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Efficiency of deep sea traps in catching Pandalid shrimps along continental slopes and seamounts in Northeast and West Philippine Sea.

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ABSTRACT
Deep sea trap exploratory fishing was conducted in the continental slopes and seamounts in the waters of Bataan, Batangas, and approaches of Manila Bay, Zambales, Ilocos and Polillo Island.
This study examines the efficiency of various designs of traps, fishing depths and fishing grounds in catching deep sea shrimps. Data covered sixteen (16) trap stations with depths ranging from 69 to 800 meters. An analysis was made on catch rates, species composition, catch variation by trap design, fishing depth and fishing ground.
In terms of catch composition, deep sea shrimp comprises 54% of total catch having *Heterocarpus dorsalis* as dominant deep sea shrimp catch. Partially covered traps significantly have a higher shrimp catch compared to other traps and deep sea traps were most effective at fishing depths ranging from 301-600 meters.

Keywords: Pandalid shrimp, deep sea shrimp, traps.

1. Introduction

Fishing is considered as the oldest and most common source of income to Filipinos [1]. It varies from simple to more complicated and efficient types to catch the fish and fishery resources. Trawl catches shrimp at the greater part of the world, both shallow and deep water. Most of the potential fishing grounds consist of uneven or sloping bottoms unsuitable for trawling and fishing, which can best be fished with traps [2].

Many fisheries in the Philippines are faced with declining resources, especially in traditional inshore and near shore areas, necessitating to introduce actions like reducing fishing capacity and other measures including options for alternative fishing grounds, resources or other livelihoods. The optimum utilization of offshore and deep-sea areas, particularly in non-traditional fishing areas are mandated under R.A. 8550 (Philippine Fisheries Code of 1998) to ensure the optimum utilization of offshore and deep-sea resources. It is in this light that the Bureau of Fisheries and Aquatic Resources (BFAR) through its 1,186 gross tonnage multi-purpose vessel M/V DA-BFAR to conduct exploratory and assessment survey of available resources in the deep sea areas.

This study was prompted by indications of potential deep sea species, particularly shrimps of Family Pandalidae from earlier cruises. Family Pandalidae is a moderately diverse group within Caridea, with 189 species distributed in 23 genera [3]. Deep sea shrimp organisms are mostly epibenthic, with a laterally compressed body, strong abdomen and the antennal scale well developed [4]. Its greatest diversity is in boreal shallow waters, while in tropical regions it is represented mainly by organisms of the cold deep sea waters [4]. Thou this deep sea shrimp species have not introduced yet in the local market of the Philippines,

Hence the objectives of this study is to determine the catch rates, species composition of deep sea trap; determine which among the three trap design is efficient in catching deep sea shrimp; and to determine the distribution of Pandalid shrimp based on depth

2. Materials and Methods: The exploratory fishing using traps was conducted onboard M/V DA-BFAR, the multipurpose vessel of the Bureau.

It is equipped with facilities and electronics needed to carry out deep sea trap fishing. It is a 1,186 gross tonnage vessel with a length of 60 m, 12 m wide and 7m depth from the upper deck.

Fishing surveys covered the continental slopes and seamounts of Bataan, Batangas, Zambales, Ilocos Norte and Polillo waters (Fig. 1). Table 1 indicates the depth where the cage were deployed. A total of sixteen (16) stations were covered during the cruises in 2011 (DY 18), 2012 (DY 20 & 21) and in June 2013 (DY 25). Fishing depths ranged from 69 m to 800 m.

Fig 1: Location of fishing area in Northern and Western Philippines.

