

Stock Assessment of Christian Crabs (*Charybdis feriatus*, Linnaeus, 1758) in San Miguel Bay

Plutomeo M. Nieves^{a}, Nelson R. Olfindo^b and Aldrin Mel Macale^a*

^a Bicol University Tabaco Campus, Tabaco City, Albay

^b Camarines Norte State University, Mercedes, Camarines Norte
plutz1122@yahoo.com

Abstract

Assessment of the status of swimming crab fisheries in San Miguel Bay with focus on Christian or Crucifix crab, *Charybdis feriatus*, was undertaken from November 2011 to January 2013. An analytical length-based fish stock assessment was employed using the FISAT (version 1.2.2). A total of 7,679 length frequencies (3,612 *C. feriatus* and 4,067 *Portunus pelagicus*) were used in the analysis. About 15 and 14 percent gravid females were harvested monthly for both species that may contribute to recruitment overfishing. Population parameters showed exploitation rate (E) for *P. pelagicus* and *C. feriatus* exceeded the optimum exploitation (E0.5) implying excessive fishing effort and heavily exploited stocks. Size at maturity of *C. feriatus* and *P. pelagicus* in San Miguel Bay is 8.3 cm and 8.5 cm, respectively. Doable options for resources conservation and management strategies are proposed and supported by local government units (LGUs) including the Integrated Fisheries and Aquatic Resource Management Council.

Keywords: stock assessment, San Miguel Bay, resource conservation and management, *Charybdis feriatus*

Introduction

San Miguel Bay (SMB) is a large fishing ground in the southeastern part of Luzon and northeastern part of the Bicol Region along the Pacific Coast. The bay is bounded in the west by the coastal municipalities of Mercedes and Basud of Camarines Norte province and in the southeast, by the coastal province of Camarines Sur with 5 municipalities: Calabanga, Cabusao, Tinambac, Sipocot and Siruma. It is enclosed in the north by an imaginary line drawn from Butauanan Island of Siruma, Camarines Sur to Canimog Island and Poblacion of Mercedes, Camarines Norte (Figure 1).

SMB has a total surface area of 1,115 sq. km. and a coastline length of approximately 240 km. The inner bay and its outer periphery (Mercedes and Siruma area) are consistently and heavily utilized by various fisheries with about 7,033 fishers. This translates to about 1 fisher per 34 m of coastline or 1 fisher per 16 ha of water. About 67 percent of the fishers are from Mercedes, Calabanga and Siruma, 27 percent from Tinambac and Cabusao and the rest from Sipocot and Basud. Thus, fishing is a way of life and human activities associated with aquatic resources are basically fishing and fishing-associated economic activities.



Figure 1. Map of San Miguel Bay (Source: Google Earth).

The fishery in the bay is generally multi-species, and fishers utilize multiple gears predominantly gill-net (32.8%), hook and lines (31.0%), fish traps (7.8%), seine nets (7.8%), squid jiggers (6.7%) and the rest are other gears. Based on post-RSA of SMB gear inventory, there are 6,712 gear units distributed to 33 distinct gear types where 66 percent of these gears are distributed in Siruma, Mercedes and Calabanga, 29 percent in Tinambac and Cabusao and 5 percent in Sipocot and Basud. The 10 most numerous gears include ordinary gill net, crab gill net, shrimp gill net, mini-trawl, fish gill net, hook and line, push net, long line, spear gun and filter nets which account to about 80 percent of the total number of gears in SMB.

Catch composition in SMB consists of more than 250 aquatic species distributed in 70 families; the most diverse are the scads, mackerels, slip mouths, sardines and herrings, and crabs. There is seasonal

variation in catch composition and a large proportion of the catch using trawl is jellyfish. In terms of stock status, 14 of the 17 species caught are exploited below the size at first sexual maturity and 11 species are exploited at sizes below 10 cm. Current estimates of the stock density of demersal fish in the SMB decreased 60 fold since 1947. Similarly, the present stock density is about 11 times less than it was 9 years ago. In terms of the changes in the number of fishing gears used over time, post-RSA result showed an increase by 40 percent between 1980 and 1992 and by 41 percent between 1992 and 2001. The largest increases were recorded for mini-trawlers and gill nets.

