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Environment and Socio-Economic Impact of Mangroves at Mobil, Dunggoan, Danao City

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Abstract
This study explored the environmental and socio-economic impacts of the mangrove rehabilitation project in Mobil, Dunggoan, Danao City, Cebu. It examined the demographic profile of residents, their perceptions and contributions to the project, and the effectiveness of project monitoring. In addition, the researchers conducted an actual measurement of the height and spread branches of the planted mangroves. The research employed descriptive method, utilizing surveys and direct measurements to assess the survival rate and growth of mangroves, as well as the distribution of marine life using quadrat method. Findings indicate a significant survival rate of mangroves, with Rhizophora stylosa and Rhizophora apiculata being the predominant species. The project has notably enhanced shoreline protection, erosion prevention, aquatic habitat, water quality, and the aesthetic appeal of the cove. The study underscored the necessity of implementing stricter monitoring, waste management, restoration projects, and community awareness programs to improve mangrove rehabilitation.

Keywords: Nature, livelihood, cove, marine ecosystem, aquaculture

1. Introduction

Mangroves stand as one of the planet's most productive and biologically diverse ecosystems, playing a pivotal role in coastal environments. Vital for biodiversity preservation, they are classified by the Department of Environment & Natural Resources (DENR) as part of the coastal and marine ecosystem, alongside seagrass and coral reefs (Peam Krasaop Fishing Community, 2021). Their significance extends beyond global ecosystems, providing essential services, especially to local communities.

These unique forests flourish along the intertidal zones of tropical and subtropical coasts, offering high productivity and significant carbon sequestration potential. Yet, they face mounting threats from climate change-induced sea-level rise and intensified storm surges (Castillo et al., (2022). While mangroves mitigate coastal flooding, their own future is at risk due to rising sea levels and coastal development pressures, exacerbating the rate of environmental change (Ellison, et al., 2020).

In 2018, a study in Dunggoan Cove underscored regarding mangrove rehabilitation and socio-economic status. Stressors like debris and tidal inundation were identified, potentially causing defoliation and uprooting. Barnacle infestations were also noted, alongside a surprising lack of community engagement in tree planting programs. Illegal small fish net usage persisted, despite regulations. On a positive note, Rhizophora mangroves exhibited consistent growth, indicating suitable environmental conditions.

A follow-up study was conducted in 2022 by Cortes, et al., it is a comprehensive socio-economic assessment in Mobil, Dunggoan was conducted, providing crucial insights into mangrove ecosystem health and significance as well as the updated economic status of the citizens in the area. Recognizing this, a continuation study is imperative to reassess the current state of mangrove ecosystems in Mobil, Dunggoan.

This study aimed to evaluate any shifts since the last assessment, identify new threats, and quantify changes in ecosystem structure and function. By building upon previous research, this continuation study seeks to inform conservation strategies, policy decisions, and sustainable management practices to ensure the long-term health of these vital ecosystems.

1.1 Research Question

The main purpose of this study was to determine the environment and socio-economic impact of the mangrove rehabilitation project to the residents of Mobil, Dunguan, Danao City, Cebu. Specifically, it answers the following sub-problems:

1. What is the demographic profile of the respondents in terms of:

1.1 age,
1.2 address,
1.3 sex,
1.4 reasons of living,
1.5 main source of income,
1.6 boat or fishing materials,
1.7 reasons of catching fish or gleaning,
1.8 estimate income from fishing/gleaning, and
1.9 frequency of fishing/gleaning?

2. What is the perception about mangrove reforestation/rehabilitation?
3. What are the respondents' contributions in the mangrove rehabilitation?
4. What is the level of monitoring of the mangrove rehabilitation project in terms of:

4.1 mangroves survival in the area,
4.2 degree of help to the mangrove rehabilitation project,
4.3 mangrove development due to monitoring, and
4.4 monitoring of mangroves by the Local Government Units?

5. What is the level of importance of the mangrove rehabilitation project in terms of:

5.1 shoreline protection (storms, floods, tsunamis, sea water level rise),
5.2 prevents erosion,
5.3 aquatic habitat
5.4 water quality maintenance, and
5.5 aesthetic (visual appeal for the cove)?

6. What are the policies in mangrove rehabilitation needs to be implemented:

6.1 waste management (garbage, other pollution factors),
6.2 impose strict policies (for any illegal activities),
6.3 strict monitoring management,
6.4 mangrove restoration projects,
6.5 mangrove clean-up drive, and

6.6 community awareness program?

7. Using quadrant method, what are the specific living organisms is live or abundant in the mangrove area?
8. What is the survival rate of the mangroves in Mobil, Dunggoan Cove in terms of:

8.1 number of mangroves planted,
8.1.1 planted in year 2013 to 2014,
8.1.2 planted in year 2015 to 2016,
8.1.3 planted in year 2017 to 2019,
8.1.4 planted in year 2020 to 2024?
8.2 number of planted mangroves that survived,
8.2.1 planted in year 2013 to 2014,
8.2.2 planted in year 2015 to 2016,
8.2.3 planted in year 2017 to 2019,
8.2.4 planted in year 2020 to 2024?
8.3 height and spread of the branches of planted mangroves that survived, and
8.3.1 height of planted mangroves survived in year:
8.3.1.1 planted in year 2013 to 2014,
8.3.1.2 planted in year 2015 to 2016,
8.3.1.3 planted in year 2017 to 2019,
8.3.1.4 planted in year 2020 to 2024?
8.3.2 highest spread of the branches of planted mangroves survived in year:
8.3.2.1 planted in year 2013 to 2014,
8.3.2.2 planted in year 2015 to 2016,
8.3.2.3 planted in year 2017 to 2019,
8.3.2.4 planted in year 2020 to 2024?
8.4 survival rate?

9. Is there a significant relationship between the height and spread of the mangroves planted in the year:
9.1 2013 to 2014,
9.2 2015 to 2016,
9.3 2017 to 2019,
9.4 2020 to 2024?

10. Based on findings, what recommendations or action plan can be drafted to improve the Mangrove Rehabilitation Project?

1.2 Significance of the Study

Community. The study of mangrove planting serves as effective infrastructure and protection for near residential areas by preventing erosion and absorbing storm surge impacts during major weather events. This also encouraged them to plant or restore mangroves to the people living in the near shore.

Economy. Mangroves particular provide a variety of goods and services that includes provision of food and clean water, impact climate regulation, soil composition management and disaster risk reduction, and recreational space. Furthermore, this enhanced mangrove ecosystems in providing considerable economic advantages, such as tourism and environmental services.

Government. The main socio-environmental benefits are related to the environment and natural resources, the population's factors and solution of saving the seashore by the support of the local

government. Moving towards a more mangrove planting could deliver benefits such as improving the security and protection of coastal areas that mostly affects by the extreme weather events.

Future Researchers. This study might be a basis for developing researcher in the future. This study can be one of their references in conducting a study about the socio-environmental impact assessment of mangrove plantation.

2. Materials and Method

This section presents the methodology that was used in the study. It comprises research design, site and participants, instruments, data gathering, and treatment of data.

2.1 Research Design

This study employed descriptive method to accurately depict the respondents and describe phenomenon, situation, or population under investigation. Quantitative data presentation is utilized. Moreover, an experimental method is employed to determine the height and branch spread of mangrove in their respective location. Additionally, the study also used quadrant method to assess the distribution and abundance of marine life, including fish and other organisms, in the study. The study population comprises fishermen residing near the cove of Mobil, Dunggoan, Danao City, Cebu

2.2 Study Site and Respondents

This study was conducted in Mobil, Dunggoan, Danao City, Cebu, also known as the Dunggoan Cove. The respondents of the study were the fishermen and gleaners near the cove from the three neighboring barangays, Dunggoan, Guinsay, and Taytay. The researchers randomly chose 150 respondents. The researchers conducted the survey questionnaire to the target individuals and explained the questionnaire one at a time while answering.

