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Original research article

Analysis of the Sustainability Status of Mangrove Crab (*Scylla sp.*) Populations in the Mangrove Area of Bengkalis Regency, Riau, Indonesia

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ABSTRACT

The mangrove ecosystem of Bengkalis Regency serves as a critical habitat for the mud crab (Scylla sp.). However, intense exploitation pressure and habitat degradation driven by anthropogenic activities threaten the sustainability of this crustacean stock in the wild. The aim of this study was to analyze the biological characteristics of mud crab (Scylla sp.) populations, evaluate the sustainability status of mud crab resources in the mangrove coastal area of Bengkalis Regency, and formulate adaptive management strategies to support sustainable fisheries management. The research was conducted from April to May 2025 using secondary data from the Ministry of Marine Affairs and Fisheries of Indonesia and relevant scientific publications. A Systematic Literature Review (SLR), meta-analysis, and Rapfish-MDS approach were employed to assess the sustainability status of mud crab (Scylla sp.) resources. using a Systematic Literature Review (SLR) and meta-analysis approach based on quantitative secondary data compiled from multiple scientific journals. The multi-dimensional sustainability status (ecological, economic, and socio-cultural dimensions) was adaptively evaluated using the Rapid Appraisal for Fisheries (Rapfish) technique based on Multi-Dimensional Scaling (MDS). Results and Discussion: Morphometric synthesis revealed that the S. serrata population exhibits a negative allometric growth pattern (b<3), indicating that carapace width growth is more dominant than weight gain due to moulting cycles and environmental conditions. The Rapfish analysis showed that the multi-dimensional sustainability index of the Bengkalis coastal area scored 45.3, classifying it under the Less Sustainable category. The economic dimension was identified as the primary vulnerability point with the lowest score (40.4), followed by socio-cultural (44.7) and ecological dimensions (48.7). Statistical validation proved robust, with Stress values of 0.14–0.17 and R2 of 0.94–0.96. Key leverage attributes

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identified include the fishermen's marketing system (RMS 8.1), ecotourism diversification (RMS 6.9), and the effectiveness of physical mangrove rehabilitation (RMS 1.1). Formulated adaptive management strategies include implementing silvofishery systems, enforcing catch-size regulations under Regulation of the Minister of Marine Affairs and Fisheries No. 12 of 2020, and strengthening Community Surveillance Group based on local wisdom.

Introduction

Mangrove ecosystems in the Mangrove Area of Bengkalis Regency, have experienced increasing environmental pressure due to coastal development, land conversion, and intensive fisheries exploitation. These pressures may reduce habitat quality and affect the ecological functions that support mud crab populations. Previous studies have demonstrated that habitat degradation can alter population structure, reduce recruitment success, and decrease fisheries productivity. Therefore, integrating biological population assessments with sustainability evaluations is essential to provide a scientific basis for adaptive management and conservation planning in mangrove-dependent fisheries (Farhaby, 2024).

The coastal mangrove areas of Bengkalis Regency, Riau, which fall within the scope of the Indonesian Fisheries Management Area (IFMA) 571, are essential ecosystems with high primary productivity and serve as critical habitats (nursery, feeding, and spawning grounds) for various economically important biota. One of the main commodities that heavily depends on the sustainability of this ecosystem is crabs (*Scylla* sp.). As the primary means of livelihood for local fishermen, the exploitation pressure on mangrove crabs in this area continues to increase along with high demand from both domestic and export markets. The potential of mangrove crab fisheries is an important livelihood for local fishermen, so the sustainability of this resource is closely expanded discussion on Negative Allometric Growth Patternelated to the health of the mangrove ecosystem (Adibrata *et al*., 2024).

