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Local conservation status and economic value of mangrove clam (*Pegophysema philippiana)* in sitio Maitom, Barangay Dahican, Mati City, Davao Oriental

Ace N. Palma Gil[1,2]*, Phoebe Nemenzo-Calica[1,2], and Jhonnel P. Villegas[3,4]

[1]Master of Science in Environmental Science Program, Davao Oriental State University, City of Mati, Davao Oriental, 8200 Philippines. ORCID Ace N. Palma Gil: https://orcid.org/ 0009-0009-4205-0966, ORCID Phoebe Nemenzo-Calica: https://orcid.org/ 0009-0004-7987-3951 [2]Faculty of Agriculture and Life Sciences, Environmental Science Program, Davao Oriental State University, City of Mati, Davao Oriental, 8200 Philippines [3]Faculty of Teacher Education, Davao Oriental State University, City of Mati, Davao Oriental, 8200 Philippines. ORCID Jhonnel P. Villegas: https://orcid.org/ 0000-0001-6387-2381
[4]Center for Futures Thinking and Regenerative Development, Davao Oriental State University, City of Mati, Davao Oriental, 8200 Philippines

Corresponding author email: rutileace@gmail.com

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ABSTRACT. This paper investigates the local conservation status and economic value of *Pegophysema philippiana* in Maitom, focusing on its population abundance, size distribution, and threats to survival. This study collected and analyzed 377 specimens. The results revealed a population density of 4 ind/m^2. Furthermore, the collected specimens displayed smaller average length and weight and lacked larger-sized individuals. The study identified two significant threats to *P. philippiana:* wastewater from adjacent prawn ponds and destructive gleaning practices. Conservation efforts, such as site alternation and selective return of premature individuals, were found to be inadequate in addressing the decline in abundance. Additionally, variations in physicochemical properties observed in this study and previous studies require further investigation. Regarding the economic value of *P. philippiana*, local pricing ranges from Php 120.00/kg-Php 180.00/kg, with a prevailing standard price of Php 150/kg. However, the pricing needs formal procedures and assessments. The *P. philippiana* fishery in Maitom operates at an artisanal level and requires essential gear or equipment, including proper harvesting techniques. Consequently, support activities beyond selling and consumption should be present. To address these challenges, this paper recommends establishing a formal business firm to streamline the flow of *P. philippiana*. Improving the fishery enhances the economic value, and conservation efforts can also be promoted, creating a positive feedback loop benefiting stakeholders and the species.

Keywords: gleaning, market price, practices, prawn-pond, wastewater, value chain,

INTRODUCTION

The mangrove clam *Pegophysema philippiana* is a species of bivalve mollusk in the family Lucinidae. They could be found burrowing in seaward fringe mangroves, hence the "mangrove clam" name, and soft substrate in shallow waters along the Indo-West Pacific, Western Atlantic, United States of America, and Canada coasts. Despite its vast distribution, it is more abundant in the Indo-West Pacific and is most dense in South East Asia, specifically the Philippines, where it derived its *"philippiana"* epithet (Abbott et al., 1995; Meyer et al., 2008; Ball et al., 2009).

The clam *Pegophysema philippiana* grows to a maximum length of 10 cm. The *Anodontia alba*, a closely related buttercup lucine that lives in the same range as it in the Caribbean region, has a striking resemblance to it. *P. philippiana* can be distinguished through the interior of its valves, colored white rather than yellow. It also has scars formed by the anterior adductor muscles that slope at 30° to the pallial line. *A. alba* prefers an estuarine environment; conversely, *P. philippiana* is one of several bivalve species found in the oxygen-depleted sediments among mangroves. It has a symbiotic relationship with certain bacteria in its gills, which oxidize methane and hydrogen sulfide. The energy generated by the bacteria is subsequently utilized by *P. philippiana,* allowing it to survive in a setting that would otherwise be too devoid of food particles (Glover et al., 2007; Glover et al., 2008).

Pegophysema philippiana is considered a seafood delicacy in the Philippines because of its flavor, size, and demand in the region (Adan, 2000; Lebata, 2001). The collection of *P. philippiana* supports the livelihood of coastal communities where they are present (Furkon et al., 2019). In the research conducted by Bacaltos et al. (2010), they discovered instances of over-exploitation. This was evident in the reduction of both the density and size of *P. philippiana* over the previous years. Consequently, there has been a decrease in the availability of this resource, which could potentially impact the economic well-being of collectors or gleaners of *P. philippiana* in the area unless addressed appropriately. This paper aimed to provide baseline information on the local conservation status and economic value, as well as the density, length, weight, maturity, physicochemical parameters, and the standard market value of *P. philippiana* resources in Maitom, Dahican, Mati City, Davao Oriental, as it is a significant commodity.

