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STOCK ASSESSMENT OF BLUE SWIMMING CRAB FOR SUSTAINABLE MANAGEMENT IN ASID GULF, MASBATE PHILIPPINES

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Abstract: Fishermen in the Asid Gulf rely heavily on the income, livelihood, and food security that Blue Swimming Crab (BSC) provides. A study was conducted in January-December, 2018 to investigate the present status of the BSC fishery in the gulf. A total of 3991 BSC were collected for length-frequency data and analysis was done using an analytical length-based fish stock assessment, FISAT (version 1.2.2). Results on Von Bertalanffy growth function parameters were $CW\infty$=170.43 mm and K=0.93year^{-1} (ELEFAN method). The current exploitation rate was 0.79 which was higher than the threshold at E=0.37. Also, an excess of 29% in the E current suggested reducing the 28% fishing effort of the current year to fulfill the MSY and FMSY. On this basis, it is safe to presume that BSC fishery from Asid Gulf is experiencing overexploitation, hence, the need to recommend interventions supportive of the sustainable management and conservation of BSC in Asid Gulf.

Keywords: Asid Gulf, Blue swimming crab, Exploitation, Mortality, Stock assessment.

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INTRODUCTION

The Blue Swimming Crabs (BSC), Portunus pelagicus (Linnaeus, 1758), of the Phylum Arthropoda, Class Crustacea, Order Decapoda, and Family Portunidae are known locally as 'kasag' in Bicol, 'alimasag' in Tagalog, and 'lambay' in the Philippines (Bisaya). They're swimming crabs with swimming paddles attached to their last set of legs. Their carapace (shell) has a gritty feel (Kailola *et al.*, 1993). Bottom-feeding carnivores and scavengers, blue swimmer crabs are opportunists. They are at their most active foraging and feeding (Grove-Jones, 1987). P. pelagicus, the blue swimmer crab, can be found in near shore marine and estuary areas around the Indo-West Pacific (Kailola *et al.*, 1993).

BSC competes commercially in the Philippines with other species like mangrove crabs due to its higher demand and economic value in the market. Data from the Bureau of Agricultural Statistics (BAS, 2010) show that BSC ranks fourth as a major fishery export in the country in terms of value at $67,612,600 US as of CY 2010 (Philippine Fisheries Profile, 2010). Also, Ingles (2004) affirms that BSC is one of the country's primary fisheries resources as an export commodity. Similarly, crab fishing is one of the most important fisheries in the Bicol Region, and it contributes significantly to the national supply of the item (Fisheries Statistics, 2007). It has the country's third-highest BSC production volume (17.89%). Camarines Sur, Masbate, and Sorsogon are the main producers. On the other hand, the BSC yield had dropped from 20 kilograms per day per fisherman in the early 1990s to 5 kg per day per fisherman between 2008 and 2009 (BFAR, 2013). The rising demand for blue crabs had driven prices up over the years despite variable catch volumes, leading to larger export revenues.

BFAR finalized the Philippines Management Plan for the Blue Swimming Crab in 2013. However, despite this national framework, lack of a proper management resources, training, and enforcement has allowed the fishery to suffer declining trends (Fish Source, 2013).

Several studies on stock assessment have been done in different fishing areas of the Philippines such as the Visayan Sea (Ingles, 1996; Romero, 2009; Afzaal *et al*., 2016; De Mesa *et al*., 2018), Guimaras Strait (Bayate *et al*., 2011), Eastern Visayan Sea (Germano *et al*., 2006). In Bicol, studies on Reproductive Biology of Christian crabs (*Charybdis feriatus*, Linnaeus, 1758) in San Miguel Bay, Philippines (Nieves *et al*., 2015), Stock assessment of Christian crabs (*Charybdis feriatus*, Linnaeus, 1758) in San Miguel Bay (Nieves *et al*., 2015), Capture Fisheries Assessment of Commercially Important Marine Crabs in Sorsogon Bay and San Miguel Bay (Nieves *et al*., 2013) and Blue Swimming Crab Reproduction and Larval Ecology of the Blue Swimming Crab *Portunus pelagicus* in Ragay Gulf, Philippines (Ingles and Braum, 1989; Soliman and Dioneda, 1998).

Despite the vast resources available, the Asid Gulf in Masbate requires more attention and research. The Asid Gulf is abundant with invaluable fish and crustaceans, such as blue swimming crab. In the Philippines, the BSC fishery is a significant component of municipal or small-scale fisheries (Ingles and Braum, 1989). From 2010 to 2019, Masbate was one of the top 20 producing provinces of BSC in the Philippines, with a downward trend in production (PSA, 2019).