However, the degradation of mangrove areas due to land conversion and anthropogenic activities (Nabilla *et al.,* 2022) on the coast of Bengkalis threatens the carrying capacity of the habitat, which has the potential to trigger a decline in population stock (overfishing). Therefore, a deep understanding of the population and habitat conditions is very necessary to maintain regional ecological and economic stability. Research on the population dynamics and biological aspects of mangrove crabs (*Scylla* sp.) has actually been conducted extensively before. Some previous studies focused on fecundity aspects, growth patterns, and sex ratios in areas near the Malacca Strait. Studies on the population dynamics of *Scylla* sp. covering sex ratio parameters and allometric growth patterns in the west coast corridor of the Malaka Strait are based on research (Pratiwi & Dimenta, 2021).

In the Mangrove Area of Bengkalis Regency, existing research is generally still limited to macro-level mangrove vegetation analysis or general fishermen's catch inventories, without specifically linking them to the carrying capacity of *Scylla* sp. populations. So far, there has been no comprehensive study that integrates population biological parameters (such as growth patterns and sex ratios) with multidimensional sustainability status, including ecological dimensions, fishing technology, and socio-economic aspects specifically in the coastal mangrove areas of Bengkalis Regency, which have the unique

hydrographic characteristics of the Malacca Strait. Crab trapping technology used by local fishermen generally consists of folding traps (Sari *et al*., 2021). The scientific novelty of this article lies in the application of a multidimensional sustainability status analysis approach that integrates the biological-ecological data of *Scylla* sp. populations directly with the portrait of local utilization dynamics at the border waters of IFMA 571. Unlike previous studies that examine population biology and coastal management aspects separately, this research constructs a model for assessing sustainability status that is holistic and contextual to environmental pressures in Bengkalis. The main issue in this study is the imbalance between the rate of mangrove crab exploitation by fishers and the natural recovery capacity of the population amid the ongoing rate of mangrove habitat degradation in Bengkalis.

Regarding this issue, the hypothesis proposed in this study is that the sustainability status of the mud crab (*Scylla* sp.) population in the coastal mangrove areas of Bengkalis Regency is currently in the less sustainable category. Therefore, this study aims to analyze the biological characteristics of mud crab (*Scylla* sp.) populations, evaluate the sustainability status of mud crab resources in the mangrove area of Bengkalis Regency, and formulate adaptive management strategies to support sustainable fisheries management in the Indonesian Fisheries Management Area (IFMA) 571.

Sustainable management of mud crab resources requires a comprehensive assessment that not only considers biological and ecological aspects but also incorporates economic and socio-cultural dimensions. The sustainability of fisheries resources is closely influenced by the interaction between environmental conditions, exploitation patterns, community welfare, and institutional capacity (Firmansyah *et al.,* 2024; Putri *et al*., 2024). Therefore, an integrated evaluation approach is needed to provide a more holistic understanding of resource conditions and management performance. One of the methods widely applied in fisheries sustainability studies is the Rapid Appraisal for Fisheries (Rapfish), which enables multidimensional assessment through ecological, economic, and socio-cultural indicators. This approach can identify sensitive attributes that significantly influence sustainability status and provide a scientific basis for developing adaptive management strategies in coastal ecosystems.

Despite the growing number of studies on mud crab population biology and mangrove ecosystem management, research integrating biological characteristics with multidimensional sustainability assessments remains limited, particularly in the coastal mangrove areas of Bengkalis Regency within the Indonesian Fisheries Management Area (IFMA) 571. This study offers a novel perspective by combining biological information on mud crab populations with ecological, economic, and socio-cultural sustainability analyses using the Rapfish approach. It is hypothesized that the sustainability status of mud crab resources in the study area is currently under pressure due to increasing exploitation and ongoing habitat degradation. Therefore, this study aims to analyze the biological characteristics of mud crab (*Scylla* sp.) populations, evaluate their sustainability status, and formulate adaptive management strategies to support sustainable fisheries management in IFMA 571 (Siahainenia & Makatita, 2023).