METHODOLOGY

The study utilized a mixed-method design incorporating qualitative and quantitative methods to achieve a more holistic view of *Pegophysema philippiana's* local conservation status and economic value.

The study was conducted in Sitio Maitom, Barangay Dahican, Mati City, Davao Oriental (Latitude 6.925981, Longitude 126.263013). The selected area was determined based on the information gathered from the residents and gleaners who specifically glean *Pegophysema philippiana.* The area is predominantly characterized as a mangrove ecosystem within an intertidal zone. Its vegetation mainly consists of mangroves and seagrass, it is surrounded by commercial fishery breeding grounds, and has a typical tropical temperature and climate.

Sample Collection

A one-shot sampling was conducted on April 29, 2023, from seven in the morning to twelve noon, when it was low tide and the water level was between two to four feet high in the sampling site. *Pegophysema philippiana* was collected with the help of hired resident gleaners, and the samples collected were bought to be further examined. The gleaners harvested the *P. philippiana* using a blade

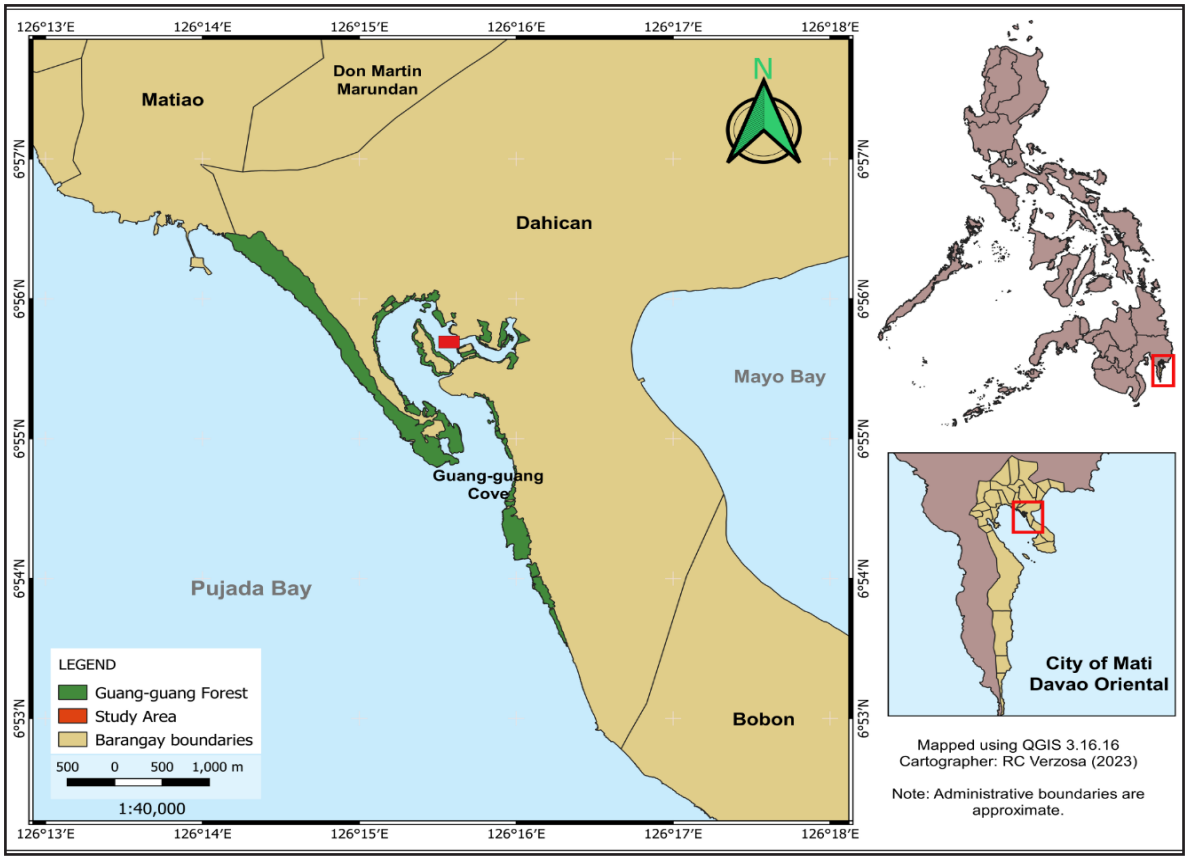

Figure 1. Map of the study area in sitio Maitom, Mati City, Davao Oriental.