For the period 1992-1995, the average municipal production was about 11,103 mt, with baby trawl contributing 9.2 percent. Several assessments (BFAR-FSP, REA SMB) indicate that the Bay is heavily exploited or, even, overfished with catch rates

significantly declining. In Calabanga, the volumes and sizes of major catch showed a decreasing trend particularly in gill net, fish corral and trawl. The main catch composition includes blue crabs, croakers, anchovies, and shrimps. Similar decreasing trend was also noted in Mercedes.

In addition, resource use conflicts are also impacting the fisheries in the SMB. These include: (1) access issues in fisheries and other coastal resource; (2) enforcement issues in fisheries and other coastal resources; (3) conflict between the fishery users (small vs. large scale fishers); (4) conflict between the fishers and other resource users (i.e. tourism vs. conservation vs. industrial development) and (5) conflict between fishers and non-fishery issues (i.e. corruption, politics).

Access issues in fisheries and other coastal resources are clearly defined by the continuously increasing number of fishers and gears. This made the entire bay exploited with an overlap in the use patterns of multiplicity of gears, hence the need for resource enhancement. Destructive fishing methods (i.e. use of fine mesh net, cyanide fishing, and dynamite fishing) and capture of endangered species are among the enforcement issues. Conflict between the fishery users are better explained by the intrusion of other municipal fishers and the incursion of commercial fishers in municipal fishing grounds. Entry of some fishers in Marine Protected Areas (MPA) and the illegal conversion of mangrove areas into brackishwater fishponds are examples of conflicting uses. The rapid development of tourism along the coastal zones and the construction of ports also created conflict of varying degrees. Noteworthy to mention is the observation that in municipalities

bordering SMB, fishers and other stakeholders openly blame corruption and politics as one of the most critical problems associated with conflicts between fishers and non-fishery issues.

Today, fishing in SMB still represents the largest extractive use of aquatic resources with demand exceeding the supply. As a matter of fact, during the “*Strengthening Governance and Sustainability of Small-scale Fisheries Management in the Philippines: An Ecosystem-based Fisheries Management Approach Seminar-workshop*” held in the Agri-Science Village, San Bernardino, Calabanga, Camarines Sur on February 21-22, 2011 and attended by representatives from the seven local government units (LGU’s) bordering SMB, all are in agreement that the system of resource extraction is expected to continue as the population increases in the next ten years and fisheries and aquaculture will be crucial sources of income and livelihood for hundreds of thousands of people in the SMB. The trading and export of high value species like live grouper, wrasses and crustaceans is now considered a lucrative business among fishers because of the booming export market for these species. For instance, Christian crab (*Charybdis feriatius*) is exported mostly in East Asia where it commands a premium price of US\$8 to US\$15/kg. As such, the intensity of fishing for high-value species at all cost has put immense pressure on the wild population which when kept unregulated may lead to over-fishing and resource depletion. Unfortunately, very little work has been carried out to manage the wild stock. Given the unregulated resource extraction coupled by the alarming impacts of climate change, the fate of this species is extremely threatened.

Considering its importance and value, it is imperative that efforts toward the development of resource enhancement measures to sustain an appropriate number of parent stock and/or breeder to maintain its population, is wanting. The Project Christian crab is an attempt to provide solutions or key strategies for resource enhancement to sustain the future of natural stocks. The output derived from the project is expected to provide doable options to enhance natural stocks for sustainable resource conservation and management and possibly the development of aquaculture technology for the species in the future. This will likewise assist decision-makers and planners in the respective LGU's in SMB to formulate management strategies for this highly valuable resource at sustained levels. This in turn would mean long-term fishing livelihood for fishermen. Without proactive moves to domesticate and propagate this crustacean species, Christian crabs will be highly vulnerable and the chance of its wild population to collapse is not far from reality. In addition, the impacts of climate change will put immense pressure, stress and ecological/environmental modification that can threaten the resources systems and their habitat, which in turn might cause species modifications, biodiversity loss and eventual extinction. Acting now to save the species while it is still manageable is an urgent growing need to focus on because of the vital contribution of the fishery to poverty alleviation and food security.