The negative allometric growth pattern observed in this study indicates that the increase in carapace width is more rapid than the increase in body

weight. Similar findings have been reported in several mangrove ecosystems in Indonesia, suggesting that negative allometric growth is a common biological characteristic of mud crab populations inhabiting estuarine and mangrove environments. Environmental conditions, particularly salinity, substrate characteristics, food availability, and habitat quality, are important factors influencing the growth performance of (*Scylla* sp.) In mangrove ecosystems, abundant organic matter derived from decomposed litter provides a continuous food source that supports crab growth and development. However, fluctuations in environmental conditions may alter energy allocation patterns, resulting in faster carapace expansion than biomass accumulation. Studies conducted in the mangrove ecosystem of demonstrated that mud crab populations are strongly associated with environmental parameters and mangrove habitat conditions, highlighting the importance of habitat quality in maintaining healthy populations (Aprilia & Irwanto, 2022).

Furthermore, mangrove forests function as nursery grounds, feeding grounds, and shelter areas for mud crabs throughout their life cycle. The complexity of mangrove root systems provides protection from predators and supports the availability of natural food resources. Research in Bali showed that the diversity and abundance of (*Scylla* sp.) are closely related to the condition and extent of mangrove forests, indicating that habitat degradation may directly affect population abundance and species composition (Pati, 2023). Likewise, studies in the Riau Islands reported that mud crab biological characteristics, including growth patterns and reproductive conditions, are strongly influenced by habitat quality and environmental stability (Nadhifah Raniah , Henri, 2022). Therefore, maintaining mangrove ecosystem integrity is essential not only for conserving biodiversity but also for sustaining mud crab fisheries resources in the long term.

The relationship between mud crab populations and mangrove ecosystems also has important implications for fisheries management. Increasing exploitation pressure, combined with habitat degradation caused by coastal development, pollution, and land conversion, may reduce the carrying capacity of mangrove ecosystems (Susiana *et al*., 2024). Habitat loss can decrease juvenile recruitment, alter population structure, and ultimately reduce fishery productivity. Recent studies have emphasized that mangrove degradation remains one of the major threats to mud crab sustainability because mangroves provide critical habitats for spawning, feeding, and juvenile development. Consequently, effective conservation and rehabilitation of mangrove forests should be considered a priority strategy in sustainable mud crab resource management (Wintah *et al*., 2026).

Research Method

Time and Location of Research

This research was conducted in from April to May 2025 by focusing the analysis of secondary data on the coastal mangrove areas of Bengkalis Regency, Riau. Administratively and ecologically, this area is located within the corridor of the Indonesia Fisheries Management Area (IFMA) 571, which includes the Malaka Strait and the Natuna Sea (MMAF, 2014).

Data Collection Method

The method used in this study is a Systematic Literature Review or SLR and meta-analysis based on quantitative secondary data collected from various national and international scientific journal articles related to the biological parameters of mangrove crabs and the mangrove ecosystem conditions in the

area.

Data Analysis

The evaluation of sustainability status is carried out using the Rapid Appraisal for Fisheries or Rapfish approach, which is based on the Multi-Dimensional Scaling or MDS statistical method (Nabilla *et al.,* 2022). This analysis examines sensitive attributes that are divided into three main dimensions, namely the Ecological Dimension, the Economic Dimension, and the Socio-Cultural Dimension. The sustainability index values resulting from the MDS ordination analysis are grouped into four categories of sustainability status, namely a value of 0.00–25.00 means poor or unsustainable, a value of 25.01–50.00 means less sustainable, a value of 50.01–75.00 means fairly sustainable, and a value of 75.01–100.00 means good or very sustainable (Nabilla *et al.,* 2022).

Results and Discussion

In determining the bio-morphometric characteristics of the *Scylla* sp. population on the coast of Bengkalis Regency, this study integrates multiple empirical data from several western coastal areas of Indonesia that have similar habitat typologies. Through the compilation of carapace width and weight relationship parameters presented in the following table to identify fluctuations in the growth constant values of crustaceans.