(bolo knife) to dig it out of the coarse substrate, which is a mixture of sediments, mud, humus, and bits of decayed organic matter that is sometimes held together by the roots of seagrass. During collection, the gleaners needed to bow down to dig through the substrate (see Figure 2.). According to the experienced gleaners, if the tide were slightly higher but not too high, the men would dive to glean *Pegophysema philippiana.*

Density

Mangrove clam samples were collected from the site using random sampling method. The gleaning site was 100 m^2, within it there were few favorable areas for gleaning, as it had a very dense seagrass population with interlocking root systems. The individual clams were counted, and the density was computed using the formula of Mendoza et al. (2019):

$$Density = \frac{number\ of\ individual\ clams}{area\ (m^2)}$$

Length and Weight

A vernier caliper (0-150 mm) was used to measure the mangrove clam's length from its umbo to pallial line in centimeters. The mangrove clam was placed in a colander and left for a few minutes to drain the water that may influence the weight, and a digital weighing scale (0-10 kg) was used to measure the mangrove clam's weight in grams.

Maturity

The maturity of the mangrove clams was determined to surmise whether the gleaners harvested premature clams or if there is an abundance or scarcity of sexually mature mangrove clams. Based on a study by Bersaldo et al., (2022), a mangrove clam measuring 3.5 cm and above was considered sexually mature, which is within the range suggested by Araneta (2016), 3 to 5 cm for determining the maturity of clams. For this study, only

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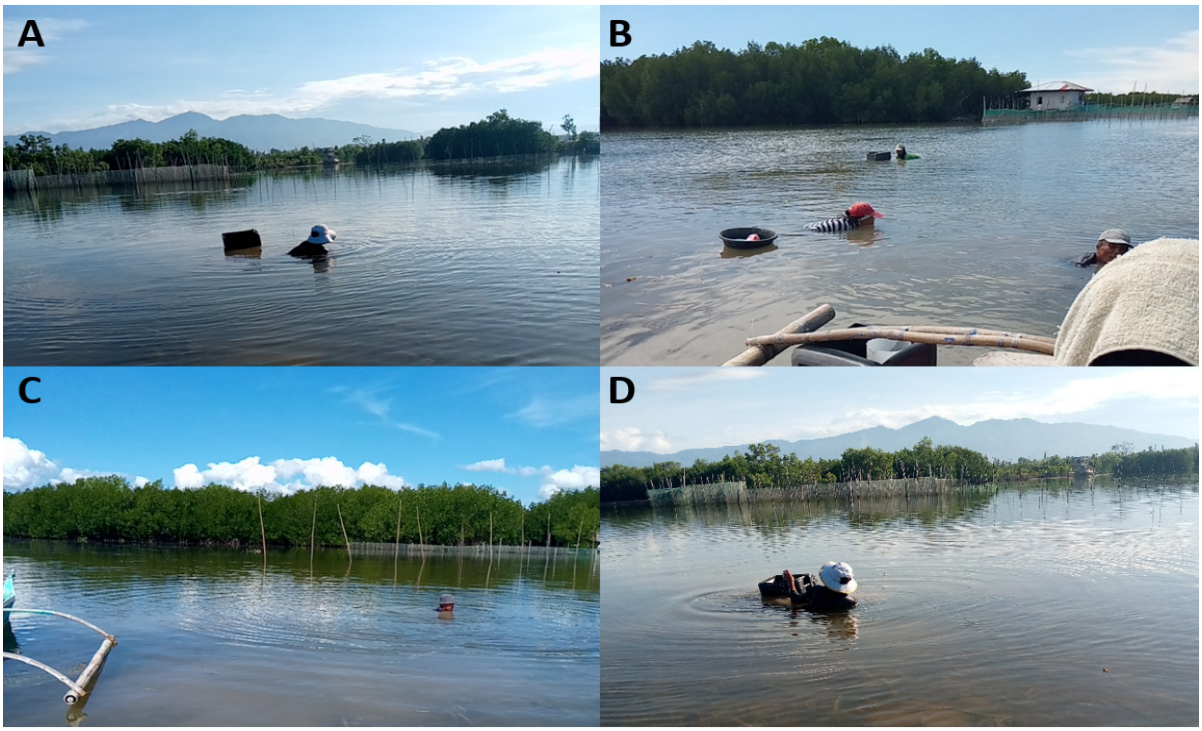

Figure 2. Collection of samples: A) Northeastern part of the site, earlier during collection; B) Northwestern part of the site, midway during collection; C) Southeastern part of the site, midway during collection; D) Northeastern part of the site, later during collection.

the *Pegophysema philippiana* that are 3.5 cm and above in length will be considered mature.