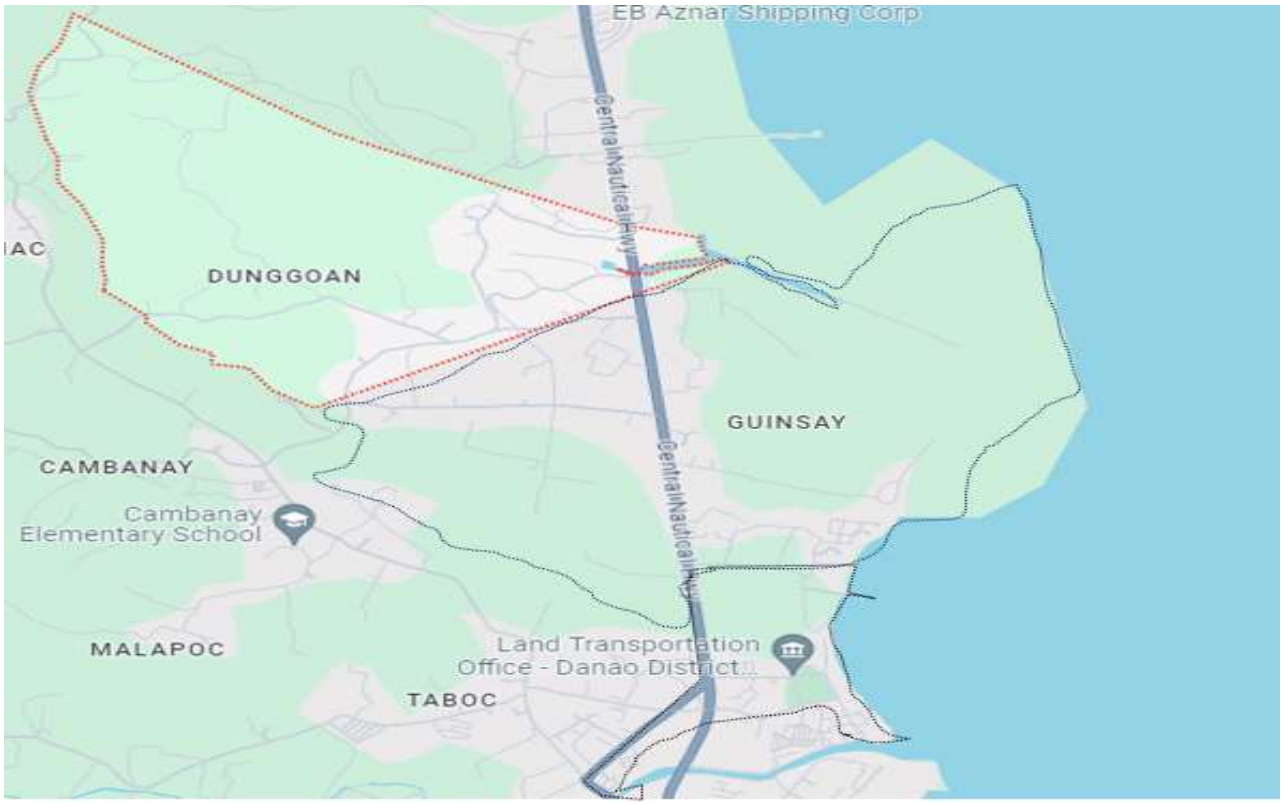


Figure 1: Taytay, Guinsay, and Dunggoan Highway Map

Figure 2. Aerial view of the Mangrove Plantation area at Mobil, Dunggoan, Danao City, Cebu

2.3 Research Instrument

The primary instrument used is the survey questionnaire. Then, researchers set a schedule to survey fishermen and gleaners in low tide condition. Also, the researchers used a push-pull measuring tape to measure the height and width of the mangrove in its respective areas. Additionally, a squared-wood with 1 meter by 1-meter measurement was used as the instrument in conducting the quadrat experiment. Additionally, the analysis employed a conversion scale and 5-point Likert interpretation tailored to the study.

2.4 Data Gathering

The researchers provided a letter of consent to the key informants and secure of their approval. Then, conducting an actual survey was scheduled. With the consent of the respondents, the researchers personally conducted a survey during low tide conditions and held at the location area near mangrove plantation. A marker was placed to mark the area for 2013-2014, 2015-2016, 2017-2019, and 2020-2024. Moreover, the other data was gathered through scheduling to visit the mangrove area for measuring and observing.

2.5 Data Treatment

This study employed various statistical methods for comprehensive data analysis, utilizing numerical statistics such as frequency distribution to characterize the socio-demographic profile distribution. Numerical statistics, including weighted mean, were utilized to measure the perception of the respondents.

2.6 Scoring Procedure

For the interpretation of the weighted mean the following verbal description are stated below.

Table 1: Scoring Procedure for the Weighted Mean of the Level of Monitoring of the Mangrove Rehabilitation Project

Weighted Mean	Category	Verbal Description
3.26-4.0	Very Satisfactory	The respondents found the monitoring of mangroves very satisfactory.
2.51-3.25	Satisfactory	The respondents found the monitoring of mangroves very satisfactory.
1.76-2.50	Dissatisfactory	The respondents found the monitoring of mangroves dissatisfactory.
1.0-1.75	Very Dissatisfactory	The respondents found the monitoring of mangroves very dissatisfactory.

The table shows the scoring procedure for the weighted mean for the results of the level of monitoring of the mangrove rehabilitation project. There were 4 categories with corresponding weighted mean and verbal description. The weighted mean 1.0 to 1.75 means that the respondents found the monitoring of mangroves very dissatisfactory. The weighted mean 1.76 to 2.50 indicates that the respondents found the monitoring of mangroves dissatisfactory. The weighted mean 2.51 to 3.25 indicates that the respondents found the monitoring of man-groves satisfactory. And lastly, the weighted mean 3.26 to 4.0 indicates that the respondents found the monitoring of mangroves very satisfactory. Based on this scoring procedure, the researchers will know the Level of Monitoring of the Mangrove Rehabilitation Project.

Table 2: Scoring Procedure for the Weighted Mean of the Level of Importance of the Mangrove Rehabilitation Project

Weighted Mean	Category	Verbal Description
3.26-4.0	Very Important	The respondents found certain mangrove ecosystem service very important.
2.51-3.25	Important	The respondents found certain mangrove ecosystem service important.
1.76-2.50	Not so important	The respondents found certain mangrove ecosystem service to be not so important.
1.0-1.75	Not important at all	The respondents found certain mangrove ecosystem service to be not important at all.

The table shows the scoring procedure for the weighted mean for the results of the level of importance of the mangrove rehabilitation project. There were 4 categories with corresponding weighted mean and verbal description. The weighted mean 1.0 to 1.75 means that the respondents found that the certain mangrove ecosystem service isn't important at all. The weighted mean 1.76 to 2.50 indicates that the respondents found that the certain mangrove ecosystem service aren't so important. The weighted mean 2.51 to 3.25 indicates that the respondents found that the certain mangrove ecosystem service is important. And lastly, the weighted mean 3.26 to 4.0 indicates that the respondents found that the certain mangrove ecosystem service is very important. Based on this scoring procedure, the researchers will know the Level of Importance of the Mangrove Rehabilitation Project.

Table 3: Scoring Procedure for the Weighted Mean of the Policies in Mangrove Rehabilitation Needs to be Implemented

Weighted Mean	Category	Verbal Description
3.26-4.0	Very Need to Implement	Respondents believe in the very need of implementing specific mangrove contributions.
2.51-3.25	Need to Implement	Respondents believe in the need of implementing specific mangrove contributions.
1.76-2.50	Can be Implemented	Respondents believe specific man-grove contributions can be Implemented.
1.0-1.75	No Implementations' Needed	Respondents believe specific man-grove contributions need no implementations.

The table shows the scoring procedure for the weighted mean for the results of the policies in mangrove rehabilitation needs to be implemented. There were 4 categories with corresponding weighted mean and verbal description. The weighted mean 1.0 to 1.75 means that the respondents believe specific mangrove contributions need no implementations. The weighted mean 1.76 to 2.50 indicates that the respondents believe in the need of implementing specific mangrove contributions. The weighted mean 2.51 to 3.25 indicates that the respondents believe specific mangrove contributions can be Implemented. And lastly, the weighted mean 3.26 to 4.0 indicates that the respondents believe specific mangrove contributions need no implementations. Based on this scoring procedure, the researchers will know the Policies in Mangrove Rehabilitation Needs to be Implemented.

3. Results and Discussion

This chapter presents the presentation, interpretation and analysis of data which may serve as an explanation of the data gathered in this study.

