Viability of Traps for Efficient Utilization of Deep-sea Shrimp Resources in Philippine Waters

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Deep-sea trap exploratory fishing operations were conducted in the continental slopes and seamounts in the waters off Bataan and Batangas, and approaches of Manila Bay, such as in Zambales and Ilocos Provinces, and Polillo Island, in the Philippines from 2011 to 2013, under the project of the Philippine Bureau of Fisheries and Aquatic Resources (BFAR) on optimum utilization of fishery resources in the exclusive economic zone (EEZ) of the Philippines. The exploratory trap fishing operations examined the efficiency of various designs of traps, fishing depths and fishing grounds for catching deep-sea shrimps through exploratory fishing operations in sixteen (16) trap stations with depths ranging from 69 to 800 meters. The findings which included catch rates, species and size composition, catch variation by trap design, fishing depth and fishing ground, could serve as basis for recommending the most appropriate trap designs and fishing depths for catching deep-sea Pandalid shrimps as well as for formulating management plan for deep-sea fisheries taking into account the need to ensure that the ecosystem is not adversely affected during deep-sea fishing operations.

Optimum utilization of offshore and deep-sea resources in Philippine waters, more particularly in non-traditional fishing grounds is embodied in Philippine R.A. 8550 or what is known as the Philippine Fisheries Code of 1998. It is in this light that the Bureau of Fisheries and Aquatic Resources (BFAR) through the use of its 1186 gross tonnage multi-purpose vessel, the M.V. DA-BFAR has been conducting exploratory and assessment surveys of available resources in the country's deep-sea areas starting in 2008. Results from previous cruise surveys in the continental slopes of western Luzon in the Philippines indicated the presence of potential deep-sea species, particularly deep-sea shrimps belonging to the Family *Pandalidae* (Nepomuceno *et al*., 2013). Consequently, it has become necessary to develop efficient methods of catching these shrimps to ensure that the ecosystem is not adversely affected or at the least, certain effects of the fisheries could be minimized. Nepomuceno *et al*. (2013) also observed that the catch rate of Pandalid shrimps could have been influenced by the zonation behavior of the species aggregating in the western seas of the Philippines (De la Cruz *et al*., 2014), as well as the optimum depth of deployment of the traps which should be around 400-500 m. Considering therefore that Pandalid shrimps has great potential for fisheries development, there is a need to develop appropriate and concrete framework in order that this resource is sustainably managed.

Exploratory Trap Fishing Operations by BFAR

The aforementioned scenario has prompted BFAR to conduct a subsequent cruise survey using the M.V. DA-BFAR to conduct exploratory fishing operations using traps in the continental slopes and seamounts off Bataan, Batangas, Zambales, Ilocos Norte and Polillo waters (**Fig. 1**). Utilizing sixteen (16) stations with depths that range from 69 to 800 m (**Table 1**), the exploratory trap fishing operations made use of traps with three varying designs.

The deep-sea traps used are passive gears and had been designed to catch species that are attracted to baits like the Pandalid shrimps. Nepomuceno *et al*. (2014) reported that traps are considered the most suitable gear to harvest the deep-sea shrimp resource. The traps which are cylindrical in shape and constructed with metal frame enclosed with polyethylene screen, had therefore been used in the current exploratory trap fishing operations that mainly aimed to determine the catch rate, species and size composition of the deep-sea trap fisheries. It is expected that this environment-friendly trap fisheries could be promoted as means of addressing the concern on the sustainable utilization of offshore and deep-sea resources.

Fig. 1. Locations of the trap fishing stations in north-western Philippines

Table 1. Fish trapping stations with corresponding depth ranges

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	69-070
TRA-618	407-555
TRA-623	439-480
TRA-624	607-653
TRA-626	353-490
TRA-628	320-529
TRA-662	424-553

Measuring 30 cm in diameter and 60 cm long, the traps have both ends provided with funnel valve for easy entrance but difficult exit, as well as with a 2 m long branch-line attached to a mainline using snap clip at 30 m interval, and baited with chopped fish to attract shrimps. Three variations of the traps had been adopted with the use of V-net as trap cover, *i.e.*: FC or fully-covered (body and funnel), PC or partially covered (body only), and UC or uncovered trap (**Fig. 2**). Depth sounder was used to determine the desired depths and types of substrates. After establishing the trapping sites, 29-45 sets of baited trap variations were dropped alternately and soaked for 8-12 hours.