Objectives

The purpose of this project was primarily to assess the status of swimming crab fisheries, particularly *Charybdis feriatus*, Linnaeus, 1758 in the SMB with the hope of helping fishers and LGUs

formulate an implementable crab fishery resource conservation and management strategy. Specifically, the project sought to:

1. Assess the status of Christian crab (*Charybdis feriatus*) fisheries in the SMB in terms of:
 - population structure;
 - growth and mortality by species;
 - fishing gears used;
 - annual production and species composition;
 - catch per unit effort (CPUE) and exploitation rates by species; and
 - existing market and channels of distribution.
2. Develop a sustainable and implementable Christian crab fishery resource conservation and management strategy.

Materials and Methods

Monthly measurements of about 300 specimens per species were conducted using vernier caliper (SE 781BC Stainless Steel, 0.1 cm) from November 2011 to October 2012. Carapace width (CW) was measured as the distance from tip to tip of the last antero-lateral teeth. Carapace length (CL) was measured as the distance from the tip of the frontal teeth to the posterior end of the carapace. Total body weight (TW) was measured using digital weighing scale (Ohaus, Model CL 501T, capacity 500 g x 0.1 g). Almost all length-frequency measures were from landings and market measurements in Tinambac, Calabanga, and Cabusao in Camarines Sur and Mercedes in Camarines Norte.

Descriptive statistics and analysis of length frequencies such as normality test and generation of total length

frequency distributions (histograms with constant class interval) were done using a commercial spreadsheet program. The analytical length-based fish stock assessment was employed using the FAO ICLARM Stock Assessment Tools (version 1.2.2). Several studies were already reported documenting the usage of the method on invertebrates (see Soliman and Dioneda (1998), Ingles and Bkaum (1989) for blue crab and Dineshbabu (2011) for *Charybdis feriatus*). The length-weight relationship was estimated using the equation: $W = aL^b$, where **W** is the weight, **a** is the intercept, **L** is carapace width and **b** is the slope (Pauly, 1983). The value of **a** and **b** were computed from the log transformed values of length and weight. The coefficient of determination (r^2) was used as an indicator of the quality of the linear regression.

Results and Discussion

Population Structure

Three species of swimming crabs were identified as: *Charybdis feriatus*, *Portunus pelagicus*, *Portunus sanguinolentus*. Two mud crab species, namely, *Scylla oceanica* (?), and *Scylla serrata* were also noted. Genus *Thalamita* which are usually collected by gleaners were also observed in stocks sold in the local market. However, the study focused on *Charybdis feriatus* and *Portunus pelagicus*.

A total of 7,679 marine crabs were collected (Figure 2) comprising of 3,612 *C. feriatus* and 4,067 *P. pelagicus* with mean CW of (mean±s.d.) 12.50±2.20 cm and 11.20±3.00 cm, respectively. This result is higher than the maturity size of 8.30 cm and 10.50 cm. However, the capture of 15 percent gravid *C. feriatus* and 14 percent *P.*

pelagicus from the monthly samples could be a factor contributory to recruitment overfishing. This means that the adult population was caught heavily that the number and size of the spawning biomass has been reduced to the point that it will not have the reproductive capacity to replenish the fishery. On the other hand, the mean weight (MW) obtained showed 375±207 grams for *C. feriatus* and 77.6±41.5 grams for *P. pelagicus*.

Regression equations for the carapace width-weight relationship of *P. pelagicus* and *C. feriatus* revealed high correlation (Table 2). The exponent 'b' value estimated for these species were below 3 indicating the allometric pattern of growth.

Growth and Mortality

Population parameters of the stock extracted using the FiSAT (version 3.2) are presented in Table 3. The ELEFAN-1 (Electronic Length Frequency Analysis) program estimated asymptotic length (L_{∞}) and growth co-efficient (K) of the Von Bertalanffy Growth Formula (VBGF) for *C. feriatus* and *P. pelagicus* were noted at 26.76 cm (0.63 year⁻¹) and 21.36 cm (0.87 year⁻¹), respectively. The resulting exploitation rate (E) for *P. pelagicus* and *C. feriatus* show overexploitation ($E > 0.50$) of the species (Gulland, 1971). Also, the resulting E optima from the Y'-PR (Yield-per-Recruit) indicates that exploitation rate of *C. feriatus* (35%) and *P. pelagicus* (10%) exceeded beyond the optimum exploitation ($E_{0.5}$), implying excess fishing effort. This finding affirms the assessments result obtained during the Fishery Sector Program (FSP) and SMB-Resource and Ecological Assessment (REA) which indicated that the fishery resources in the Bay have been heavily exploited or overfished with catch



Figure 2. Main species, *Portunus pelagicus* (left) and *Charybdis feriatus*, exploited in San Miguel Bay.