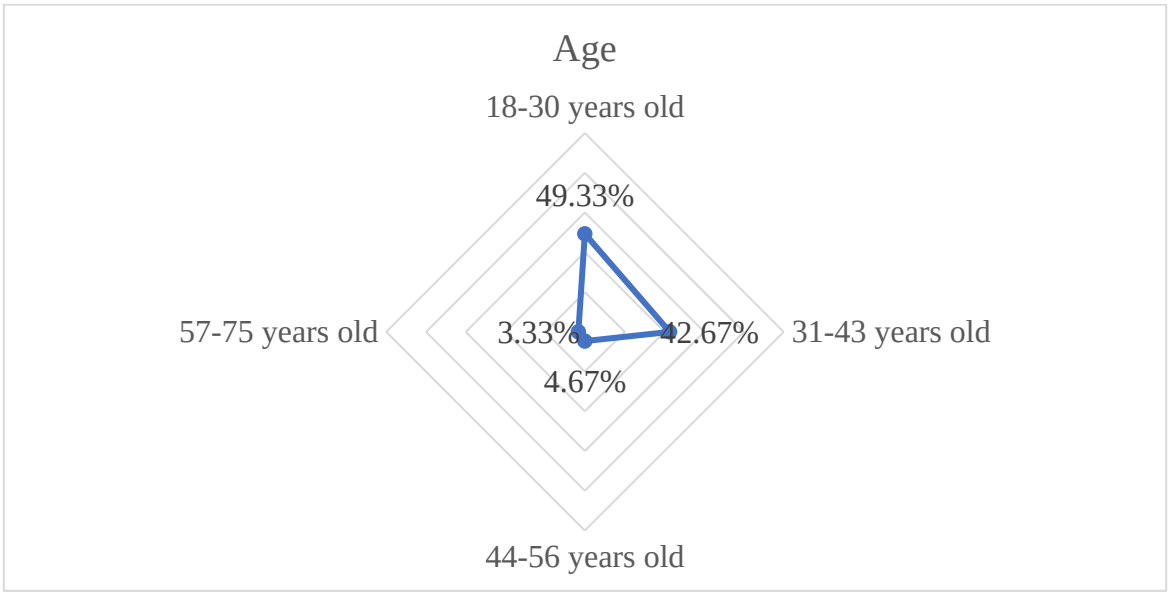
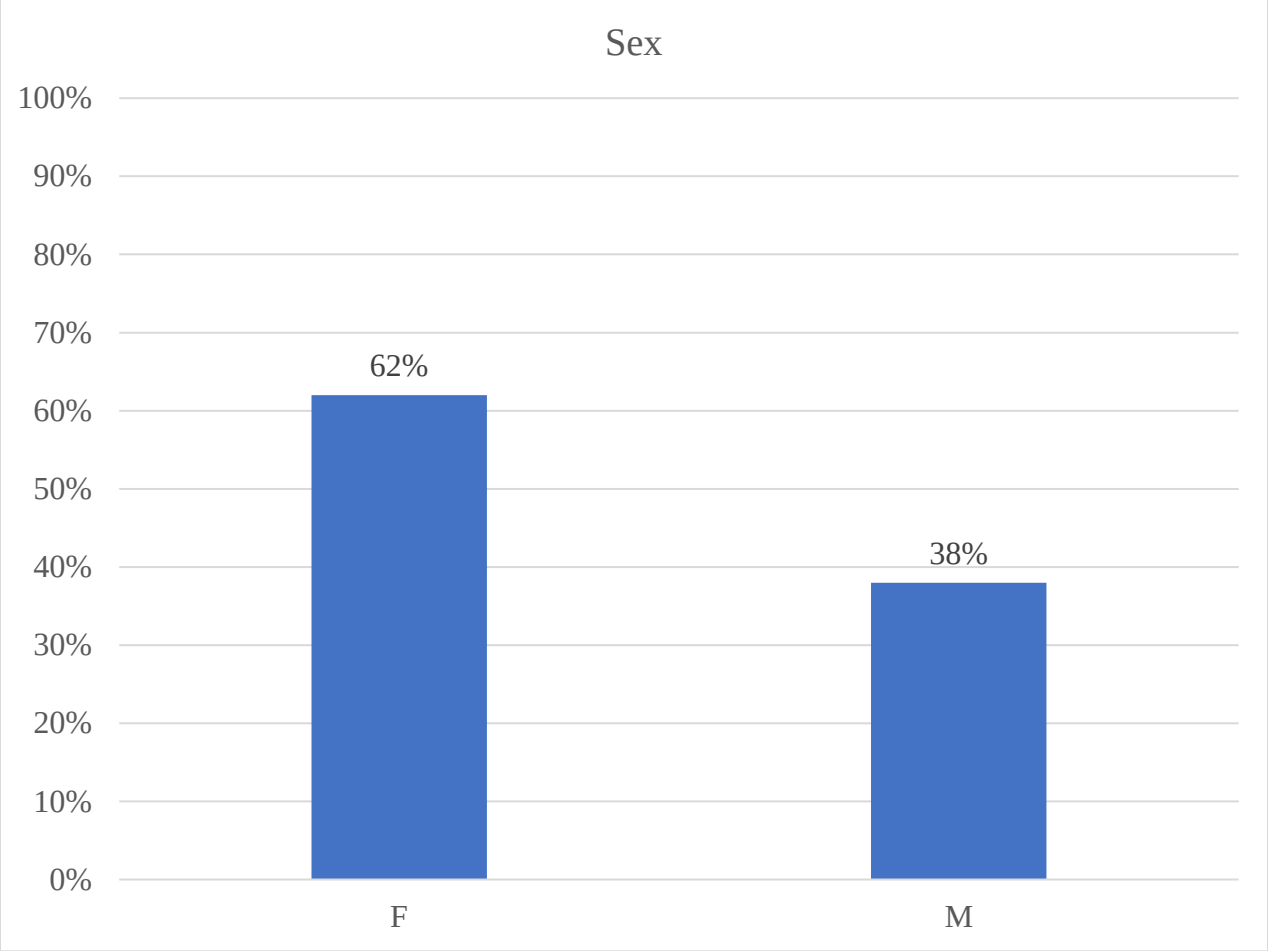


Figure 3. Age of the Respondents

The data shows the age of the respondents. The majority of the 49.33% respondents are 18-30 years of age, 42.67% responds to their age at 31-43 years old, 4.67% of the respondents responds to their age at 44-56 years old and 3.33% of the respondents respond to 57-75 years old which is the least respond. This means that the respondents are old enough to go to the cove for fishing, selling, and/or gleaning shellfish.

According to Jawad (2021), in the province area, 36.2% of fishermen are over 50 years old, with ages ranging from 19 to 77. While, in the marshes near Province, 25.3% of people with selling and fishing livelihood fall into the 31-40 age group, with ages ranging from 19 to 71. Study by Bersaldo and Lacuna (2022) found that most fishers in Fishing Barangays located in Davao Occidental, are between 31-40 years old (36.67%), with a significant portion (30%) falling in the 41-50 age bracket in both areas. Purcell et al. (2020) determined that 17% of the fishers included in the study were women, aged between 19 and 65 years. Men fishers ages ranged from 16 to 68 years, similar to those of the surveyed women.

Figure 4: Sex of the Respondents



The data shows the sex of the respondents. Majority of the respondents are Female which ac-quired 62% of the respondents and the Male is the least response of the respondents which only acquired 38%. This data means that most of the respondents are Female.

According to (Vitukawalu, et al., 2020), women play crucial roles in fisheries and are often the main income earners for their families. They are involved in a variety of activities such as gleaning, fishing, post-harvesting processing, selling, and marketing of value-added products. In Pacific Island markets,

75-90% of vendors are women. This high participation is partly due to the mistaken belief that fishing is mainly a male activity, and the lack of data specifically on women fishers. Women depend heavily on selling fish and other seafood at the markets near the coves. The survey highlighted their dedication to post-harvest processes, sales, and marketing. Therefore, it's important to strengthen and support women's participation in the fisheries sector.

According to Fisheries and Aquaculture Department (2022) about 58.5 million people worked in fisheries and aquaculture, either full-time, part-time, occasionally, or in unspecified roles, with around 21 percent of these being women. Magesa et al. (2024) highlight the important role women play in this sector. The study shows that women contribute significantly to various value-added activities in fisheries and aquaculture, emphasizing the broader discussions on gender, fisheries, and economic development.

The researchers Lampe, M., Waris, R. & Rajab, M. (2020), men are considered to be physically active at sea to adapt to the circumstances of nature and employment, but women are physically weak, so they dwell on land to conduct a range of activities that are generally light and safe, primarily domestic affairs.