Physicochemical parameters

Physicochemical parameters were obtained on-site to evaluate whether they were detrimental or conducive to *Pegophysema philippiana's* growth and proliferation. Using a mercury thermometer, the area's temperature was obtained by dipping the thermometer's lower half a few cm into the sea surface water for one minute. For water salinity, a few drops of seawater were placed on the prism of a refractometer, and the reading was obtained by peering at the scale through the eyepiece. The substrate of the area was identified through sampling and direct observation.

Interview

The participants were selected via purposive sampling. Ten gleaners who specifically target *Pegophysema philippiana* were frequently interviewed on their perspectives of the local conservation status, conservation threats to, and conservation efforts for *P. philippiana* prevalent in their locale. An interview geared for value chain analysis was also conducted to determine the economic value in terms of the market price of *P. philippiana* sourced from Sitio Maitom. The questionnaires are self-structured and validated by three experts on biodiversity, economic valuation, and fishery.

Value Chain Analysis

Value chain analysis was used to assess the local economic value of Sitio Maitom's *Pegophysema philippiana* in Mati City, and this was conducted simultaneously with the interview. A referral sampling was utilized to trace the flow of Sitio Maitom's *P. philippiana* in Mati's market economy, starting with the ten gleaners interviewed initially, inquiries were made to identify other participants involved in the distribution of Sitio Maitom's *P. philippiana* supply. There

were 4 peddlers, three markets, and three restaurants identified by the participants. They were interviewed on their knowledge of the primary and support activities undergone by Sitio Maitom's *Pegophysema philippiana* in the value chain and how each step adds or subtracts to its value price.

Data Analysis

Comparative analysis was used to determine the differences in density, length, weight, maturity, and physicochemical parameters of the *Pegophysema philippiana* in Maitom with the average properties exhibited by the *P. philippiana* in Bersaldo's study. Also, we used Spearman's correlation test to determine whether there was a solid length-weight relationship.

RESULTS AND DISCUSSION

Density

During sample collection, a total of 377 *Pegophysema philippiana* specimens were gathered. By utilizing the density formula, we determined that the population density, measured as the number of individuals per square meter, is 4. Comparing this value to the average density of clams observed in Bersaldo's study, which was 6, we can conclude that there is a scarcity of *P. philippiana* in Maitom. Although the difference in density is small, it becomes more pronounced as the area size increases.

Length and weight

The collected *Pegophysema philippiana* specimens were grouped based on their length and weight (as shown in Table 1 and Table 2). Most of the *P. philippiana* fell within the length range of 3.5 to 4.4 cm and weighed between 10 to 19.9 g, which is very close to the calculated average length of 3.8 cm and weight of 21.2 g for this group. Comparing these findings to Bersaldo's study, where the majority of *P. philippiana* fell within the length range of 3.5 to 4.4 cm and weighedbetween 20 to 29.9 g, with a calculated average length of 4 cm and weight of 27.7 g, we observed that while the majority of *P. philippiana* in Maitom share the same length range as in Bersaldo's study, the majority of Maitom's clams have slightly smaller weight ranges and average length and weight compared to Bersaldo's study. It is also important to note that unlike in Maitom, there have been *P. philippiana* specimens with lengths greater than 5.6 cm and weights greater than 59g observed in Bersaldo's study.

Table 1. Length range of *Pegophysema philippiana* in Maitom, Dahican, Mati City, Davao Oriental.

Length range (cm)	n	%
1.5-2.4	3	0.80
2.5-3.4	100	26.52
3.5-4.4	225	59.68
4.5-5.4	48	12.73
5.5-6.4	1	0.27
TOTAL	**337**	**100**

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Table 2. Weight range of *Pegophysema philippiana* in Maitom, Dahican, Mati City, Davao Oriental.