Considering its impacts on the environment, livelihood, and economy of the country, hence an assessment and management should be considered. Thus, the main goal of the current study is to document the growth, exploitation rate, and mortality rate of blue swimming crab in Asid Gulf, which could be beneficial for improving the management of this species.

MATERIALS AND METHODS

Study Site

The Visayan Sea's northernmost extent is formed by the Asid Gulf. It is located south of the island province of Masbate at 12.18° N latitude and 123.50° E longitude

Fig. 1: A Map displaying the study area and sampling site (Source: Google Earth).

(Fig. 1). The gulf is rich in pelagic and demersal fishes, as well as an abundance of invertebrate species, which contribute to fisheries production not only in the Bicol Region, but also in the Visayan Sea as a whole (Regions 5, 6 and 7).

In the Asid Gulf, the invertebrate *Portunus pelagicus* is the most common species (Atlas of Philippine Marine Fisheries, BFAR-NSAP, 2016). In the Philippines, the blue swimming crab fishery is a prominent component of the municipal or small-scale fisheries (Ingles and Braum, 1989). From 2010 to 2019, Masbate was one of the top 20 producing provinces of BSC in the Philippines, with a downward trend in output (PSA, 2019). The main landing centre for the samples was Poblacion Milagros, Milagros Masbate.

Data Collection

From January to December 2018, BSC was randomly selected from brokers in Milagros Masbate. The broker loaned the fishermen money for fuel, food, and other necessities, and the fishermen agreed to deliver their catch to them immediately. To determine the species growth, mortality factors, and exploitation rate, length, width, and weight measurements were taken.

Fig. 2 shows the morphometric measurements of the blue swimming crab. The distance between the tips of the last antero-lateral teeth was used to calculate carapace width (CW). The distance between the tip of the frontal teeth and the posterior end of the carapace was measured as carapace length (CL). A vernier caliper (SE 781BC Stainless Steel, 0.01 mm) was used to measure the width and length of the carapace of a blue swimming crab A digital weighing scale Ohauz, Model CL 501T, capacity 500 g x 0.1 g) was used to determine total body weight (BW). Almost all length-frequency measures came from Milagros landings in Milagros, Masbate.

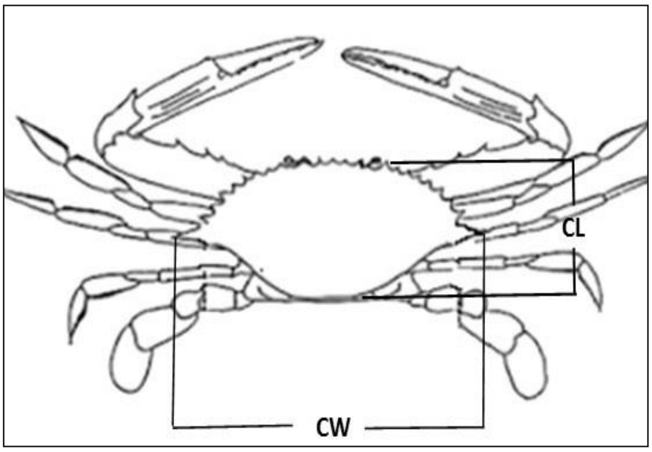

Fig. 2: Morphometric measurements of the carapace width (CW) and carapace length (CL) of Blue Swimming Crab in Asid Gulf.

Data Analysis

Stock assessment data were examined using descriptive statistics and analysis of length frequencies such as normality test and generation of total length-frequency distributions (histograms with constant class interval) was done using a commercial spreadsheet program. The population parameters were analyzed using the FAO ICLARM Stock Assessment Tools (version 1.2.2) (Gayanilo and Pauly, 1997).

RESULTS AND DISCUSSION

Size Structure

A total of 3991 BSC were collected comprising 1,793 males and 2,198 females from January to December 2018 with a mean carapace length of 105.07 ± 11.07 (male) and 106.10 ± 11.85 (female), respectively (Fig. 3). Moreover, the present mean CW is higher than the mandated minimum size of BSC to be captured, sold, or traded, which is 102 mm (4 inches) in carapace width, according to DA-DILG JAO No. 1, series (2014) on the Regulation for the conservation of blue swimming crab. This indicates that the adult population was overfished to the extent that the number and size of the spawning biomass have been diminished to the point where they are incapable of reproducing to restock the fishery.