Table 1. Comparison of the Relationship Parameters between Carapace Width and Weight of *Scylla* sp. based on Multi-Journal Synthesis

water location	Gender	Sampel Size (n)	Allometric Equation	Constant Value (b)	growth pattern
Karangsong Coast (Sanur *et al*., 2021)	Male Female	520 299	$W = 0.0003L^{2.8793}$	2.8793	Negative Allometric
Tanjung Jabung Timur, Jambi (Setiyawan *et al*., 2025)	Combination	127	$W = 0.003L^{2.3210}$	2.3210	Negative Allometric
Muara Sungai Barumun, Labuhan Batu (Pratiwi & Dimenta, 2021)	Combination	90	$W = 0.0028L^{2.6422}$	2.6422	Negative Allometric

Source: Secondary Data (Sanur *et al*., 2021), (Pratiwi & Dimenta, 2021), dan (Setiyawan *et al*., 2025)

Based on the results in Table 1, the data synthesis shows a strong biological consistency where the allometric constant (b) values from all study locations are less than 3. This concept clearly proves that the mangrove crab population in coastal waters experiences a negative allometric growth pattern. From a macro-biological perspective, this indicates that the growth rate of crab carapace width is much more dominant than the increase in body weight, so the crabs found in the field tend to have wide bodies but relatively light meat mass.

This negative allometric phenomenon does not stand alone, but is simultaneously influenced by internal biological factors and the external conditions of the mangrove habitat. From an internal aspect, (Pratiwi & Dimenta, 2021) explains that the fluctuations in crab weight are greatly influenced by the molting cycle as well as the level of gonad maturity during the mating season. (Sanur *et al*., 2021) stated that when entering the post-moulting phase, crabs will absorb a

large volume of water to loosen and expand their new carapace, resulting in a surge in the size of the carapace dimensions that is not matched by the density of the meat mass.

From the bioecological aspect of the region, the abundance of nutrient availability under the mangrove canopy on the coast of Sumatra also plays a crucial role. The fertility of the mud substrate and the optimal supply of organic matter are very determinant for the annual moulting frequency of crustaceans. (Setiyawan *et al*., 2025). If correlated with the mangrove areas of Bengkalis Regency located in the IFMA 571 area, this negative allometric pattern in males and females suggests that environmental pressure or water quality parameters such as salinity and tidal circulation still support the periodic molting phase for the large mangrove crab commodity.

Evaluation of the Multidimensional Sustainability Index

The environmental carrying capacity in supporting the sustainability of crustacean populations is comprehensively evaluated through the MDS ordination approach of the Rapfish program. The output of secondary data processing that represents the condition of mangrove ecosystem management in Bengkalis Regency is presented in the table as follows.

Table 2. Sustainability Index Values and Statistical Validation Parameters of the Rapfish Model

Environmental Management Dimension	Index Score MDS	Monte Carlo Simulation Value	Mathematical Error Difference Score	Stress Coefficient	Coefficient of Determination (R^2)	Sustainability Status
Ecological Dimension	48.7	48.0	0.7	0.17	0.94	Less Sustainable
Economic Dimension	40.4	40.5	0.1	0.15	0.94	Less Sustainable
Socio-Cultural Dimension	44.7	45.2	0.5	0.14	0.94	Less Sustainable
Multidimensional Cumulative Index	45.3	45.7	0.4	0.14	0.96	Less Sustainable

Source: Secondary Data of Coastal Sustainability Study Report (Nabilla *et al*., 2022)