Table 1: Stations and corresponding depth range

Station Code	Depth Range (m)
TRA-556	285-293
TRA-558	602-651
TRA-559	780-800
TRA-562	296-330
TRA-564	320-564
TRA-565	235-254
TRA-567	280-298
TRA-569	567-593
TRA-571	609-770
TRA-573	69-70
TRA-618	407-555
TRA-623	439-480
TRA-624	607-653
TRA-626	353-490
TRA-628	320-529
TRA-662	424-553

2.1 Trap Designs and Fishing Techniques

Traps used in the surveys were cylindrical in shape and constructed with a metal frame enclosed with polyethylene screen. It measured 30 cm in diameter and 60 cm long. Both ends were provided with funnel valve for easy entrance, but difficult exit. Each unit was baited with chopped fish to attract shrimps. Each trap was provided with a 2 m long branch line that was attached to a mainline using snap clip at 30 m interval.

There were three varieties of gear prepared for this experiment based on the use of V-net as trap cover. The three (3) variations were the fully-covered (body and funnel), partially covered (body only) and uncovered.

Depth sounder was used in determining desired depths. After establishing the trapping site, the vessel set 29-45 baited trap variations alternately and soaked for 8-12 hours.

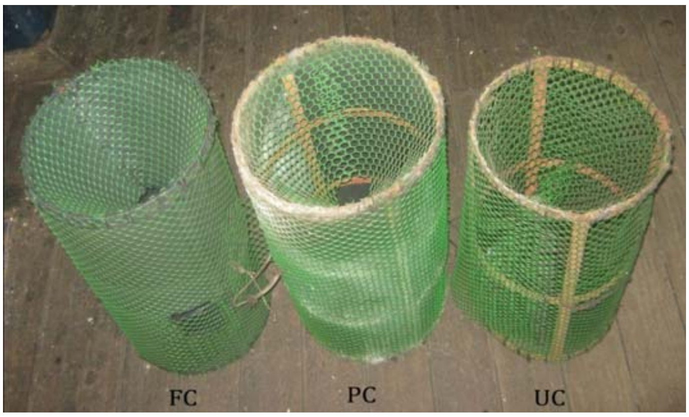

Fig 2: Trap variations: fully covered (FC), partially covered (PC) and uncovered (UC)

2.2 Sampling and Data Analysis

The traps were emptied by inverting the funnel and pouring the catch on the sorting table. The catch was grouped into species, and was recorded. These activities were done for every fishing set/operation.

Catch per unit effort (CPUE) was computed as weight of the catch in gram per trap (g/trap). The data were processed on MS Excel and catch variations by trap variation, depth class and fishing ground were done using STATISTICA 7 software (One-Way ANOVA, Post hoc/LSD).

3. Results and discussions

3. 1 Total Catch

Total catch from all stations was 124.9 kgs (7.88 kgs/set) with a mean catch rate of 191 g/trap. The catch was comprised of 54% deep-sea shrimps, 36% fish, 7% crabs, 2% isopods and 1% of other species. Commonly caught fish groups were hagfishes (Myxinidae) and swell sharks (Scyliorhinidae) in deeper areas and cardinal fishes (Apogonidae) in shallower stations. Crabs belonging to genus *Homola, Charybdis, Pulcratis, Goneplax, Kandalin, Nepinnotheres, Carcinoplax* and some unidentified species of deep-sea crabs were also commonly caught. On the other hand, deep sea shrimps were all of family Pandalidae.