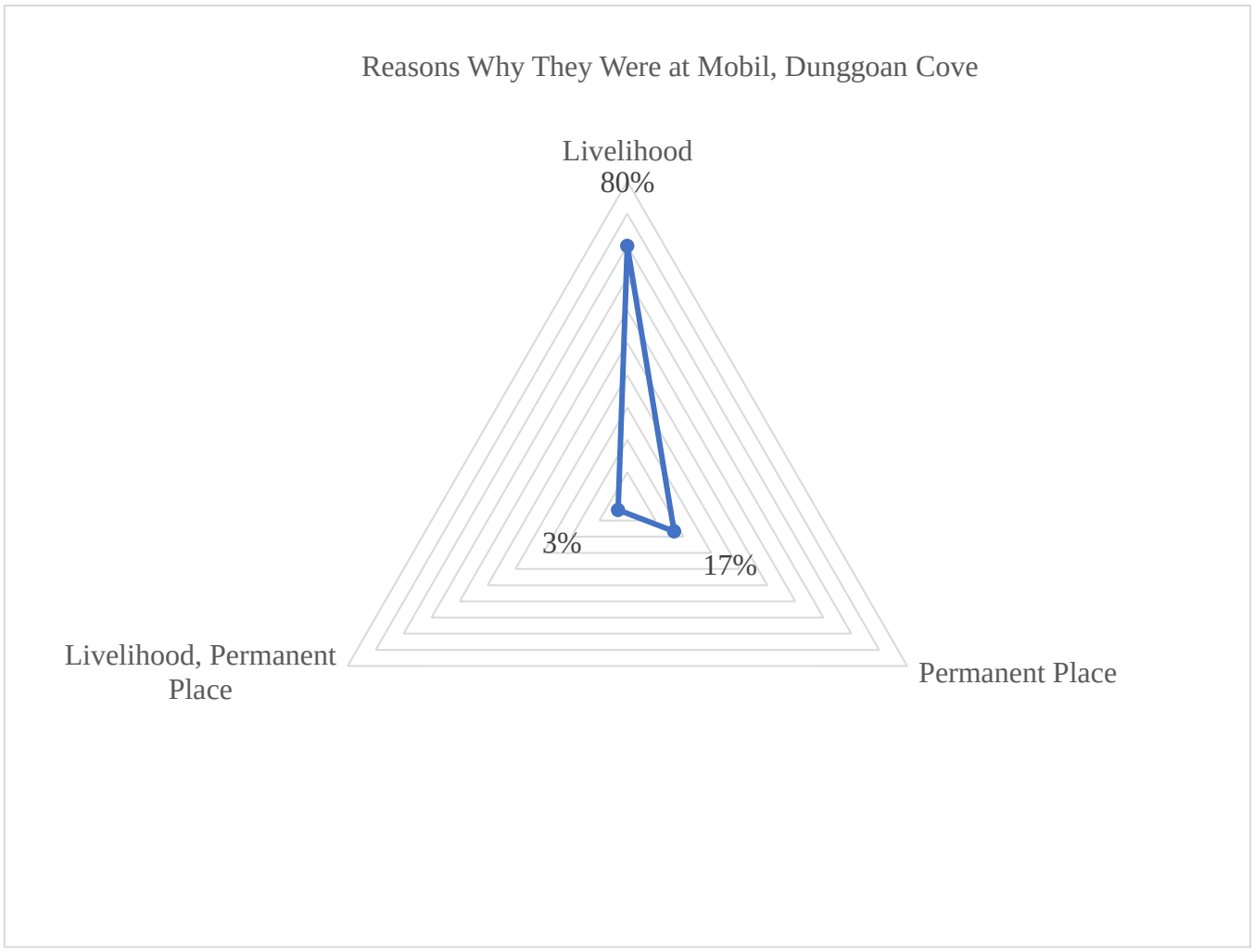


Figure 5: Reasons of the Respondents Why They Were at Mobil, Dunggoan Cove

The data shows the reasons of the fishermen respondents why they were at Mobil, Dunggoan Cove. The majority of the respondents acquired 80% of responses said that they were at the cove are for their livelihood, 17% of responses said that it is their permanent place, and atleast 3% of responses said the

cove was both their livelihood and permanent place. This means that most of the respondents in Mobil, Dunggoan Cove are there for their livelihood.

According to Idrus, A., Syukur, A. & Zulkifli, L. (2019), mangrove ecosystems are natural resources in coastal locations that have their own ecological systems and have served as a source of food for locals. In this sense, mangrove sustainability is critical to ensuring that people's livelihoods are not jeopardized. In addition, local residents in coastal areas rely heavily on fisheries and coastal resources for a living (Barua, P. & Rahman, S. H. (2019).

Mangroves play an important role in local livelihoods. Mangroves provide different sources of income for many households. In terms of local livelihoods, mangroves provide diverse sources of income for many households. The rich biodiversity and resources found in mangrove forests support various economic activities. This includes the farming of fish, shellfish, and other marine species that thrive in the waters of mangrove ecosystems (Thuy, 2021).

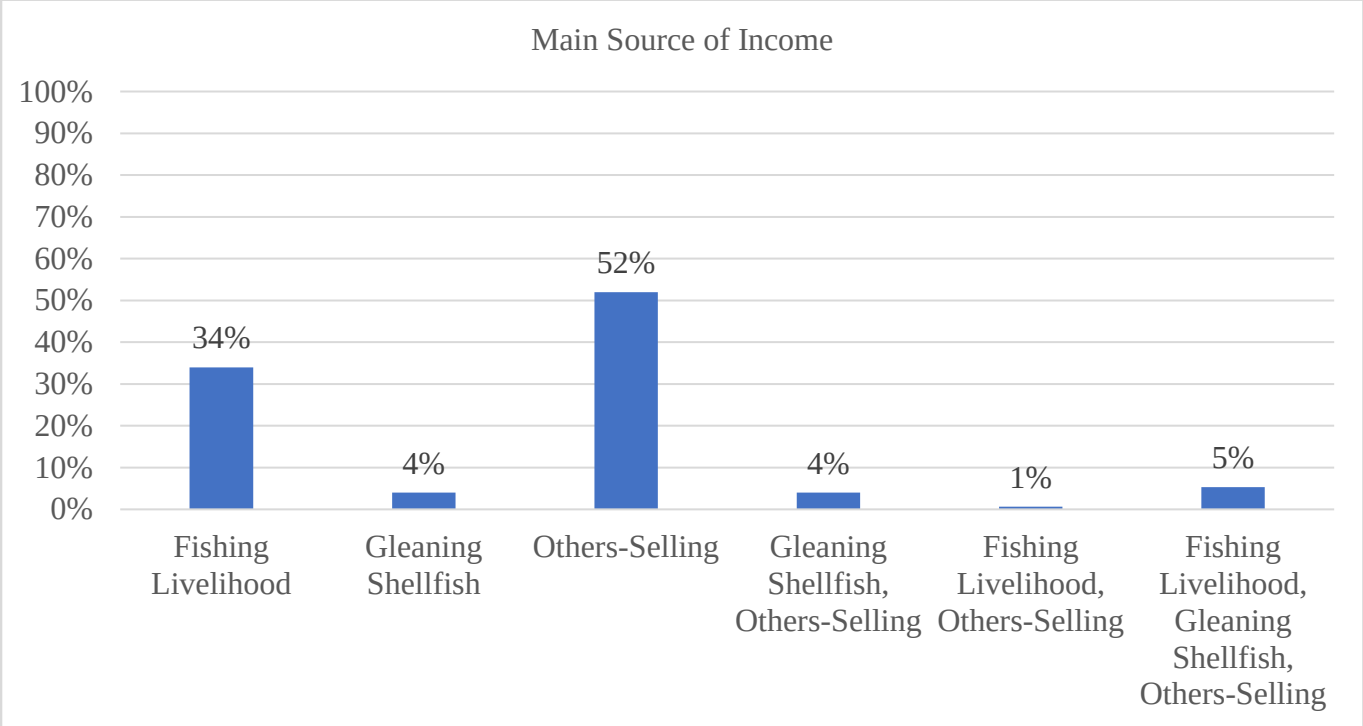
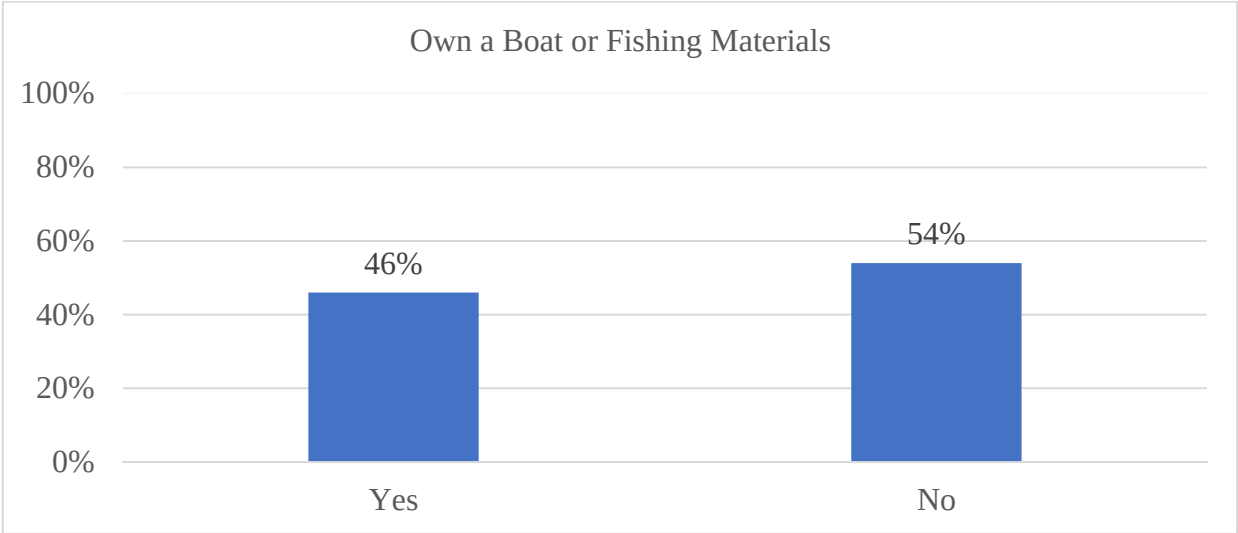