Based on Table 2, it shows that the multidimensional sustainability index for coastal ecosystem management in Bengkalis Regency is at an absolute figure of 45.3. Referring to the integrated fisheries assessment criteria developed by (Alfira *et al*., 2018), The score formally establishes the status of the study area in the Less Sustainable category. Comparative analysis by dimension shows that the economic sector holds the distinction as the main point of vulnerability with the lowest score of 40.4. This sector is followed by the socio-cultural dimension with a score of 44.7, and the ecological dimension, which occupies the highest position but has not yet reached the ideal sustainability threshold, with a score of 48.7. The degree of scientific reliability of the simulation results was validated through the interpretation of Stress values and the coefficient of determination (R_2). The quantitative data processing results show that the Stress coefficient values ranged from 0.14 to 0.17. This figure meets the scientific feasibility requirements because it is below the maximum standard deviation of 0.20. This reliability is reinforced by obtaining coefficient of determination (R_2) values that fall within the interval of 0.94 to 0.96. The high value indicates that the variation of all sensitive variables included in the model can explain up to 96% of the real phenomena of coastal governance in

Bengkalis. In addition, the stability of the model is demonstrated by the difference value (root-mean-square error) between the results of MDS ordination and Monte Carlo random testing, all of which are below the threshold of 1.0. The small difference value provides scientific assurance that the data structure is robust and free from the impact of data entry errors (Nabilla *et al*., 2022).

Leverage Analysis and Strategic Policy Formulation

The structure of the main lever components that affect the sustainability of the mangrove crab population is presented in the table as follows.

Table 3. Components of Priority Sensitive Attributes for Resource Management Based on Leverage Parameters

Dimension Category	Sensitive Attribute Component Main Lever	Score Value RMS (*Root Mean Square*)
Economic Sector	Marketing structure system for fishermen's catch	8.1
Economic Sector	Percentage level of local workforce absorption	7.6
Economic Sector	Optimization of mangrove landscape aesthetic utilization	6.9
Ecology Sector	Effectiveness of physical rehabilitation of mangrove forest ecosystems	1.1
Social and Cultural Sector	The existence of customary law institutions and the role of non-formal institutions	Very Significant

Source: Processed Data Results of Bengkalis Region Leverage (Nabilla *et al*., 2022)

Based on the data in Table 3, the recovery of the mangrove crab population in Bengkalis Regency demands a reform of the coastal community's economic policies. The high RMS value in the marketing management attribute (8.1) indicates the existence of welfare disparities experienced by fishermen. According to (Ahmad, 2025) The domination of the informal auction system by middlemen often suppresses prices at the lower level. This situation forces fishermen to increase the frequency of their catch without regard to biological limits in order to meet daily financial needs, which triggers the phenomenon of overfishing in coastal areas. As an adaptive solution, (Safitri & Sofiana, 2024) offering a business diversification scheme through the utilization of the aesthetic value of mangrove forests (RMS 6.9) for integrated coastal ecotourism.

From the perspective of ecological sustainability, intervention in the attributes of physical rehabilitation of mangrove ecosystems (RMS 1.1) is of absolute value because mangrove vegetation functions as a nursery ground as well as the main feeding ground for mangrove crabs. The linear damage of mangrove forest areas will cut off the natural recruitment pathways of large mangrove crab populations in the wild. To address this, (Parni *et al*., 2020) recommending the implementation of environmentally friendly aquaculture using the silvofishery system (wanamina). This integration of a mangrove green belt with traditional trench ponds has been proven effective in rehabilitating mangrove forest areas while independently restoring the abundance of mangrove crab populations.

All of these technical steps must be bound by national marine regulatory instruments that are enforced consistently. Referring to the Minister of

Marine Affairs and Fisheries Regulation Number 12 of 2020, the government strictly prohibits the capture of mangrove crabs that are below a carapace width of 120 mm. However, formal surveillance in the waters of the Malacca Strait is often constrained by limited operational fleets. Therefore, strengthening the role of non-formal institutions and customary law structures at the village level becomes key to success (Marsuki *et al*., 2025) concluding that strengthening the Community Surveillance Group (Pokmaswas) based on local wisdom is the strongest defense in ensuring fishermen's compliance with the proper catch size rules to guarantee the sustainability of mangrove crab stocks in the future.