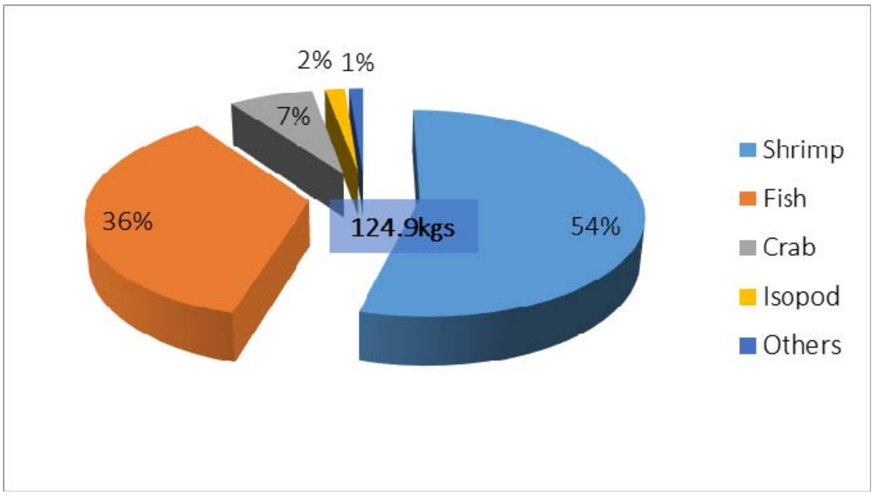

Fig 3: Species Composition of deep sea traps catch.

Deep sea traps used in this experiment were designed to catch Pandalid shrimps. The designed traps were effective in catching the target species based on the dominance (54%) of Pandalid shrimp caught using these traps. Presence of some pelagic fishes and sharks in the total catch maybe accounted to the feeding behavior and migratory pattern of this fish [5, 6].

3.2 Deep Sea Shrimps Catch Composition

Total shrimp catch was 67.9 kgs (4.2 kg/set) or CPUE of 101 g/trap. The catch was highly variable depending on the depth and fishing ground that ranged from negative catch at <100 m in Mariveles, Bataan to 16.3 kg/set at 400-600 m in Polillo Island. Correspondingly the CPUE ranged from 0 g/trap to 562 g/trap.

Shrimp catch was generally comprised of two genera - *Heterocarpus* and *Plesionika*, comprising of 31% *Heterocarpus dorsalis*, 25% *H. hyashii*, 24% *H. sibogae*, 14% *H. gibbosus*, 5% *H. laevigatus* and 1% *Plesionika edwardsii*.

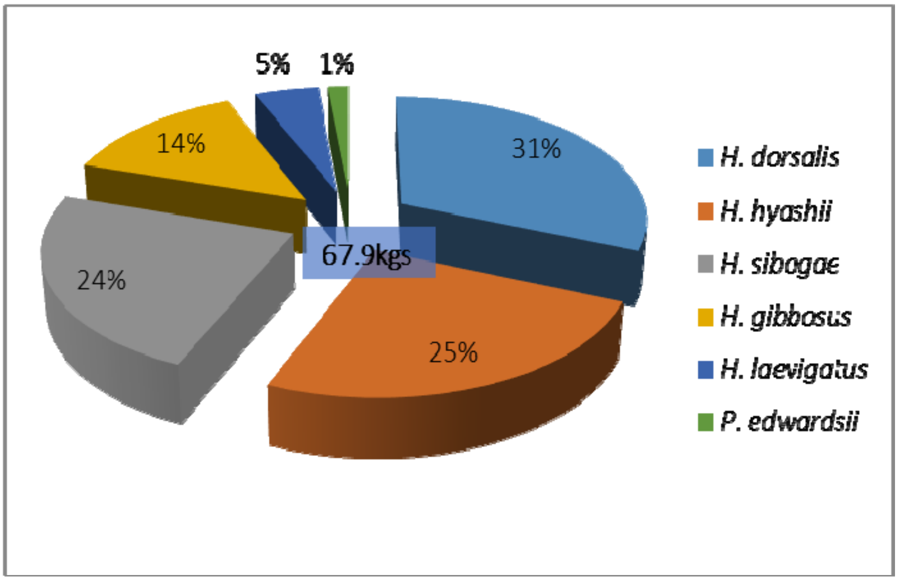

Fig 4: Deep sea shrimp composition.

This study shows the different species of deep sea shrimp that is present in the Philippines. Previous study on deep sea shrimp catch in Hawaii, islands in the Pacific and also islands near Indian Ocean using variety of gears were already conducted [5]. Variation in gear used during deep sea fishing [7], availability of prey for shrimp [8] and also the geographical location, including water depth [9] are the factors responsible for the variation of species of deep sea shrimp caught in every country.