Weight range (g)	n	%
1-9.9	38	10.08
10-19.9	150	39.79
20-29.9	118	31.30
30-39.9	51	13.53
40-49.9	14	3.71
50-59.9	6	1.59
TOTAL	**377**	**100**

Using Spearman's correlation test, we observed a strong positive relationship (0.87, higher than Bersaldo's correlation coefficient of 0.86) between the length and weight of *Pegophysema philippiana* in Maitom (as depicted in Figure 3). This finding indicates that the shell length can be a reliable predictor of *P. philippiana's* weight, as the length and weight exhibit a direct proportional relationship. Specifically, as the length of *P. philippiana* increases, its weight also increases. Despite this proportional relationship, the collected *P. philippiana* samples exhibited allometric growth, similar to the results in Bersaldo's study.

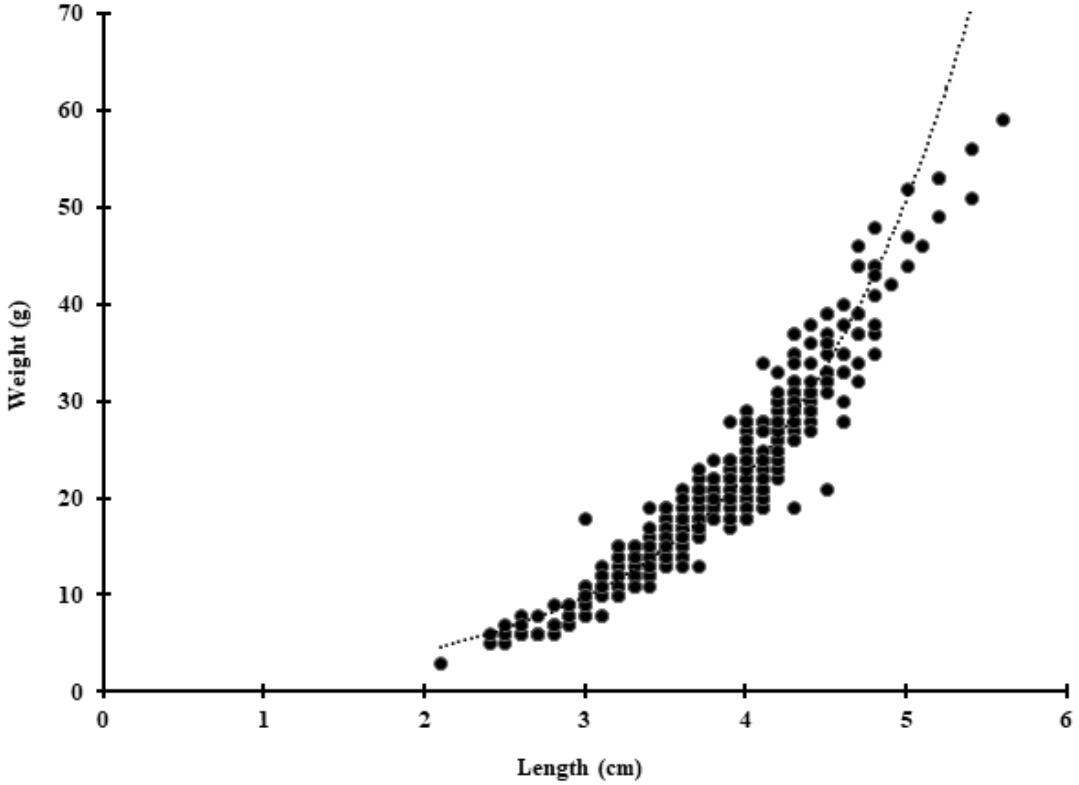

Figure 3. Length and weight of *Pegophysema philippiana* scatter plot.

Maturity

The maturity of *Pegophysema philippiana* serves as an indicator of potential over exploitation in the area. Among the collected *P. philippiana* specimens, 27% were identified as immature, which is 1% lower than the average of 28% reported in Bersaldo's study. According to the interviews conducted, Gleaners determine the maturity of *P. philippiana* using manual assessment. They employ two methods: Firstly, they determine maturity by comparing the clam's size to the size of their thumb, considering clams smaller than their thumb as immature. Secondly, they evaluate maturity by checking if the clam fits within the circumference formed by their joined thumb and pointer finger, with clams fitting within this circumference also considered immature. Their methods are unreliable as human anatomy comes in varying proportions, and any gleaner with a thumb smaller than 3.5 cm abiding by this standard will include immature clams in their collection process. The same goes for the second method.