Table 2. Carapace width-weight relationship of *P. pelagicus* and *C. feriatus* in San Miguel Bay.

Crab	Sex	Carapace Width-Weight Equation	R ²
<i>Portunus pelagicus</i>	Male	$W=1.17*CW^{2.91}$	0.80
<i>Portunus pelagicus</i>	Female	$W=1.25*CW^{2.97}$	0.83
	Mean	$W=1.21*CW^{2.94}$	0.82
<i>Charybdis feriata</i>	Male	$W=0.59*CW^{2.83}$	0.79
<i>Charybdis feriata</i>	Female	$W=0.49*CW^{2.73}$	0.79
	Mean	$W=0.54*CW^{2.78}$	0.79

Table 3. Population parameters of *C. feriatus* and *P. pelagicus* studied.

species	L _∞ (cm)	K (/yr)	Z (/yr)	M (/yr)	F (/yr)	E _{curr} (/yr)	L ₅₀ (cm)	Sampling period
<i>Charybdis feriata</i>	26.76	0.63	3.70	1.41	2.29	0.62	9.62	Dec.2011-Nov.2012
<i>Portunus pelagicus</i>	21.36	0.87	4.66	1.85	2.81	0.60	10.53	Nov.2011-Oct.2012

rates significantly declining. Ingles and Flores (2000) also reported that fishing effort of swimming crabs has been well above sustainable levels since 1999.

The LC₅₀ statistics which is the population length at which 50% of the population is harvested (the other 50% remains) when subjected to fisheries showed a computed LC₅₀ = 9.62 cm for *C. feriatus* and 10.53 cm for *P. pelagicus*. These values are slightly higher compared to the size at first maturity of 8.3 cm and 10.50 cm for *C. feriatus* and *P. pelagicus*, respectively. However, this may also contribute to recruitment overfishing wherein the adult population was caught so heavily that the number and size of the adult population (spawning biomass) has been reduced to the

point that it will not have the reproductive capacity to replenish the fishery.

Fishing gears, CPUE, Annual Production and Species Composition

Crabbing is a multi-gear fishery (Ingles, 2004). In Tinambac, Calabanga, and Cabusao, Camarines Sur, the majority of the gears used are crab gillnet or CGN (~220 units). In Mercedes, Camarines Norte, crab pots (CP= ~59 units) are commonly used. CGN locally known as “hikot” has an average length of 1,000 meters (~40 *banata*, 25 meters/*banata*) and a mesh size of 5 cm, wherein baits are not needed. Soaking duration per set is 15-16 hours. Meanwhile, CP locally known as “bobo” is an enticing device with a length of 69 centimeters,

30 centimeters width and a depth of 18 centimeters. The frame is made of 8 mm steel bar with bamboo attachment to form the pot and polyethylene webbings of 3 centimeters mesh size with an opening at both ends. The steel bar served as sinkers of the pot. An average of 160 pots connected with a main line is being deployed per fishing boat. Trash fish are used as baits. Setting and hauling of the gear usually last for 16 to 36 hours. It is mostly recommended as environmental and social-friendly gear because it allows the fishermen to return gravid and juvenile crabs to the sea which encourage sustainable fishing. In contrast, the CGN is a non-selective fishing method that does not allow for the return to sea of juvenile crabs that have not yet reached sexual maturity or gravid crabs that have not yet spawned.