Conclusion

The population of mangrove crabs (*Scylla* sp.) in the coastal area of Bengkalis Regency shows biological characteristics of a negative allometric growth pattern (b<3), where the growth rate of carapace width is more dominant than the increase in body weight due to the influence of moulting cycles and environmental conditions. Based on the Rapfish multidimensional analysis, The sustainability status of this area falls into the Less Sustainable category with a cumulative index score of 45.3, where the economic dimension is the main vulnerability point with the lowest score (40.4), followed by the socio-cultural dimension (44.7) and ecology (48.7). This condition reflects an imbalance between the high rate of exploitation by fishermen for financial needs and the natural recovery capacity of the population amid mangrove habitat degradation. To achieve adaptive and sustainable fisheries management, priority strategies are recommended that focus on the reform of fishermen's marketing systems (RMS 8.1), diversification of integrated ecotourism businesses (RMS 6.9), optimization of physical mangrove rehabilitation through silvofishery systems (RMS 1.1), and enforcement of catch size regulations according to Minister of Marine Affairs and Fisheries Regulation No. 12 of 2020 through the strengthening of Community Surveillance Groups based on local wisdom.

References

Adibrata, S., Wahidin, L. O., Franto, Komarullah, U., Perangin-angin, R., Simanjuntak, H., & Aisyah, L. (2024). Unlocking Mangrove Potential: Sustainable Crab Fisheries in Selindung Sub-watershed, Bangka Island – Indonesia. *Coastal and Marine Journal, 2(2): 71-80. 2*(2), 71–80. https://nusantara-research.com/index.php/coastal-and-marine-journal/article/view/36

Ahmad, T. B. (2025). Bioeconomic Analysis of Mangrove Crab (Scylla serrata) Resources on the Coast of Semarang City. *Undergraduate thesis,* Diponegoro University. https://eprints2.undip.ac.id/id/eprint/32477

Alfira, R., Djafar, S., & Ilmiah. (2018). Sustainability Analysis of Mangrove Crab Utilization on the Coast of Pangkajene and Islands Regency. *Journal of Agricultural Technology Education*, 4(January), 38–48.

Aprilia, F., & Irwanto, R. (2022). The Diversity and Abundance of Mud Crab (Scylla spp.) in The East Coastal Mangrove Ecosystem, Central Bangka. *Biota Jurnal Ilmiah Ilmu-Ilmu Hayati*, *7*(2), 121–132. https://doi.org/10.24002/biota.v7i2.5447

Farhaby, A. M. (2024). Estimation of Biomass and Below Ground Carbon in the Lepar Island Mangrove Ecosystem, South Bangka Regency. *Jurnal Ilmiah PLATAX*, 12(1), 304–311.

Firmansyah, M., Adibrata, S., Muftiadi, M.R., & Perangin-angin, R. (2024).

The Coral Reef Health Disturbance in The Waters of Pongok Island, South Bangka District. *Coastal and Marine Journal,* 2(1), 47-60. https://nusantara-research.com/index.php/coastal-and-marine-journal/article/view/24

MAAF (2014). *Regulation of the Minister of Marine Affairs and Fisheries of the Republic of Indonesia Number 18/PERMEN-KP/2014 concerning the Fisheries Management Areas of the State of the Republic of Indonesia.*

Marsuki., Zulhayyir., & Lukman, S. H. (2025). Mangrove Crab Cultivation Using Vertical Crab House at UMKM Aneka Jaya, Lalolang Village, Tanete Rilau District, Barru Regency. *Journal of Community Service*. 5(4): 268–279. https://doi.org/10.31004/abdira.v5i4.996

Nabilla, L. M., Putra, R. M., & Efriyeldi. (2022). Sustainable Mangrove Ecosystem Management Strategy in Buruk Bakul Village, Bukit Batu Subdistrict, Bengkalis Regency, Riau Province. *National Seminar on Ecosystem and Environmental Protection*. 478–491. https://doi.org/10.24319/jtpk.12.27-38

Nadhifah Raniah , Henri, K. (2022). On the abundance and occurrence of the mangrove crabs, *Scylla spp.* (Crustacea: *Portunidae*) from Munjang mangrove, Bangka Belitung Island. *Jurnal Riset Biologi dan Aplikasinya*, 4(2), 75-82. https://doi.org/10.26740/jrba.