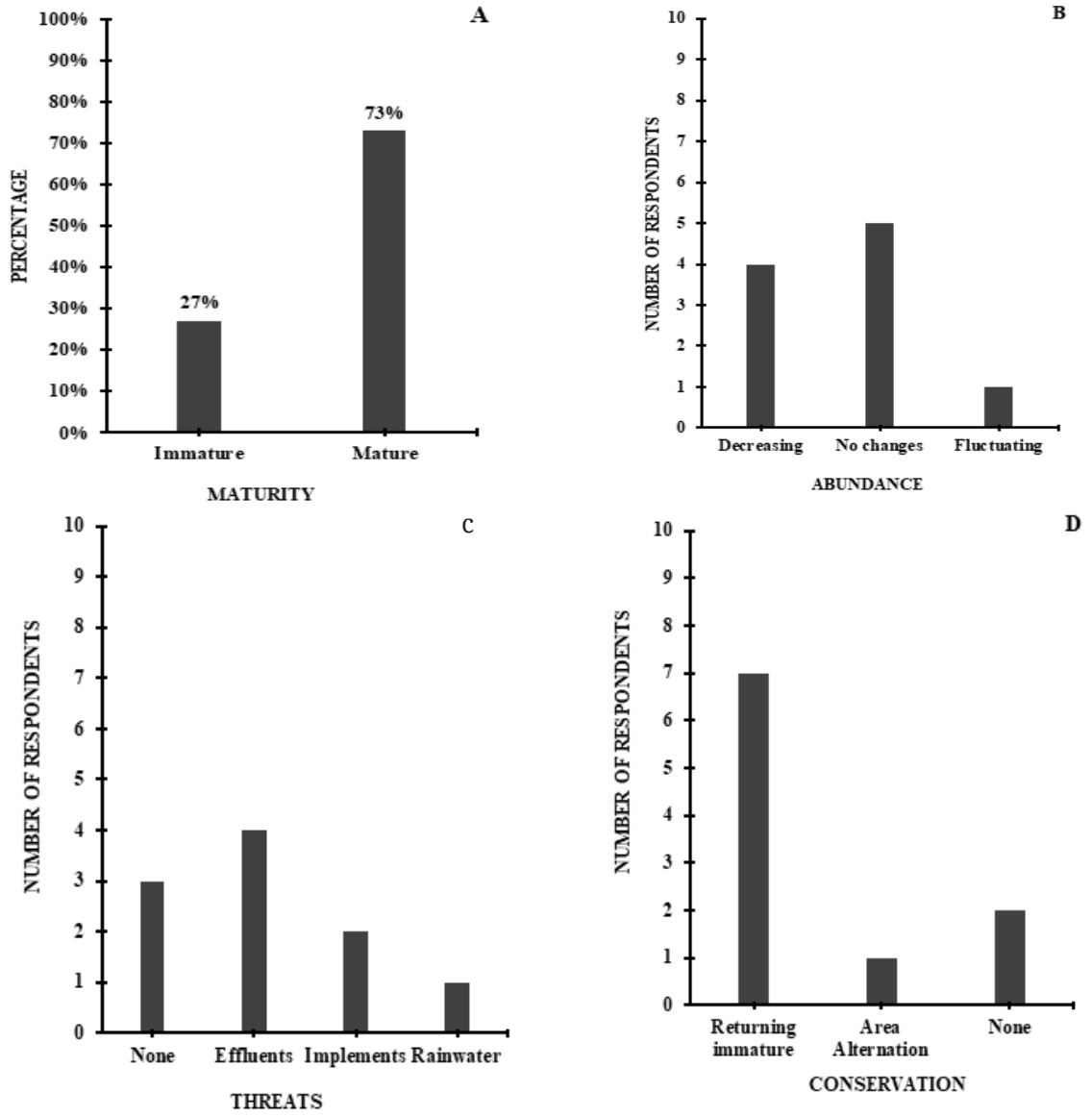

Figure 4. A) Sexual maturity of *Pegophysema philippiana*; B) Local perception on the Conservation Status of *Pegophysema philippiana;* C) Local perception on the Conservation Threats of *Pegophysema philippiana;* D) Local perception on the Conservation Efforts for *Pegophysema philippiana.*

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Physicochemical parameters

The average temperature of Maitom's seawater is measured at 25⁰ C, with an average salinity of 51.7 ppt, and the substrate composition in Maitom consists of a mixture of sediments, mud, humus, and fragments of decayed organic matter. Bersaldo's study reported an average temperature of 30⁰ C, a salinity of 28.3 ppt, and a mud substrate. These differences in environmental factors suggest that the Maitom and Bersaldo et al. (2022) site exhibits considerable variations in temperature, salinity, and substrate composition. Further analysis of these contrasting conditions is necessary to understand their implications on the ecology and distribution of *Pegophysema philippiana* in both areas.