Figure 6: Main Source of Income of Fishermen Respondents

The data shows the different main source of income of respondents. The majority of the responses which acquired 52% whose main income is from Selling; this follows by fishing which acquired 34% of responses. Fishing Livelihood, Gleaning Fishing, selling all together got 5% from the responses. Both Gleaning Shellfish and Gleaning Shellfish while also Selling got 4% from the responses. Atleast 1% responses is Fishing Livelihood and Selling.

According to Camacho et al. (2020), 43 percent of total family income is created via the sale of mangrove forest goods such as fish and crabs. As studied by Peam Krasaop Fishing Com-munity (2021), mangrove habitats are important to the livelihoods among many coastal people across the world. Fishing communities depend heavily on selling the fish they caught for their livelihoods. Small-scale fisheries play a crucial role in providing income and sustenance to these communities (National Oceanic and Atmospheric Administration, 2020).

Figure 7: Respondents Own a Boat or Fishing Materials in Catching Resources



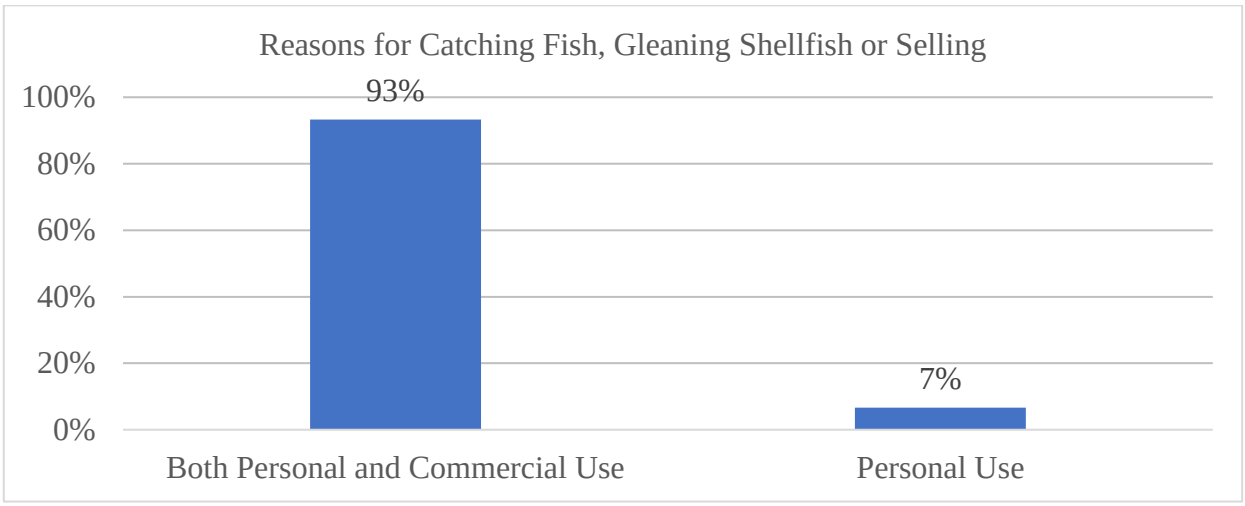
The data shows if the respondents own a boat or fishing materials in catching fish, shellfish and other resources. The majority of the respondents which acquired 54% of the respondents doesn't have while 46% of responses have their own boat and other materials. This means that most of the respondents doesn't have their very own boat or fishing materials in catching resources at the cove.

According to Mendoza et al. (2021), many fishermen rely on traditional methods and lack access to modern fishing gear and fishing boats, which significantly limits their catch and income potential. Without ownership of fishing equipment, these fishermen are often dependent on outdated and less efficient techniques, which restricts their ability to compete in the market and sustain a stable livelihood.

A study by Muringai et al. (2020) found that the majority of fishers indicated that lack of access to fishing equipment is one of the major challenges impeding their fishing practices. This limitation severely restricts their ability to engage in productive fishing activities, often forcing them to rely on renting or borrowing equipment, which can be both costly and unreliable.

Fishermen need decent fishing boats to effectively carry out their work. The quality and reliability of a fishing boat significantly impact a fisherman's ability to catch a sufficient quantity of fish and shellfish, which are essential for their livelihood. The fishing boat use fishing nets and gears, and the main catch is shellfish and some other fish (Ahmad & Hermanto, 2020).

Figure 8: Reason of the Respondents for Catching Fish, Gleaning Shellfish or Selling



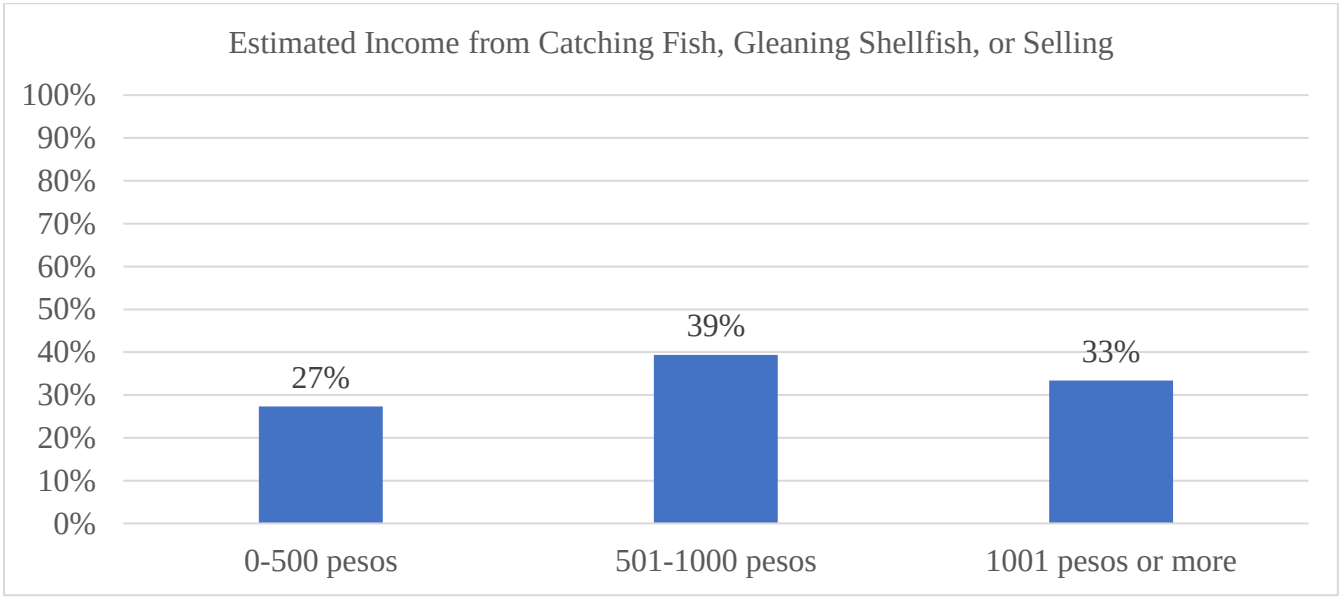
The data shows the reason of the respondents for Catching Fish, Gleaning Shellfish, or Selling. The majority of the respondents which acquired 93% of responses uses their fish or gleaned shellfish for both personal & commercial use and the least response which acquired 7% is personal use only. This means that the fishermen mostly use their resources for both personal and commercial.

According to Idrus, A., Syukur, A. & Zulkifli, L. (2019), mangrove ecosystems are natural resources in coastal locations that have their own ecological systems and have served as a source of food for locals.

