Class: Holothuroidea

Sea cucumbers (Holothuria)

Phylum Porifera

Sponges

Phylum Chordata

Tunicate

As mentioned in this report, the only otter trawl operation was not successful due to the damaged net, it should be note that the numbers of all collections as well as the specimen photos of all species obtained from otter trawl operation will not represented of the total catches of this survey station.

#### 4. ACKNOWLEDGEMENTS

The authors wish to thanks to the captain and crews of the M/V DA-BFAR for their help during the surveys. We also acknowledge the support of the Fisheries Agency of Japan (Japanese Trust Fund) for funding this project.

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# **Appendix: Photos of the Survey**

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1) The M/V DA-BFAR of the Philippines



2) Beam Trawl



3) Otter Trawl



4) Deep-Sea Trap



5) Fish baits used for deep-sea trap



6) Sample collecting from deep-sea trap



7) Catches from beam trawl



8) Specimens sorted on deck



9) (Left) Dr. Kotaro and Ms. Servidad working on the mollusks specimens; (Right) a deep-sea squid (*Mastigoteuthis cordformis*) weighing more than 3 kg caught by beam trawl at 722-922 meter deep.



10a)



10b)



10c)

10a), 10b), and 10c) A tub full of sponges (10a), and diverse invertebrates (10b) from beam trawl operations while Ms. Jenny and Ms. Neth of invertebrates group preserve their specimens (10c).



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