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MUD CRAB WEIGHT PREDICTION USING MULTIPLE LINEAR REGRESSION MODEL

Yusrina Andu^{1,*} and Maisarah Saqinah Mohd Ridzwan²

¹Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan

²Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA Cawangan Negeri Sembilan, Kampus Seremban, Negeri Sembilan, Malaysia.

*yusrinaandu@uitm.edu.my

Abstract

*This study explores the use of multiple linear regression (MLR) to predict the weight of mud crabs (*Scylla spp.*) based on gender, carapace length (CL), sternum width (SW), and propodus width (PW). Data from 60 mud crabs comprising two species, *Scylla paramamosain* and *Scylla olivacea*, were analyzed. Key predictors, including CL, SW, and PW, demonstrated significant correlations with body weight, explaining 95.9% of the variance in the final regression model. Model validation showed high reliability, with adherence to linearity between the variables, normality, homoscedasticity, and error terms assumptions. The findings offer a practical tool for fisheries management, allowing efficient and non-invasive weight estimation, which aids in sustainable harvesting and population assessments. Despite the model's strong predictive capabilities, the study acknowledges limitations, such as reliance on secondary data and geographic constraints, and suggests the inclusion of additional variables and expanded datasets to enhance generalizability. This research provides a foundation for improved aquaculture practices and the development of adaptive management strategies in dynamic environmental conditions.*

Keywords: Mud Crabs, Morphometric Measurements, Multiple Linear Regression

Introduction

Mud crabs (*Scylla sp.*) are a valuable aquatic resource with high economic value, making them an important species for fisheries management. Mud crabs are large crabs found in estuarine and mangrove habitats throughout the Indo-Pacific region, especially Malaysia [1-3] These crabs are highly valued for their meat, making them an important species in both commercial fisheries and aquaculture. There are several species of mud crabs, with the most recognized being *Scylla serrata*. The management of mud crab fishery ultimately depends on the understanding of the factors influencing their population dynamics, growth patterns, and size distribution [2][4]. Furthermore, the length-weight relationship of mud crabs has been considered the most important foundation in fish biology, the knowledge of which can provide insight into the general health and productivity of crab populations. Additionally, considering the influence of gender on crab growth and size distribution is essential for implementing targeted management strategies.



Mud crab (*Scylla sp.*) also is one of the waters resources, which can have high economic value. Therefore, scientific information related to length-weight relationships is necessary for sustainable fisheries management [5]. The length-weight relationship is one of the paramount things which must be considered before the fish binomial studies. In this viewpoint, the relationship is commonly used to index aquatic life including fish and crustaceans [6]. It can discover the variation caused by this odd length and can be used as an indicator of the fatness, breed of the species, and feed of the species and the way the species has adapted to the environment and if it is optimal or not. Data that tempers its population biology in the Malaysian country which relates to its population biology in Malaysia is limited and lacks depth. The research on the length-weight relationship in crustaceans including mud crabs has come into the spotlight by virtue of the physiological processes and the structure and function of tissues involved in fish. It has been used as an indirect tool to study population dynamics, and growth rates. This is because knowledge on how crab weight range with length is essential to stock assessment of biomass, size and stock status estimation. Besides that, through the gender integration gender in the analysis allows us to study whether the male and the female crabs presents different growth patterns and size distributions which are very important in the fisheries management practices and sustainability [4].

Morphometric measurements can be defined as the process of measurement of various features of an organism and quantifying a creature's shape. These measurements are used to describe the size and shape such as length, width, height and even circumference of any body parts of the creature. For instance, in the analysis of mud crabs, the morphometric measurements may be limited to, the carapace length and width, sternum width, abdomen width, and length and width of propodus that is part of a claw. These measurements are critical in biosciences especially when defining the differences between one species over the other, monitoring growth rates, and defining the morphology of the physical properties of an organism that may define its functionality and behavior in the ecosystem. Morphometric data may also be incorporated into other statistical models for the estimate of other light biological characteristics, such as weight, from these dimensions.

Methodology

The methodology for this study was designed to predict the weight of mud crabs using multiple linear regression (MLR). The research relied on secondary data comprising 60 observations of two mud crab species, *Scylla paramamosain* and *Scylla olivacea*, sourced from Kelantan, Malaysia. The data included morphometric measurements such as carapace length (CL), sternum width (SW) and propodus width (PW), along with gender as categorical predictors. The dependent variable was body weight, expressed in grams. The primary objective of the study was to develop a model for predicting mud crab weight using MLR and to identify significant factors influencing weight.