The dynamics of the mangrove ecosystem and livelihood security are linked through connecting supply and expenditure of ecosystem resources utilized and/or regulated by farmers, fishermen, and the forest office (Sweety et al., 2022).

World Fish Center (2020) states that many coastal communities rely heavily on gleaning and small-scale fishing as essential sources of income. These activities are crucial for sustaining the livelihoods of numerous households. Women glean shellfish and other marine species, which they can sell at local markets for significant amounts of money relative to their living standards.

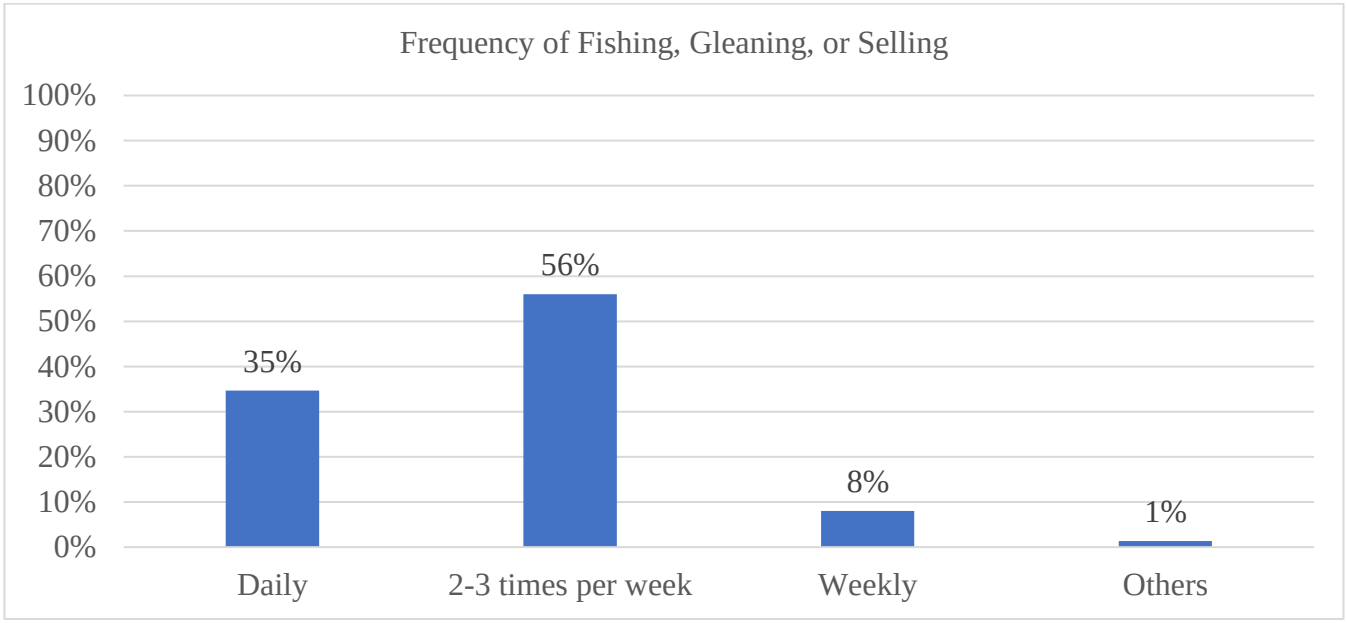
Figure 9: Estimated Income from Catching Fish, Gleaning Shellfish or Selling



The data shows the estimated income of the respondents from Catching Fish, Gleaning Shellfish, or Selling. The majority of the respondents have their estimated income of ₱501-₱1000 which acquired 39% of responses, this followed by the estimated income at ₱1001-₱1500 which acquired 33% of responses and lastly estimated income of ₱0-₱500 acquired 27% of response. This means that the fishermen have estimated income of ₱501-₱1000 from these resources they got.

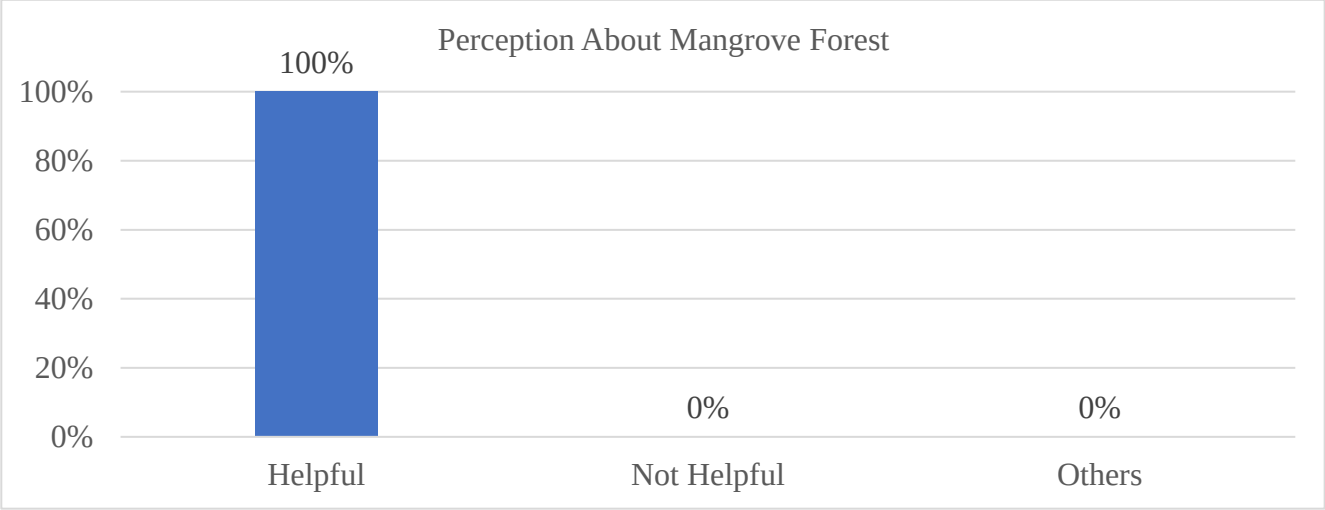
According to Lahjie et al. (2019) the mangrove forests, have been a source of income for the local people. As study by Peam Krasaop Fishing Community (2021), some coastal community's yearly landed harvest is expected to be around 1000 tons of fish and other seafood.

Figure 10: Respondents frequency of Fishing, Gleaning or Selling



The data shows respondents frequency of Fishing, Gleaning, or Selling at the cove. The majority of the respondents does frequency of fishing, gleaning, or selling 2-3 times per week which acquired 56% of responses, followed by the frequency of daily which acquired 35% of responses, Frequency of weekly got 8% from the responses and the least response which only acquired 1% of responses is others. This means that most of the respondents goes at the Mobil cove with only 2-3 times per week frequency.

Figure 11: Perception of Mangrove Forest Cover for the Past Years by Respondents



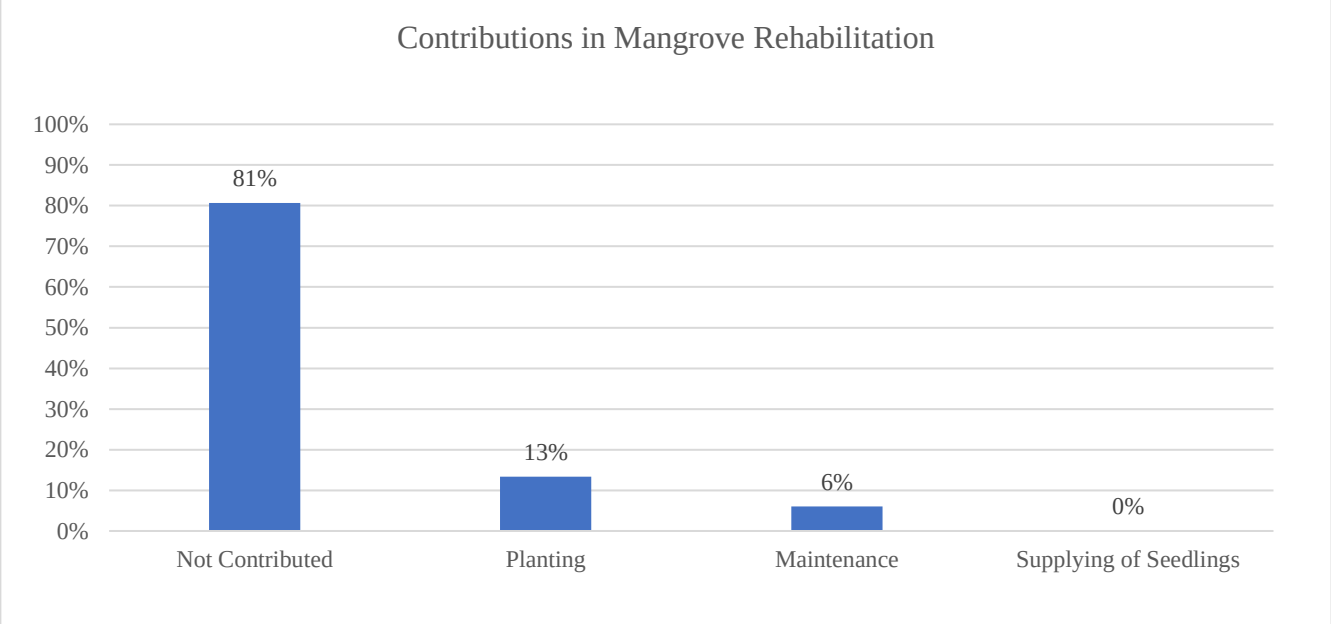
The data shows the perception of respondents by the mangrove forest that covers the cove for the past years. The majority of the responses which acquired a 100% by the respondents believes that the mangrove forest was helpful to them and the other perceptions which are not helpful and others acquired no responses at all which is 0%. This means that the mangrove forest was helpful to the respondents of the cove.