Local Perception

When respondents were asked about their observations regarding the population of *Pegophysema philippiana*, four out of 10 indicated a decrease, five reported no changes in quantity, and one mentioned that the population has constantly fluctuated. The four respondents who mentioned that there is a decrease in quantity claim that the cause is the wastewater of an adjacent prawn pond, two of the four, in particular, are gleaners who only glean *P. philippiana* and glean daily given that conditions such as weather and tides are favorable. The decrease due to prawn pond wastewater could be true since prawn ponds use chemicals that can sterilize the water of unwanted organisms before breeding. After harvesting, harmful polluted water is discharged (Vigneswaran et al., 1999), but further study must be conducted to prove or disprove this notion. Regarding the "fluctuating" response, the gleaner might refer to the species' seasonality. It is important that we determine if there is indeed a decline in population as this species plays a role not only in the economy as a food and income resource but also plays a role in the mangrove's ecology (Adan, 2000; Lebata, 2001; Furkon et al., 2019).

When asked about observed conservation threats against *Pegophysema philippiana*, three out of 10 respondents mentioned none, four respondents said occasional drainage of wastewater from a nearby prawn pond into the *P. philippiana's* habitat leads to their mortality, two respondents cited the damaging impact of the digging blades used during *P. philippiana* collection on its habitat, and one respondent highlighted the detrimental effects of excessive freshwater from rainfall, causing flooding and subsequent mortality of the *P. philippiana.* According to the statements of the four respondents who expressed concern about the wastewater threat, the wastewater used in clearing ponds of unwanted organisms before culturing and after harvesting contains chemicals that sterilize the water. They highlighted that a previous gleaning area in Maitom, which was close to the wastewater discharge point, now shows a scarcity of *P. philippiana,* leading them to cease gleaning activities there. Though there is no direct study conducted in Maitom to back up their claim, it is known that effluents are threatening and can sterilize organisms in bodies of water if not appropriately managed (Vigneswaran et al., 1999). The respondents also believe that the current sampling area, where they currently glean, is affected by the wastewater, albeit to a lesser extent, owing to a significant distance between the site and the wastewater discharge point. The two who mention the blade threats add that in the hands of an inexperienced gleaner, the blade can be used inadequately and, in turn, needlessly damaging, as they are yet to develop and understand how to dig efficiently to minimize the damage done, and selectively dig only the mature *P. philippiana* with considerable length and weight, a similar concern has been observed in a study cataloging gleaning practices at Baganga (Bantayan, 2022). The sole respondent mentioning excessive rainfall explains that *P. philippiana* prefers saltwater and is not adapted to freshwater. Thus, excessive rainfall that leads to freshwater flooding in the mangroves kills off the *P. philippiana.*

When asked about observed conservation efforts to protect *Pegophysema philippiana*, two out of 10 respondents mentioned none, one respondent said the exclusion of immature *P. philippiana* from harvesting, and seven respondents mentioned the practice of alternating between Maitom and Guang-guang areas to allow *P. philippiana* to repopulate. No other methods were observed. Although the exclusion of immature specimens is a good approach, their unreliable manual assessment method of determining maturity defeats the purpose. Innovative practices in gleaning should be implemented, one that is sustainable and helps conserve the species better (Simon, 2021).

Value Chain Analysis

The process of preparing for the gleaning of *Pegophysema philippiana* involves having a blunt knife (i.e., bolo), containers, and, optionally, goggles for gleaners to dive during high tide. The estimated cost of these materials ranges from Php 700-Php 1000 and may require periodic replacement due to wear and tear. To reach the gleaning area, gleaners will walk barefoot, rent a boat, or hitch free rides on fishing boats passing by. Regarding operations, *P. philippiana* undergoes minimal processing by gleaners and peddlers (from Maitom) who sell it directly. Occasionally, a cleaning service is offered, which enhances the price. Uncleaned *P. philippiana* typically sells Php 120/kg-Php 130/kg, while the cleaned variety commands a higher cost of Php 140/kg-Php 180/kg. The prevailing standard price is around Php 150/kg, although factors like quantity and quality can influence pricing. For outbound logistics, gleaners and peddlers (from Maitom) distribute their products to predetermined buyers, such as other retailers, like other peddlers (outside Maitom) and displays in local markets (within Barangay Dahican and adjacent Barangays), and direct sales to restaurants and costumers. The cost of transportation is typically not factored into the pricing of *P. philippiana* and needs to be accounted for. The *P. philippiana* industry in Maitom needs more firm infrastructure, human resource management, marketing and sales strategies, and technology development, resulting in the absence of secondary or support activities beyond procurement.