Parni, B., Prianto, E., Hasbi, M., & Hendrizal, A. (2020). Pengembangan Budidaya Kepiting Bakau (*Scylla sp*) Sistem Silvofishery untuk Melestarikan Hutan Bakau di Kabupaten Kepulauan Meranti Provinsi Riau. *Jurnal Kebijakan Perikanan Indonesia*, 12(2), 101–108. https://doi.org/10.15578/jkpi.12.2.2020.101-108

Pati, S. G. (2023). *Impacts of Habitat Quality on the Physiology , Ecology , and Economical Value of Mud Crab Scylla sp .: A Comprehensive Review*. Water, 15(11), 1-39. https://doi.org/10.3390/w15112029

Pratiwi, I., & Dimenta, R. H. (2021). Population of Mangrove Crabs (Scylla serrata) in the Waters of the Barumun River Estuary, Labuhan Batu Regency Reviewed from Growth Patterns and Condition Factors. *Scientific Journal of Biology*. 9(1), 209–222. https://doi.org/10.24319/jtpk.12.27-38

Putri, V. J., Linda, R., & Marista, E. (2024). Diversity of Mud Crabs (Scylla spp.) in the Mangrove Area of Masbangun Village, Teluk Batang District, North Kayong Regency. *Journal of Marine and Coastal Affairs*, 1(1), 34–41.

Safitri, I., & Sofiana, M. S. J. (2024). Mud Crabs in the Mangrove Area of Natuna Regency, Riau Islands. *Jurnal Perikanan*. 14(1), 103–110. https://jperairan.unram.ac.id/index.php/JP/article/view/752/440

Sanur, I. P., Samosir, A. M., Wildan, D. M., & Ervinia, A. (2021). Growth Estimation Of The Mudcrab (Scylla serrata FORSKAL) In Karangsong Waters, Indramayu, West Java Province. *Journal of Fisheries and Marine Technology*. 12(1), 27–38. https://doi.org/10.24319/jtpk.12.27-38

Sari, N., Kurniawan, & Adibrata, S. (2021). Analysis of the Abundance of Mangrove Crab (Scylla tranquebarica) in the Mangrove Area, East Belitung Regency. *Aquatic Science*, 3(2), 23–29. https://journal.ubb.ac.id/index.php/aquaticscience/article/view/3035

Setiyawan, K. A., Depison., Heltria, S., Lisna., Arfiana, B. M., & Magwa, R.

J. (2025). The Relationship of Carapace Width and Weight of Mandaugh Crab (Scylla serrata) In Sinar Village, Kalimantan, District East Tanjung Jabung Khoirudin.

Siahainenia, L. & Makatita, M. (2023). Bioecological Aspects as Basic for Mud Crab (Scylla spp.) Resource Management in Passo Ecosystem Mangroves. *Jurnal TRITON*, 16(1), 8–18.

Susiana, R., Kurniawan, D., Rochmady, Nurwisti, I., Rezky, B., & Lestari, F. (2024). Biological Aspects of Mangrove Crab (*Scylla serrata*) at The Beladen Estuary, Dompak, Tanjungpinang, Riau Islands. *BIOTROPIA*, 31(1), 54–62. https://doi.org/10.11598/btb.2024.31.1.2036

Indonesian Journal of Fisheries Science and Technology. 21(3), 155–161. https://doi.org/10.14710/ijfst.21.3.155-161

Wintah, K., Kiswanto, Sastranegara, M.H. (2026). Diversity of Mangroves and Crabs (Scyllaspp.) in the Ketapang Indah Mangrove Forest, Aceh Singkil, Indonesia. *Jurnal Agosia*, 29(1), 42-47.