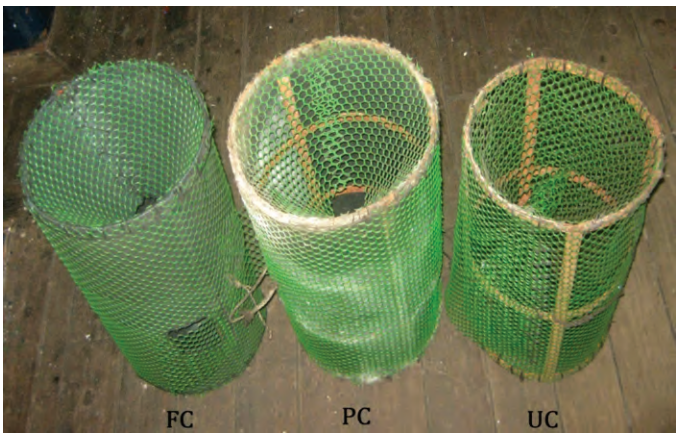

Fig. 2. Variations of traps used: fully covered (FC), partially covered (PC) and uncovered (UC)

Results and Discussion

After each fishing operation, the traps were emptied of the catch, and then classified by species, counted, measured, weighed, and recorded. Catch per unit effort (CPUE) was computed as weight of catch in grams per trap (g/trap). The trap exploratory fishing operations in all stations resulted in the total catch of 124.9 kg or 7.88 kg/set with mean catch rate of 191 g/trap. The total catch comprised 36% fish, 54% deep-sea shrimps, 7% crabs, 2% isopods, and 1% other specie (**Fig. 3**). The most commonly caught fish were the 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 caught. The deep-sea shrimps all belonged to the family *Pandalidae*.

Of the total catch of 124.9 kg, 67.9 kg were deep-sea shrimps (4.2 kg/set) with CPUE of 101 g/trap. Nevertheless, the catch was highly variable depending on the depth and fishing ground, giving negative catch at <100 m in Mariveles, Bataan to 16.3 kg/set at 400-600 m in Polillo Island. Thus, the CPUE ranged from 0 g/trap to 562 g/trap. As shown in **Fig. 4**, the deep-sea shrimp caught belong to two genera: *Heterocarpus* and *Plesionika* which had been classified as *Heterocarpus dorsalis* (31%), *H. hyashii* (25%), *H. sibogae* (24%), *H. gibbosus* (14%), *H. laevigatus* (5%), and *Plesionika edwardsii* (1%).

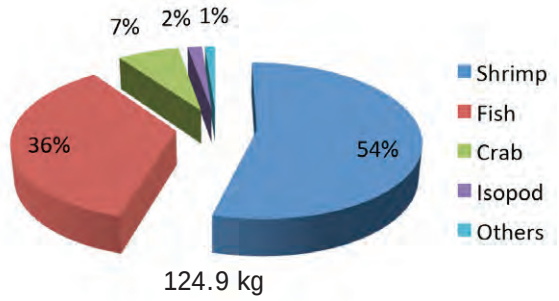

Fig. 3. Composition of deep-sea catch using traps

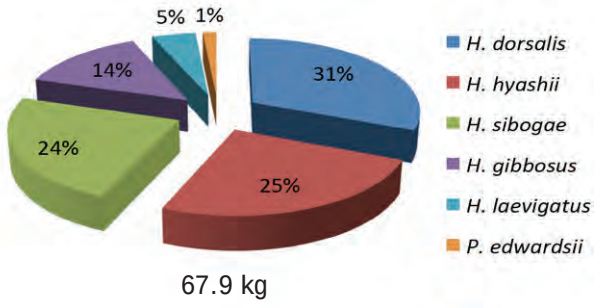

Fig. 4. Species classification of deep-sea shrimp catch using traps

The results also showed that variations of the traps in terms of design, the locations and depths of the fishing ground affected the catch of Pandalid shrimps. Although 54% of the total catch from the exploratory fishing operations as shown in **Fig. 3**, the average shrimp catch among the three designs of the trap significantly varied with the partially covered trap producing higher catch rate at 165 g/trap than the fully covered traps at 34 g/trap, and uncovered traps at 62 g/trap. The cover net of the partially covered trap may have added to the efficiency of the trap, not only by providing shade to the trap but also leading the shrimps to smell the bait at the entrance of the funnel. For the fully covered trap on the other hand, the efficiency could have been reduced due to the restricted vent for smelling the bait. In addition, the trap also holds much water inside that causes the funnel to flip and spill out some of the catch during hauling. Meanwhile, for the uncovered trap, the smell of the bait comes from all over the trap reducing the chance for the shrimp to get attracted to the funnel entrance.