According to Dasgupta et al. (2019), mangrove forests play a vital role in providing ecosystem-based protection from cyclonic storm surge. The tree roots, trunks, and leaves hinder the flow of water as it travels through the mangrove forest.

According to Montgomery et al. (2022), the past, current, and predicted future risk of coastal flooding needs coastal community and environment protection measures, including the use of natural protection such as mangroves.

According to Sunkur et al. (2024), mangroves are now recognized as one of the most effective nature-based solutions for climate change adaption and to reduce disaster risk.

Figure 12: Respondents Contribution in Mangrove Rehabilitation



The data shows on how did the respondents contributed in mangrove rehabilitation. The majority of the respondents not contributed which acquired 81% of responses, followed by 13% of responses contributing in mangrove rehabilitation by planting, followed by maintenance which acquired 6% of responses and the supplying seedlings which acquired 0% of response or no response at all. This means that majority of the respondents have not contributed in mangrove rehabilitation.

According to Cudiamat et al. (2023), the local community should have sufficient awareness on mangrove forest in term of ecosystem services and local knowledge which significantly affect how they utilize and manage their resources. The use of biocultural approach to conservation shows potential to build sustainability. Restoring mangrove forests also helps to achieve many other SDGs, such as eradicating poverty and hunger, ensuring livelihoods and economic growth, combating climate change, and halting biodiversity loss (Hidayah et al., 2024).

Camacho et al. (2020) proposed that the empowerment of local communities in managing responsibilities is crucial for the successful rehabilitation of mangroves in the Philippines. The study emphasized that the local community should be actively involved in project planning, implementation, and the monitoring and evaluation processes of mangrove rehabilitation and
planting initiatives.

Table 4: Level of Monitoring of the Mangrove Rehabilitation Project in Mobil, Dunggoan

	Weighted Mean	Description
Mangrove survival in the area	3.45	The respondents found the monitoring of mangroves very satisfactory.

	Weighted Mean	Description
Mangrove survival in the area	3.45	The respondents found the monitoring of mangroves very satisfactory.
Degree of help to the mangrove rehabilitation project	3.41	The respondents found the monitoring of mangroves very satisfactory.
Mangrove development due to monitoring	3.49	The respondents found the monitoring of mangroves very satisfactory.
Monitoring of mangroves by the Local Government Units	3.48	The respondents found the monitoring of mangroves very satisfactory.
OVERALL WEIGHTED MEAN	3.46	The respondents found the monitoring of mangroves very satisfactory.

The table above illustrates the mean level of monitoring of the mangrove rehabilitation project in Mobil, Dunggoan. The respondents were very satisfied with mangrove survival in the area with a mean score of 3.45. A mean score of 3.41 indicates a high level of satisfaction for the degree of help to the rehabilitation project. Mangrove development, due to monitoring, acquired a mean of 3.49, and 3.48 for the monitoring by Local Government Units, both indicate high satisfaction. Overall, the weighted mean value of the following on how mangroves are monitored was 3.46, which means that the level satisfactory by monitoring of mangroves in Mobil, Dunggoan has very satisfactory.

According to Kongkeaw et al., (2019), the establishment and consolidation of community – mangrove management occurred in several stage, including collective action with Non-Government Organization.

Table 5: Level of Importance of Mangrove Rehabilitation Project in Mobil, Dunggoan

	Mean	Description
Shoreline Protection (Storms, Floods, Tsunamis, and sea water level rise)	3.44	The respondents found certain mangrove ecosystem service very important.
Prevent Erosion	3.43	The respondents found certain mangrove ecosystem service very important.
Aquatic Habitat	3.53	The respondents found certain mangrove ecosystem service very important.
Water quality Maintenance	3.37	The respondents found certain mangrove ecosystem service very important.
Aesthetic (Visual appeal for the cove)	3.31	The respondents found certain mangrove ecosystem service very important.
OVERALL WEIGHTED MEAN	3.41	The respondents found certain mangrove ecosystem service very important.

Table 5 depicts the mean level of importance of the mangrove rehabilitation project in Mobil, Dunggoan. Based on the gathered data, shoreline protection has a mean of 3.44 and is categorized as very important in the cove. Similarly, preventing erosion is also categorized as very important, with a mean of 3.43. The aquatic habitat had the highest mean among the five, at 3.53, and was categorized by the respondents as very important. Likewise, water quality management was categorized as a very important benefit of mangrove ecosystems, with a mean of 3.37. Lastly, aesthetics has a mean of 3.31, which was deemed very important by the respondents for the benefits of the mangrove ecosystems. Overall, the weighted mean value of the importance of the following mangrove ecosystem services was 3.41, indicating that the level of importance of mangrove ecosystems in Mobil, Dunggoan is very important.

According to Montgomery et al. (2022), the past, current, and predicted future risk of coastal flooding needs coastal community and environment protection measures, including the use of natural protection such as mangroves.

A study by Miranda et al. (2021), shows that the root systems of mangrove forests may serve to lessen the impact of hurricanes, therefore stabilizing the shoreline and preventing erosion from waves and storms.

Mangroves not only play an important role in climate change adaptation and mitigation but also significantly benefit local communities by supporting aquaculture production and providing crucial habitats for various marine species. These unique coastal ecosystems act as natural barriers against storm surges and coastal erosion, thereby protecting shorelines and reducing the impact of extreme weather events (Thuy, 2021)

Table 6: Policies in Mangrove Rehabilitation Needs to be Implemented in Mobil, Dunggoan

	Mean	Description
Waste Management (Garbage, Other pollution factors)	3.39	Respondents believe in the very need of implementing specific mangrove contributions.
Impose Strict Policies (for any illegal activities)	3.29	Respondents believe in the very need of implementing specific mangrove contributions.
Strict Monitoring Management	3.44	Respondents believe in the very need of implementing specific mangrove contributions.
Mangrove Restoration Projects	3.49	Respondents believe in the very need of implementing specific mangrove contributions.
Mangrove clean-up drive	3.39	Respondents believe in the very need of implementing specific mangrove contributions.
Community Awareness Program	3.35	Respondents believe in the very need of implementing specific mangrove contributions.
OVERALL WEIGHTED MEAN	3.39	Respondents believe in the very need of implementing specific mangrove contributions.

Table 6 shows the mean levels of policies needed for implementing mangrove rehabilitation. Waste management garners the third highest mean among the five, at 3.39, and respondents believe that it is very important to implement certain mangrove contributions. Similarly, imposing strict policies has a mean of 3.29 and is characterized as very important to implement in the cove. A mean score of 3.44 in-

dicates a strong need to implement strict monitoring for the cove. The highest mean of all is for mangrove restoration projects, also classified by the majority of respondents as very important to implement, with a mean of 3.49. Mangrove clean-up scores 3.39, and respondents believe it is very important to implement. Lastly, the community awareness program gathers the second highest mean among the five, at 3.35, and it is considered very important to implement. Overall, the weighted mean value of the implementation of the following mangrove contributions was 3.62. This implies that the importance level of mangrove ecosystems in Mobil, Dunggoan is very high and should be implemented as soon as possible.

According to Nicholis et al. (2021), garbage disposal options abound in densely populated coastal areas. There is growing concern that landfill sites near and along the coast pose a considerable environmental risk as a result of the potential release of liquid and solid waste materials.