The genus *Heterocarpus* includes about 30 species [10], that can be found in all tropical and some temperate deep seas, in depths varying from 73 to 2.834 m [9]. The adults are benthic, being caught in greatest abundance by bottom traps and bottom trawls, while juveniles and larvae are often caught in the water column [11]. *Heterocarpus* sp. except *H. laevigatus* were present in water column being captured mainly by mid-water trawls [12].

Common species of *Heterocarpus* in Indian Ocean and Pacific Island is *H. sibogae, H. gibbosus* and *H. laevigatus* [5]. In this study, *H. dorsalis* (31%) had the high catch composition among sp. followed by *H. hyashii* (25%) and *H. sibogae* (24%). Species of deep sea shrimp can be found in varying water column like *H. dorsalis* that can be found in the Tropical zone and are distributed around the world in the Indo-Pacific: East Africa to the Pacific and is commonly found in depth

range 185 – 1400 m [13].

H. gibbosus had higher catch of 14% compared to *H. laevigatus* (5%). Based on orevious study, *H. laevigatus* usually have the high catch compared to *H. gibbosus* [5]. The difference has something to do with the depth of water and nature of shrimp species to move between different water depths. There is some evidence that deep water shrimps move between different depths on the outer reef slopes. This behavior of deep sea shrimp was evident for *Heterocarpus gibbosus* in Fiji that appears to move between depths of about 450 m to 550 m seasonally and in Hawaii, *Heterocarpus laevigatus* migrates from depths of about 550 m to 700 m during the egg bearing season [14]. To add with, deep sea shrimp has the tendency to move in different water column during the night and feeding time to feed for their desired food [8].

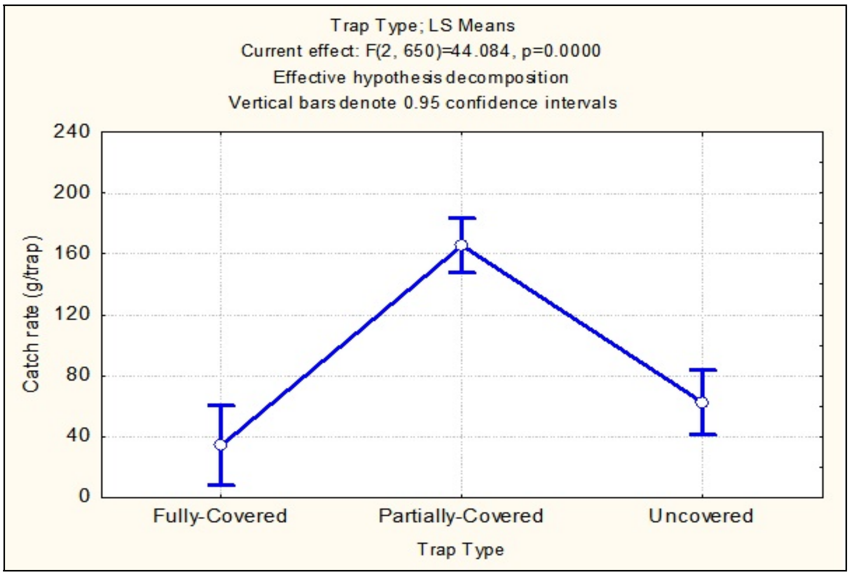

Fig 5: Mean catch (g/trap) of deep sea traps in all stations.