Theoretical Framework

Figure 1 illustrates that the body weight of mud crabs, the dependent variable in this study, is influenced by the independent variables, which are the morphometric measurements: CL, SW



and PW.

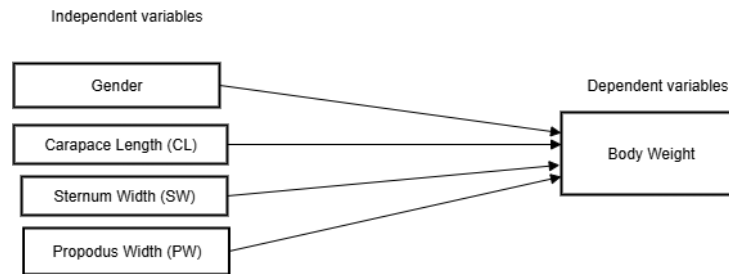


Figure 1: Theoretical Framework

Multiple linear regression

Multiple linear regression (MLR) is a statistical technique that represents the relationship between one dependent variable and two or more independent variables. The model assumed a linear relationship between the dependent variable and each of the independent variables, as shown in Eq.1:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \varepsilon \quad (1)$$

where,

Y : Body weight

β_0 : y-intercept

β_p : Coefficient for each independent variables

X_1 : Gender

X_2 : Carapace Length (CL)

X_3 : Sternum Width (SW)

X_4 : Propodus Width (PW)

ε : Error Term

Result and Analysis

By using MLR, we can determine the measurements that affect the body weight of mud crab. The result is present in Table 1.

Table 1: ANOVA Table

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	12.501	4	3.125	325.914	<0.001
Residual	0.489	51	0.010		
Total	12.990	55			



Based on Table 1, the significant value is < 0.001 which is less than α value equal to 0.05, therefore, it can be concluded that the model is fit and significant.

Table 2: Model Summary

R Square	0.962
Adjusted R^2	0.959

It can be observed from Table 2, R^2 value is 0.962, this indicates that about 96.2% of total variation in body weight of mud crab is explained by gender, CL, SW and PW, while the balance 3.8% is explained by other factors. A high R^2 value, close to 1, suggests a very good fit, meaning the model explains most of the variability in the dependent variable. This implies that these predictors are highly influential in determining the weight of the mud crab. Additionally, it is also important to consider the Adjusted R^2 , as it accounts for the number of predictors and the sample size. In this case, the Adjusted R^2 is 0.959, which is very close to the R^2 , suggesting that the inclusion of predictors has not led to overfitting.

Table 3: Coefficients of Significant Regression Table

Model	B	t	Significance
(Constant)	2.190		
Gender	-0.100	-2.740	0.008
Carapace Length (CL)	0.020	3.600	<0.001
Sternum Width (SW)	0.023	6.807	< 0.001
Propodus Width (PW)	0.023	3.325	0.002

All these four variables affect the body weight of mud crab since they all have significant value less than α value equal to 0.05 (Table 3). The final MLR model is as follows:

$$\hat{Y} = 2.190 - 0.100 \cdot \text{Gender} + 0.013 \cdot \text{CL} + 0.037 \cdot \text{SW} + 0.024 \cdot \text{PW}$$

When carapace length, sternum width and propodus width are not available or at zero, the average of body weight of mud crab will lie at 2.190. Meanwhile on average, when gender increase by one unit, body weight of mud crab will decrease by 0.100, while propodus width and carapace width is held constant. In this model, the assumptions of MLR which are linearity, normality, homoscedasticity, and independence of error terms were all satisfied.

Conclusion

This study successfully developed a predictive model for mud crab body weight as a function of morphometric measurements; in which carapace length and sternum width were the most significant predictors. Additionally, gender was identified as a contributory factor, but less so than in the case of other variables. The best MLR model showed excellent predictability, as indicated by an R^2 of 0.962, and an adjusted R^2 of 95.9% of the variation in body weight. The



results also highlighted the importance of considering several variables when predicting stock depletion, which could help scientists and fisheries managers better manage fishing stocks. This model will help simplify the estimation of mud crab weight through simple measurements for resource assessment to ensure sustainable exploitation. Furthermore, there were strong positive correlations between morphometric characteristics and weight, confirming the hypothesis that these physical traits are good indicators of the crab weight. This adds validity to the potential utility of the model in real-world settings as well as providing a scientifically sound framework for population monitoring and ecological assessment.

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