The average catch for CGN is 7.25 ± 2.41 kg/trip (CPUE=0.48) and 11.09 ± 7.93 kg/trip (CPUE=0.69) for CP. Highest catch for CP was observed during December

(CPUE=2.11), whereas in CGN in February and September (CPUE=0.63) (Figure 4). Capture of immature crabs was observed as a factor to growth overfishing (Ingles, 2004). Noticeably, about 1 – 7 percent (Figure 5) of the *C. feriatius* are captured undersized (CW=<8.3 cm.). The catch composition for CGN consists of 58 - 99 percent *P. pelagicus*, 1-24 percent *C. feriatius*, and 1 - 23 percent by-catch (Table 5). On the other hand, catch composition for CP is 48 - 92 percent *C. feriatius*, 21 - 27 percent *P. pelagicus* (Figure 6b), and 8 - 25 percent by-catch. Baby trawl fishing gears were also noted operating in Cabusao and Mercedes. An annual production of 524.90 mt of crabs was estimated in the SMB (Table 4). The production constitutes 3.11 percent of the 16,879 mt fisheries annual productions in SMB (Soliman and Dioneda, 1997). Catches in the Philippines have been around 34,000 mt in recent years and evidence has shown the abundance of swimming crabs has declined (www.fao.org).

Table 4. Estimated annual production in San Miguel Bay (metric ton).

Area	Crab gill net	Crab pot	total
Tinambak (Sogod)	134.78	10.80	145.58
Calabanga (Sabang)	154.43	1.14	155.57
Cabusao (Castillo)	121.50	-	121.50
Mercedes (Mangisoc & Mambungalon)	-	102.24	102.24
total	410.72	114.18	524.90



Figure 3. Gears used in crab fishing (left: crab gill net; right: crab pot).

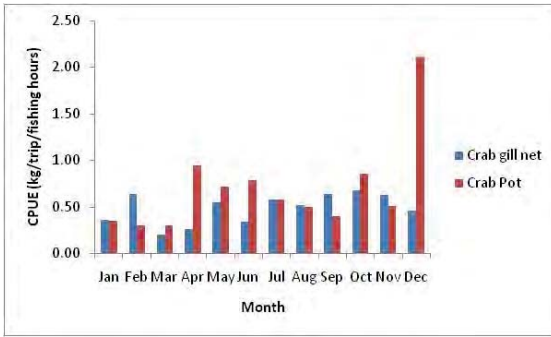


Figure 4. Monthly CPUE (crab gill net and crab pot) in San Miguel Bay.

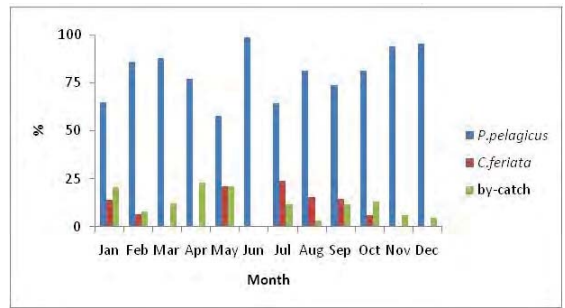


Figure 6a. Catch compositions caught by crab gillnet in San Miguel Bay.

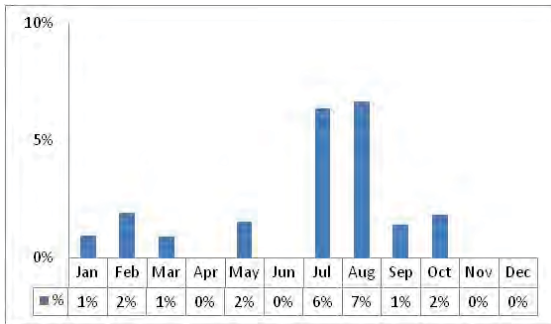


Figure 5. Percentage catch of "undersized" (<8.3 cm CW or CL) *C. feriatus* in San Miguel Bay.

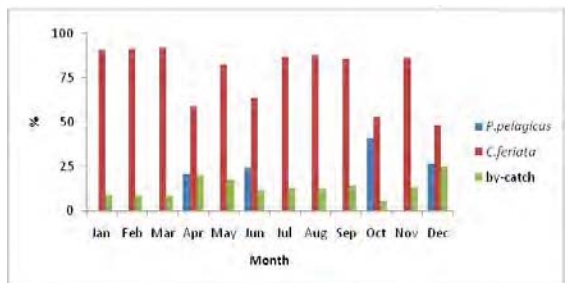


Figure 6b. Catch compositions caught by crab pot in San Miguel Bay.