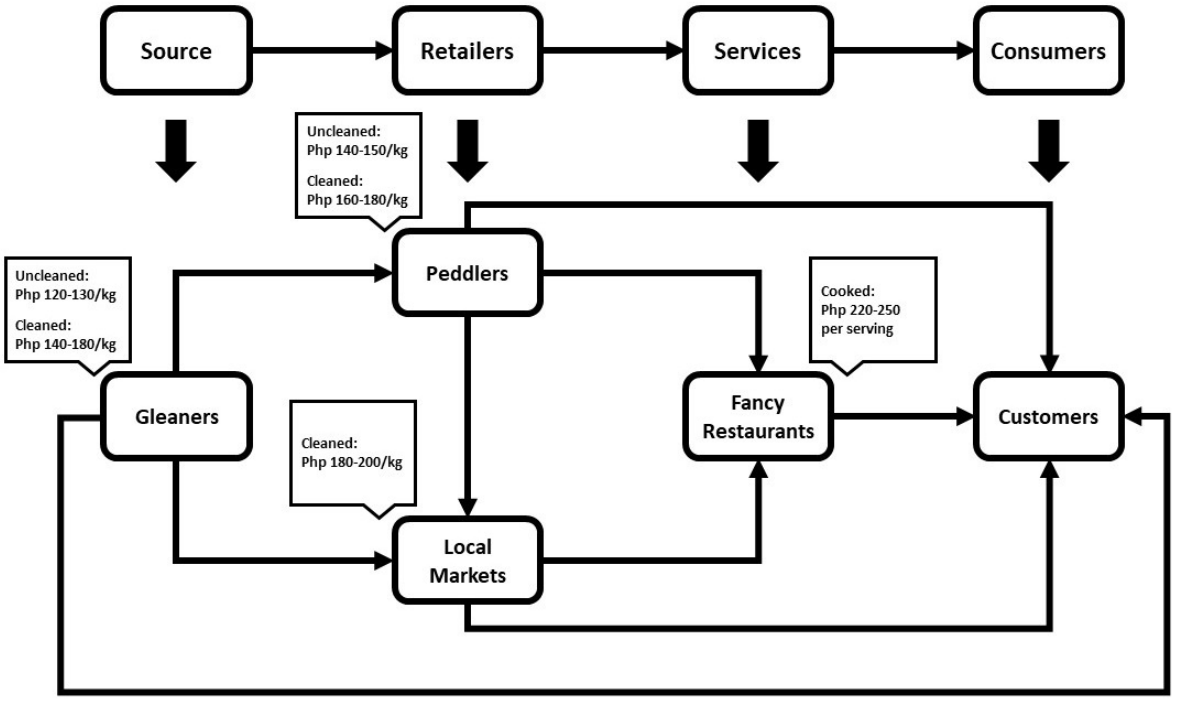

Figure 5. Value Chain of *Pegophysema philippiana* in Mati City, Davao Oriental.

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CONCLUSION

The *Pegophysema philippiana* in Maitom has a lower density, average length, and weight, and there is a need for specimens larger than 5.6 cm and heavier than 59 g. These observations suggest the need to enhance conservation efforts. Wastewater from adjacent prawn ponds is a threat; means to reroute or neutralize its' chemical effects should be developed, and gleaners should invest in improving implements and harvesting practices to alleviate habitat destruction and harsh collection. Conservation efforts include alternating between gleaning sites to allow repopulation and the return of premature specimens. The former is not enough to ensure the survival and sustainability of *P. philippiana* alone, and the latter is not effective as the gleaners employ an unreliable manual assessment for maturity, as it includes specimens smaller than 3.5 cm. Maitom's *P. philippiana* fishery is artisanal, caught in the wild, and not operated commercially, e.g., aquaculture. Thus, it still has points to improve on, such as finding suitable areas where this can be cultured so that gleaners who are mainly subsistent can have a better livelihood. The local economic value of *P. philippiana* sourced from Maitom ranges from Php 120/kg-Php 180/kg, with Php 150/kg being the average price. This price was established through an aggregation of mutual consent by the parties involved in its distribution, and this pricing was not derived through formal procedures. The *P. philippiana* fishery should be protected and conserved to make it sustainable, which could benefit the local market.

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