The catch had also been observed to have varied according to the depth of the fishing ground. Analysis of the relationship of the water depths to the catch rates of deep-sea shrimps indicated that the average catch rate was significantly higher in depths from 300 to 600 m (195 g/trap) compared with the catch at depths less than 300 m and more than 600 m which were at 24 g/trap and 42 g/trap, respectively. In terms of locations of the fishing grounds, the analysis also suggested that the catch rate in five stations in Ilocos Norte and Zambales was 131 g/trap compared with that of the other stations in the approaches of Manila Bay which yielded 57 g/trap (**Fig. 5**). On the other hand, the catch rate in the station off Polillo Island in northeastern Philippines was significantly higher at 562 g/trap. However, the seas around Polillo Island could not be easily accessed especially during inclement weather conditions.

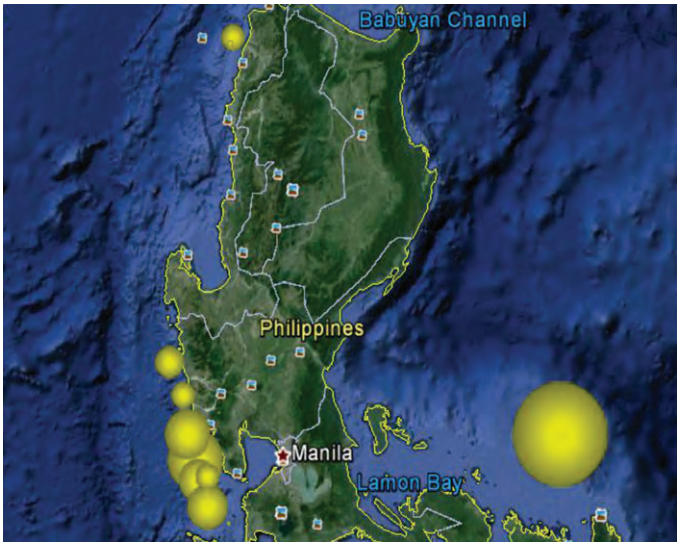

Fig. 5. Catch rate of deep-sea shrimps using traps from all stations

Conclusion and Way Forward

Deep-sea exploratory fishing using traps provided the opportunity to collect information on the species that inhabit the continental slopes and seamounts, and distribution of such species with respect to fisheries. Deep-sea shrimps are among the promising fishery resources that can be an alternative to the declining fisheries especially in the near-shore areas. As established earlier by Nepomuceno *et al*. (2013), deep-sea shrimps of family Pandalidae which has great potential for fisheries development flourish in the continental slopes and seamounts in the north-western part of Philippine Sea. Deep-sea shrimps may be commercially exploited in some Pacific island countries but in the Philippines, the deep-sea shrimp resource is still undeveloped due to inadequacy of the capacity of fisherfolks to explore the high seas and insufficiency of economic information about the species.

The information compiled through this study, especially on catch composition, catch rate and variations according to gear type, location and depth of fishing ground therefore provided baseline information, *i.e*. appropriate gear designs, fishing depths and potential fishing grounds, that could be used as reference in the formulation of the country's National Deep-sea Fisheries Management Plan that would serve as guide for the sustainable development of deep-sea fisheries not only for the Philippines but also for other countries in the Southeast Asian region having similar characteristics as that of the Philippines.

In pursuing further research on this aspect, a pilot project could be considered to determine the viability of the fisheries based on the recommended designs of the gear as well as the depths and locations of the fishing grounds. In this connection, more surveys of other areas and further studies on trap designs, *e.g.* shape, size, number of funnels, would be conducted in the future using the M.V. DA-BFAR and in conjunction with existing national survey program and framework.

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