Table 5. Catch composition of other species (by-catch) using crab gillnets and crab pot in San Miguel Bay.

Common Name	Family	Catch Composition (%)	
		Crab Gillnet	Crab Pot
Croaker	<i>Scianidae</i>	7.65	
Catfish	<i>Arridae</i>	0.46	
Grouper	<i>Serranidae</i>	0.15	11.11
Scad	<i>Carangidae</i>	1.68	
Trevally	<i>Carangidae</i>	2.45	
Mullet	<i>Mugilidae</i>	0.15	
Catfish	<i>Plotosidae</i>	2.45	
Sillago	<i>Sillaginidae</i>	1.99	
Toungefish	<i>Cynoglossidae</i>	25.08	
Spider conch	<i>Strombidae</i>	0.76	
Cockle	<i>Arcidae</i>	3.06	
Mantis shrimp	<i>Gonodactylidae</i>	52.75	74.08
Shrimp	<i>Penaeidae</i>	0.15	14.81
Prawn	<i>Penaeidae</i>	0.76	
Mudcrab	<i>Portunidae</i>	0.46	
Total		100	100

Market and Channel of Distribution

Marketing and distribution in SMB is characterized by competitive market structure where there are many sellers and buyers with free trading of aquatic products. The most common practice is from crab fishers to traders (“*factorador*”) or local crab meat processors (“*beneficiador*”). According to key informants, these are delivered to Manila or Cebu for domestic market or exported to China, Hongkong and Taiwan as live crabs, fresh frozen or processed crab meat. Another market player is the broker who sells crab to the trader or street/market vendor (“*regaton*”). The “*regaton*” sells directly to the consumers in their places (Figure 7). The number of crab fishers, *factorador*, and *beneficiador* are presented in Table 6.

Crab pot fishers usually sell 75 percent of their catch to “*factorador*”, 15 percent to “*beneficiador*” and 10 percent to “*regaton*”. On the other hand, crab gill net fishers sold 90 percent of their catch to “*beneficiador*” and the remaining 10

percent to “*factorador*”/“*regaton*”. Selling price of crabs sold to “*beneficiador*” ranges from Php100.00 to Php 120.00/kg whereas rejected crabs (e.g. molting, small sizes, no longer alive, low weight, pinchers removed, etc.) are either consumed for food or brought to “*factorador*”/“*regaton*” and sold at Php 50.00. For live crabs, prices range from Php 300.00 to as high as Php 2,000.00/kg depending on the size and species of crab.

“*Suki*” system is a prevalent practice among fishers in SMB. “*Suki*” is the local term used to refer to a special relationship between two individuals wherein one provides credit for fishing input or family expenses in exchange to the exclusive right to purchase their catch at a lower price. In terms of market structure, aside from having a competitive market, there are barriers to fish trading business, which include legal (i.e. license, permit, taxes, limited operation of brokers), financial (i.e. lack of capital, limited credit and high interest rates) and market information limited to the middlemen.

Table 6. Number of crab fisher, factorador, and beneficiador in sampling areas.

Area	Crab fisher	Factorador	Beneficiador
Tinambak (Sogod)	152	-	3
Calabanga (Sabang)	198	-	3
Cabusao (Castillo)	250	10	15
Mercedes (Manguisoc & Mambungalon)	165	3	-

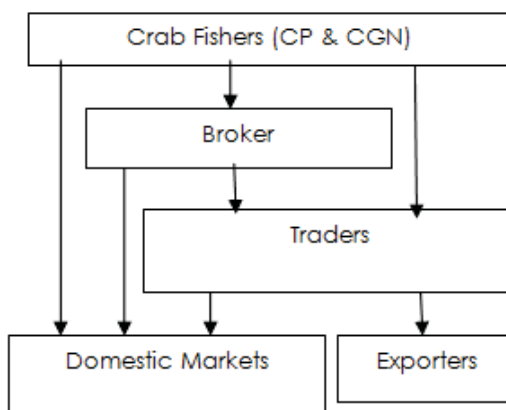


Figure 7. Marketing channels for swimming crabs in San Miguel Bay.