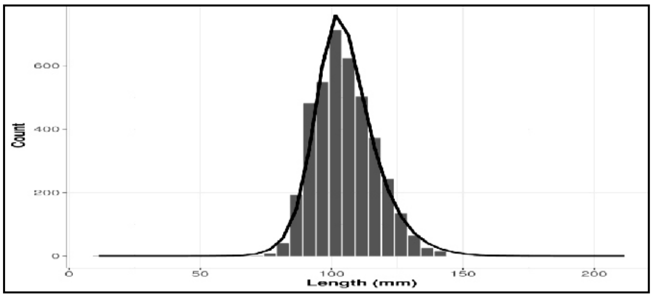

Fig. 3: Observed frequency distribution of carapace length of BSC from Asid Gulf.

Growth parameters

The ELEFAN method was used to estimate the growth parameters from a total of 3991 crabs gathered during January to December 2018. The length-frequency distribution data were used to analyze the Von Bertalanffy Growth (VBGF) growth parameters such as growth coefficient (K year^{-1}) and asymptotic length (CW∞). The von

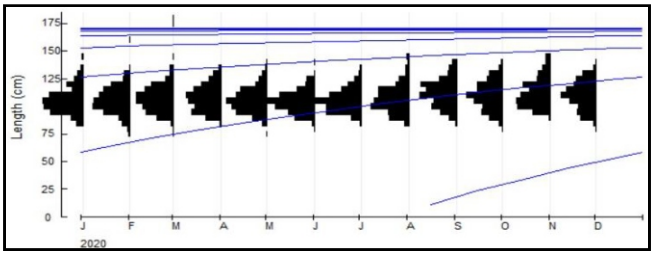

Fig. 4:. Length Frequency Distribution (*n*=3991) the Growth Rate was Estimated by ELEFAN Method where (CW∞ 170.43 mm and K = 0.93 year^{-1}) from Asid Gulf.

Bertalanffy growth parameters of BSC were at CW∞ 170.43 mm and K = 0.93 year^{-1}

The current study was compared to earlier studies conducted in the Philippines' various fishing sites (Table 1). Previous research found that the growth characteristics and asymptotic length of BSC from various fishing areas in the Philippines were higher than the current study. The CW (180 mm) of BSC from Ragay Gulf, on the other hand, was lower than in the current investigation.

Table 1: Growth parameter of Blue Swimming Crab and comparison results of the present study with previous studies during 2018.

Philippine Fishing Grounds	K-value	CW∞ (cm)	References
San Miguel Bay	0.87	21.36	Nieves *et al.*, 2015
Ragay Gulf	1.58	18.00	Ingles and Braum, 1989
Sorsogon Bay			Olano *et al.*, 2009
Female	1.58	21.09	
Male	1.58	19.39	
Guimaras Strait	1.40	21.77	Bayate *et al.*, 2011
Visayan Sea	0.70	22.50	Ingles, 1996
Visayan Sea	1.40	19.95	Romero, 2009
Visayan Sea			De Mesa *et al.*, 2018
Female	1.55	19.10	
Male	0.55	19.20	
Asid Gulf	0.93	17.04	Present study

The discrepancies in these numbers could be due to a variety of factors affecting the growth characteristics, such as ecological and environmental conditions, as well as the methods used to catch crabs in various fishing sites.

Mortality and Exploitation Rates

Predation by large animals (Otob, 1993), aging effects (King, 1991), parasites and diseases (Landau, 1979), and environmental conditions are all factors that contribute to mortality (Chapman and Van Well, 1978). Crab stocks with increasing mortality imply diminishing populations.

The length-converted catch curve with the input data of growth rate (CW = 170.43 mm and K = 0.93 year-1) was used to calculate BSC mortality. The total mortality of Asid Gulf blue swimming crabs was Z = 5.31, with a 95 percent confidence interval of Z. (CI of The fishing mortality was computed as year-1, and the exploitation rate (E) was calculated as year-1, using as the natural mortality (Fig. 5).