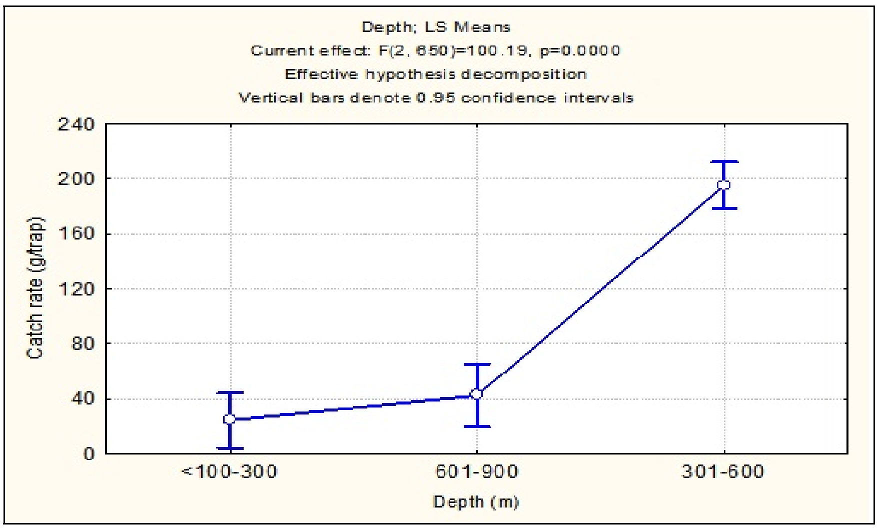

Fig 6: Mean catch of shrimps by depth.

3.3 Catch Variation by Gear Design
Statistics showed that there is a significant difference ($p<0.05$) for trap variation and catch of *Pandalid* shrimps. The average shrimp catch between trap variations was significantly different ($p<0.05$), with partially covered trap indicating higher catcher rate of 165 g/trap compared to fully covered (34g/trap) and uncovered (62 g/trap) (Fig. 5).

Experiment on uncovered traps and traps covered with burlap and found that the catch rate of the covered traps was 2.5-10 times greater [16]. Increased in catch was because by covering the traps (except the ends) has the effect of concentrating the bait odor through the entrance funnel and directing the shrimp into the trap. In the partially covered trap used in this experiment, the cover net may well add efficiency in its shading and leading smell of bait in the entrance/funnel. In contrast, fully-covered traps may have reduced the efficiency which can be attributed to restricted vent for bait smell.

Escapes from traps decrease as the volume of the trap increases and it is likely that square design traps has better catch than conical and triangular shapes traps [17].

3.4 Catch Variations by Depth
Depth significantly affect the catch of deep sea shrimp. Statistic showed relationship to catch rates of deep sea shrimps with depth, with average catch rate significantly higher in depths >300 to 600 m (195 g/trap). At depth of <300 m catch rate reached 24 g/traps and increasing depth >600 reduced the catch to 42 g/respectively (Fig. 6).

Deep sea survey with regards to the distribution of *Heterocarpus* sp. in Indian Ocean and Pacific Island was carried out [14]. Based on the result of their study, *H. sibogae, H. gibbosus* and *H. laevigatus* is commonly found in depth range of 400 m to 700 m. *H. laevigatus*, in New Caledonia best catches have been obtained in the 800 m zone but in Hawaii [18, 19], it was most abundant between 440 and 680 m and in Fiji and the New Hebrides it occurred in depths greater than 470m and became increasingly abundant down to 570 m, which was the maximum depth fished [16]. With regards to depth, results of previous studies correlates with the *Heterocarpus* sp. catch in this study.

3.5 Catch Variation by Fishing Ground
Polillo Island had significantly higher catch at 562 g/trap compared to other sites including ten stations in the approaches of Manila Bay with a mean catch rate of 57 g/trap which was closely similar to 131 g/trap in five stations of Ilocos Norte and Zambales (Fig. 7).