Sustainable and Implementable Christian Crab Fishery Resource Conservation and Management Strategy

To promote the idea of crab resource conservation and management using the recent biological research findings as basis, the project co-sponsored an action planning meeting designed to update SMB-LGU's Coastal Resource Management Plans (CRMP) held February 16, 2012 at Regent Hotel, Naga City which was attended by 42 representatives. Among the major agreements were the inclusion of crab fisheries in the CRMP and the total banning of active fishing gear in SMB to sustain crab fisheries particularly *C. feriatatus* and other swimming crabs.

A set of resource management options based on the biological and fisheries information generated were also prepared and presented during the "Stakeholders Consultation and Presentation of Resource Enhancement Plan for Marine Crab in San Miguel Bay" held at BFAR-RFFC, Bula, Camarines Sur last January 30, 2013 attended by DOST-V, BFAR-V, IFARMC and LGU's officials bordering SMB. The same option was presented and deliberated during the Integrated Fisheries and Aquatic Resource Management Council (IFAMRC) of SMB meeting held at Mercedes School of Fisheries last January 18, 2013 where all LGUs in SMB was represented.

From these exercises, it appears that scientific findings may not necessarily be the best solution should one consider the socio-economic implications of such option to livelihood and food security of the people. While poverty cannot certainly be used as an excuse for sound judgment, at least the sentiments of resource users are considered prior to decision-making and

implementation. For instance, considering the reduction of fishing effort proportional to excess exploitation level through mesh size regulation (use of >12 cm stretched mesh size), catch regulation (minimum of 9 cm for *C. feriatatus* and 11cm for *P. pelagicus*, based on size at maturity) and regulating fishing intensity (e.g. shifting to deeper ground, reduced fishing time, etc.), LGU representatives and fisherfolks argued that such option is not realistically acceptable to fisherfolks since it will affect their only means of livelihood. In addition, regulating mesh size will not work because the crabs are entangled to the net beside that will entail procurement of another fishing gear to comply; making it very difficult for resource-poor fisherfolk. Regulating fishing intensity by shifting to deeper ground is also risky and expensive in terms of fuel cost.

It is interesting to note that LGUs and fisherfolk groups expressed unanimous acceptance to the declaration of a closed season as an option during periods of peak reproductive activity for *C. feriatatus* particularly in December and January where higher percentages of GSI, mature, and gravid crabs were observed. Apparently, the underlying reason for agreement follows that the months of December and January coincide with rough sea and occurrence of bad weather making fishing risky; hence, for the fisherfolk, closed season does not matter much since they have nothing to lose. On the other hand, for the LGUs, there will be less opposition making it easier to pass a resolution for a close season but it does not make sense in as much as the decision is merely based on convenience instead of scientific basis most appropriate to the resource.

Table 7. List of management options and its implications to science and socio-economics of crab resource management in San Miguel Bay.

Management option (Research-based options)	Scientific implication (Based-on R&D Findings)	Socio-economic implications (LGU-Fisher's perspectives)
1. Reduction of fishing effort proportional to excess exploitation level.		
a. mesh size regulation (use of >12 cm stretched mesh size)	Better chances for mature crabs to breed at least during their size at 1 st maturity (<i>C. feriatius</i> - 8.3 cm and <i>P. pelagicus</i> - 10.50 cm)	Would mean a reduction of 14% and 15% from the catch and income. Besides, the claws may still be entangled even with stretched mesh.
b. catch regulation (minimum of 9 cm for <i>C. feriatius</i> and 11cm for <i>P. pelagicus</i> , based on size at maturity)	Better chances for mature crabs to breed at least during their size at 1 st maturity (<i>C. feriatius</i> - 8.3 cm and <i>P. pelagicus</i> - 10.50 cm)	Would mean a reduction of 14% and 15% from the catch of fishers and income but at least no deprivation of the fisher's livelihood
c. regulating fishing intensity (e.g. shifting to deeper ground, lessen fishing time, etc.	Lessen fishing pressure on wild population	Unacceptable to fishers as it implies increased cost of fuel, longer fishing time and more risky
d. Closed season during periods of peak reproductive activity for <i>C. feriatius</i> particularly in December and January where higher percentage of gonado-somatic index or GSI, mature, and gravid crabs were observed.	Does not have much impact on the resource but 14% and 15% gravid female crabs are given the chance to propagate without much fishing pressure	Acceptable to fishers since at this point in time fishing is not favorable due to bad weather. Fishers have nothing to lose after all it has been a practice.
2. No extraction of egg-bearing swimming crabs. Gravid crabs caught will be released in fishing ground immediately after caught.	Better chances of breeding biomass to reproduce to sustain the fishery	Unacceptable to fishers as they perceived it as a reduction to their CPUE and income
3. Egg-bearing swimming crabs will be held in a spawning tank and monitored until it hatches. Larvae will be returned in fishing ground, or in marine protected areas.	No scientific evidence of success but releasing larvae in fishing ground or in MPA's is a sound resource conservation practice	Unacceptable to fishers as they perceived it as reduction to their CPUE and income. The practice may soon be a habit for resource conservation and management; Doable and acceptable to LGU's in collaboration with the buyers
4. Increase the number of protected areas and widen the functional and well-managed protected areas in the bay.	Very essential not only to swimming but other species as nursery, feeding, and spawning grounds.	More MPAs more "no fishing zone" from the fisher's perspective
5. Diversification of alternative livelihood, especially those not related to fisheries.	Will lessen fishing pressure	Acceptable to fishers with very few success stories