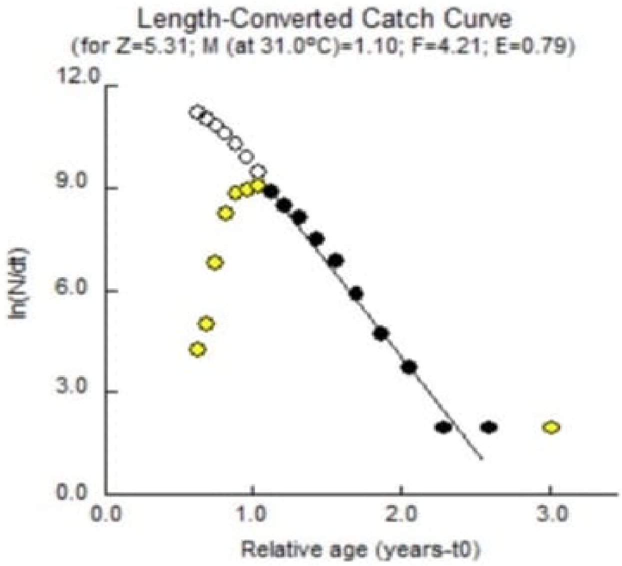

Fig. 5: The length converted catch curves were used to estimate the total mortality of blue swimming crab with an input value of VBGF growth parameters CW∞ = 170.43 mm (CW) and K=0.93), only the black dots were considered for total mortality estimation, where Z=5.31 year^{-1} with Cl of Z (4.60-6.02) from Asid Gulf.

Table 2 shows the comparison results of mortality (Z, M, F) and exploitation rate of blue swimming crab from other areas of the world were higher than in the present study. It only means that BSC in the entire world has high commercial demand in the market.

Table 2: Comparison Results of the Mortality Rate of Blue Swimming Crab from Previous Studies.

Areas	Z	M	F	E	References
Thailand	8.96	1.61	7.35	0.82	Sawusdee and Songrak, 2009
Arabian Sea	4.6	1.68	2.92	0.63	Afzaal *et al*., 2016
San Miguel Bay, Phil.	4.66	1.85	2.81	0.60	Nieves *et al*., 2015
Asid Gulf, Phil	5.31	1.10	4.21	0.79	Present study

Z=Total Mortality, M= Natural Mortality, F=Fishing Mortality, E= Exploitation Rate

The exploitation rate (E) from Asid Gulf was 0.79. According to Gulland (1979) if the E is greater than 0.5 it may be assumed that the stock in the said fishing ground is in an overexploitation state and also it was stated by Patterson (1992) exploitation rate should not be greater than 0.4 for the sustainable state. It only means that the stock of BSC in Asid Gulf was overexploited.

Relative Yield and Biomass Per Recruit

An estimated value of E should be equal to natural mortality or an optimum exploitation rate that is approximately equivalent to 0.5 year-1, greater than that stock should be considered overexploitation (Pauly and Ingles, 1984).

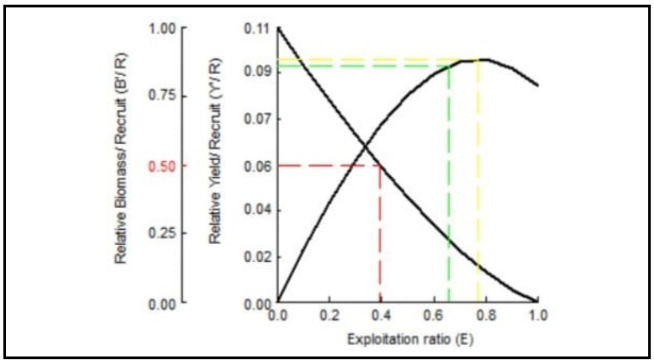

Fig. 6: Exploitation Rate of BSC in Asid Gulf.

Fig. 6 shows the computed (E), optimum (E10), and threshold (E=0.5) values of exploitation rates of BSC in Asid Gulf. The computed E at 0.79 year $^{-1}$ shows a higher value compared with that of the threshold E=0.5 year^{-1} at an excess of 58%. It only shows high fishing pressure among crab resources for Asid Gulf.

CONCLUSIONS

In conclusion, overharvesting has placed the blue swimming crab population at risk. Masbate's production declined from 2010 to 2018 due to illegal fishing, pollution, and overharvesting for export to other countries. The current rate of exploitation of Asid Gulf was 29% above normal at the time, and it was recommended that the current year's 28% fishing effort be cut in half to fulfil the Maximum Sustainable Yield and Fishing Mortality Maximum Sustainable Yield.

On the other hand, the exploitation rate was 0.79, which was greater than the optimal rate of 0.39. The data of exploitation rate shows an increase in overfishing, with high E values compared to E10, and decreasing length infinity values, with 225 mm in 1996, 199.5 mm in 2009, and 170.43 mm in 2018. Overfishing occurs during recruitment, as seen by the high percentage of sizes caught before L*m* for bottom set gillnet.

Finally, on the basis of the findings of the study, it is therefore imperative that a follow-up study be considered in collaboration with the concerned LGUs and stakeholders to ensure that the options presented were converted into feasible action plans and that the outcomes were monitored and reviewed. The study also believes that having a concrete foundation in scientific knowledge is necessary for sustainable management.

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