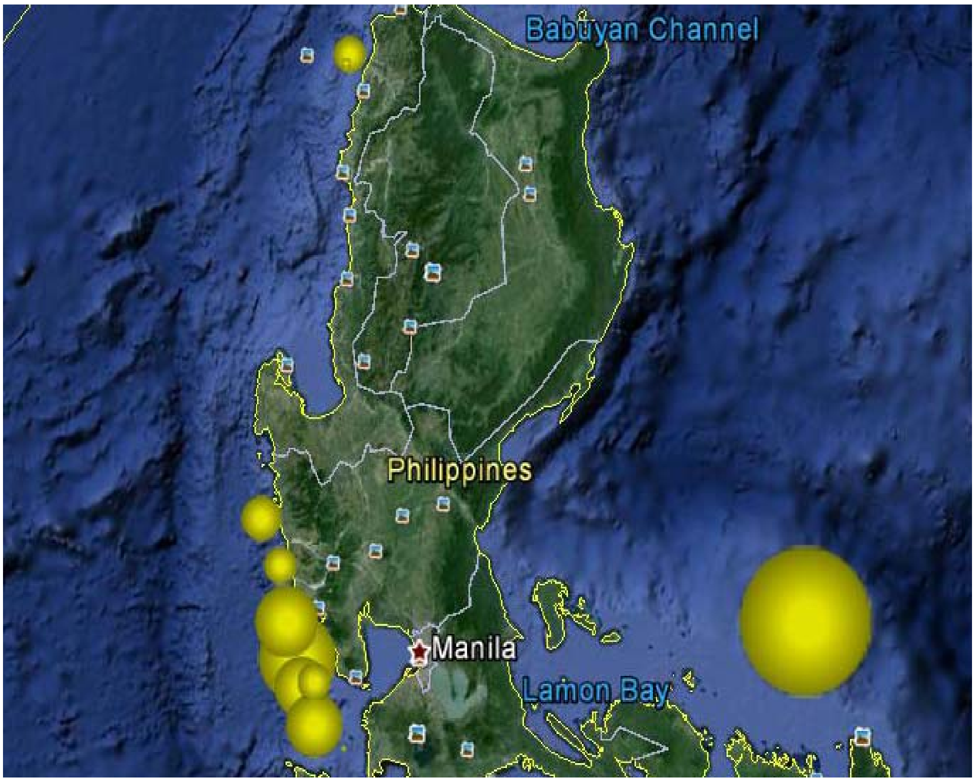

Fig 7: Catch rates of all stations

Water near Polillo Island is said to be in good condition compared to other sites like approaches of Manila Bay, Ilocos Norte and Zambales. In 2009, Tuna and other Scrombrid larvae distribution and density in Polillo Island reaches 44 larvae/1000^m^{3}seawater [6]. Tuna and Scrombrid are deep sea fish and there are possibilities that the abundance in catch of deep sea shrimp in area of Polillo Island is due to the presence of fish larvae that serves as a food for adult deep sea shrimp.

4. Conclusions
Deep sea exploratory fishing using traps provided the opportunity to collect information of inhabitants and their distribution in continental slopes and seamounts with interest to fisheries. Deep sea shrimps were among the promising fishery resources that can be an alternative to the declining fisheries especially from in nearshore areas. Information on catch composition, catch rate and their variations according to gear type and fishing ground depth provided baseline

information (i.e. appropriate gear/designs, fishing depths and potential fishing grounds as well as in the formulation of a National Deep Sea Fisheries Management Plan) that governs the fisheries in deep sea areas [19].

5. Recommendation

It is recommended that other useful information to collect for the future study would be the type of bottom and the water characteristics (such as temperature) where shrimps are most abundant and the factors affecting catch of deep sea traps.

As an initial step, a pilot project to determine viability of a fishery based on the recommended designs and fishing depths and areas should be considered. Further surveys of other areas and further studies on trap designs (shapes, sizes and number of funnels, etc.) should be conducted in conjunction with other activities of M/V DA-BFAR.

With regards to management of deep sea fishery, we need to realized that as the depth of the fishery increases, the number of low productivity species encountered increases [20]. This indicate that Pandalid shrimp might be slow growing, have low natural mortality, potentially have intermittent recruitment of successful year classes and may not spawn every year making them vulnerable to rapid resource depletion. Thus, there is need to manage deep sea fishing of this organism.

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