Another accepted option is the holding of egg-bearing crabs in a spawning tank to spawn and the larvae released in fishing ground or MPAs. Unfortunately, no scientific evidence relative to its success is available but the practice may eventually be the basis for future sound management practice for responsible fisheries. From the economic perspectives, the above options can be explained by simply understanding the fact that catching the breeders or small crabs is not an efficient way of using the resource rather it will just cause its depletion. A case in point is that female *C. feriatus* with CW from 8.3 cm-15 cm has a fecundity of about 1,513,660 to 6,357,133 eggs. Assuming that only 10 percent of these eggs hatched and survived to juvenile stage, some 151,366 to 635,713 juveniles may be produced. Assuming further that only 1.0 percent reach marketable size, 1,513 to 6,357 crabs is expected per female. At 8 pieces per kg, 189.13kgs to 792.13kgs of crabs can potentially be harvested. Catching gravid female crab therefore represents an economic loss of approximately Php 56,739.00 – Php 237,639.00 at a selling price of Php 300.00 per kg or Php 226,956.00 to Php 950,556.00 at a live weight price of Php 1,200 per kg. Moreover, from the reported annual production of 524.90 MT of crabs in SMB, 5.25- 126 mt are *C. feriatus* (1-24 percent), from these, 15 percent are gravid females which mean some 0.7875- 18.9 mt are not given the chance to reproduce and replenish natural population, hence may lead to resource depletion.

The last identified option is the diversification of alternative livelihood, especially those that are non-fisheries related. This is has been the usual quick answer to most coastal resource

management project (CRMP), unfortunately with stories of few successes and more failures as experienced in many CRMP in the country.

Finally, a follow-up collaborative research implemented with the concerned LGUs, fisherfolks and IFARMC to translate the option into realistic action plans and that outcomes are monitored, evaluated and scaled-up for replication in other areas.

Conclusion and Recommendation

Population parameters using the FiSAT (version 3.2) showed exploitation rate (E) for *P. pelagicus* and *C. feriatus* exceeded the optimum exploitation (E0.5) implying excessive fishing effort or heavily exploited fisheries. Harvest data also showed 15 percent and 14 percent of the catch are gravid *C. feriatus* and *P. pelagicus* which indicates potential recruitment overfishing. Doable options for resources conservation and management strategies supported by LGU's in SMB including the IFARMC include (1) declaration of closed seasons during periods of peak reproductive activity for *C. feriatus* particularly in December and January where higher percentages of GSI, mature, and gravid crabs were observed, (2) the collection of egg-bearing swimming crabs which will be held in a spawning tank, hatched and the larvae returned in fishing ground or in marine protected areas (MPA) and (3) diversification of alternative livelihood, especially those non-fisheries related. It is recommended that a follow-up research effort be implemented collaboratively with the concern LGU's and IFARMC to ensure that the options identified were translated into realistic action plans and that outcomes are monitored and evaluated.

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