According to Ellison et al. (2020), rehabilitation projects are planned, designed, executed, and managed by people with diverse backgrounds and different scientific and sociopolitical agendas.

Mangrove Rehabilitation policies implementation involves several meetings with key local government officials, NGOs and academic institutions to convey concerns for pursuing rehabilitation and clarification of roles that the community will play in rehabilitation. Eventually, an agreement (e.g. Memorandum of Agreement or resolution) with local community could be sought to ensure provisions of sustained support or commitment to rehabilitation of mangroves (Camacho, et al., 2020).

Table 7: Ranking of Specific Living Organisms at Mobil

Living Organism	Frequency	Percentage
Jumping Shell	37	12 %
Clam	31	10 %
Sea Cucumber	27	9 %
Spinefoot	27	9 %
Whitebait Fish	25	8 %
Shellfish	25	8 %
Cockle shell	20	7 %
Sea grapes	20	7 %
Tabudios	18	6 %
Eel Fish	15	5 %
Crab	11	4 %
Rusell's Snapper	11	4 %
Euchema	10	3 %
Shrimp	8	3 %
Rabbitfish	5	2 %
Oyster	4	1 %
Sea urchin	4	1 %
Squid	2	1 %

Table 7 presents the ranking of specific living organisms observed using quadrant method at Mobil. The ranking begins with the jumping shell, holding the top position by comprising 12% of the total observed organisms. At rank number 2 are clams, representing 10% of the observed organisms. According to Bersaldo et al. (2022), mangrove clams are predominantly found in mangrove ecosystems in the

Philippines. At rank number 3 are sea cucumbers and spinefoot, each accounting for 9% of the observed organisms. According to Alam et al. (2022), sea cucumbers are a key source of revenue for coastal people and play a significant role in marine ecosystems. Moving down, at rank number 4, both whitebait fish and shellfish share the position, constituting 8% of the total. Cockle shells and sea grapes occupy rank number 5, with each representing 7% of the observed organisms. At rank number 6 sits tabudios, contributing 6% to the total. Eel fish claim rank number 7, representing 5% of the observed organisms. Tied at rank number 8 are crabs and Russell's snapper, each comprising 4% of the total. Euchema secures rank number 9, with 3% of the observed organisms. According to Feller, C. (2018), mangrove ecosystems are home to a myriad of marine life species (fish, crab, shellfish, sea turtle, etc). Many crabs, shrimp, and fish will spend the early stages of life within the safety of the mangrove roots before making their way out into the open ocean as adults. At rank number 10, both shrimp and rabbitfish share the position, contributing 2% each. Finally, occupying rank number 11 are oysters, sea urchins, and squid, each representing 1% of the observed organisms. Status of mangrove clam (Anodontia philippiana Reeve, 1850) in Baganga, Davao Oriental, Philippines.

Table 8: Survival Rate of the Mangroves in Mobil, Dunggoan

	First Plantation (2013-2014)	Second Plantation (2015-2016)	Third Plantation (2017-2019)	Fourth Plantation (2020-2024)
Number of Planted Mangroves	1000	1000	1000	1000
Survival Number of Mangroves	347	361	384	342
Percentage of Survival	35 %	36 %	38 %	34 %

Table shows the survival rates of mangroves in Mobil, Dunggoan over four plantation intervals ranging from 2013 to 2024. In 2013 - 2014, approximately 35% of the 1000 mangroves were able to survive. Following this, a modest improvement was observed in the 2015-2016 plantation period, with the survival rate increasing to 36%. During the third plantation period from 2017 to 2019, there was a notable increase when the survival rate increased to 38%, indicating potentially improved environmental conditions or refined planting methodologies during this timeframe. Unfortunately, the ascendancy observed in the third phase was not sustained in the subsequent fourth plantation cycle spanning 2020 to 2024, wherein the survival rate experienced a decline with a survival rate of 34%. According to the latest estimates, the global mangrove extent was reduced by 3.4 % in less than three decades (1996–2020) due to natural and anthropogenic deforestation (Bunting et al., 2022). This concluded that there was less existence of mangroves in the fourth plantation compared to other plantations. Furukawa et al. (2019) found that between 2010 and 2013, the survival rates of Avicennia marina, Sonneratia alba, and Rhizophora mucronata were 44.0 percent, 73.6 percent, and 0%, respectively. These differences can be attributed to differences in natural succession and species tolerance. In December 2021, the area was struck by Typhoon Odette, however not much damage was done. Breakwaters and mangroves provided protection.

According to the study by Daquinan, Guirhem & Mediodia (2023), over the past three (3) decades, the Philippines has lost 20% of its mangrove forests. From 31713 ha in 1991 to only 25313 ha in 2021.

Table 9: Mangrove Species, Height, and Spread Branches of the Planted Mangrove in 2020-2024 at Mobil, Dunggoan

Trial	Species of Mangrove	Height	Spread 1	Spread 2
1st Trial	Rhizophora stylosa	258cm	143cm	142cm
2nd Trial	Rhizophora apiculata	252cm	140cm	138cm
3rd Trial	Rhizophora apiculata	308cm	152cm	153cm
4th Trial	Rhizophora apiculata	273cm	129cm	130cm
5th Trial	Rhizophora stylosa	167cm	118cm	118cm
6th Trial	Rhizophora apiculata	250cm	147cm	147cm
7th Trial	Rhizophora apiculata	234cm	154cm	155cm
8th Trial	Rhizophora stylosa	248cm	156cm	157cm
9th Trial	Rhizophora stylosa	154cm	98cm	97cm
10th Trial	Rhizophora stylosa	178cm	102cm	100cm
Average		251.2cm	143.9cm	143.7

Table 9 presents the ten trials by measuring the mangrove species, the height and spread branches of the planted mangroves in 2020 – 2024 at Mobil. In the first trial, rhizophora stylosa is a specie of mangrove having a height of 258cm with a branch first spread of 143cm, and the second spread was 142cm. In the second trial, rhizophora apiculata having a height of 252cm with a branch first spread of 140cm, and the second spread of 138cm. In the third trial, rhizophora apiculata having a height of 308cm with a branch first spread of 152cm, and the second spread of 153cm. In the fourth trial, rhizophora apiculata having a height of 273cm with a branch first spread of 129cm, and the second spread of 130cm. In the fifth trial, rhizophora stylosa having a height of 167cm with a branch first spread of 118cm, and the second spread of 118cm. In the sixth trial, rhizophora apiculata having a height of 250cm with a branch first spread of 147cm, and the second spread of 147cm. In the seventh trial, rhizophora apiculata having a height of 234cm with a branch first spread of 154cm, and the second spread of 155cm. In the eighth trial, rhizophora stylosa having a height of 248cm with a branch first spread of 156cm, and the second spread of 157cm. In the ninth trial, rhizophora stylosa having a height of 154cm with a branch first spread of 98cm, and the second spread of 97cm. In the tenth trial, rhizophora stylosa having a height of 178cm with a branch first spread of 102cm, and the second spread of 100cm. Overall, there were two kinds of mangrove species in the fourth plantation of 2020 – 2024 period; rhizophora stylosa and rhizophora apiculata. In the study of Lillo et al. (2022), Rhizopohoraceae was the most recorded Family, and Rhizophora was the most dominant genus. In the study of Pototan et al. (2020), Rhizophoraceae is the most represented with eight different species. Apparently, these species are the most popular to locals and are promoted for mangrove planting subsequently influencing the abundance of the species. In the study of Bersaldo et al. (2023), the general observation shows that the survival of mangroves, particularly the species that belong to the family Rhizophoraceae were over 80%.

Table 10: Mangrove Species, Height, and Spread Branches of the Planted Mangrove in 2017-2019 at Mobil, Dunggoan

Trial	Species of Mangrove	Height	Spread 1	Spread 2
1st Trial	Rhizophora stylosa	113cm	35cm	34cm
2nd Trial	Avicennia marina	118cm	136cm	140cm
3rd Trial	Rhizophora stylosa	152cm	32cm	17cm
4th Trial	Rhizophora stylosa	206cm	50cm	71cm
5th Trial	Rhizophora apiculata	144cm	32cm	56cm
6th Trial	Rhizophora stylosa	197cm	50cm	47cm
7th Trial	Rhizophora apiculata	148cm	50cm	25cm
8th Trial	Rhizophora stylosa	194cm	68cm	50cm
9th Trial	Rhizophora stylosa	195cm	50cm	64cm
10th Trial	Rhizophora stylosa	195cm	84cm	75cm
Average		166cm	59cm	58cm

Table 10 presents the ten trials by measuring the mangrove species, the height and spread branches of the planted mangroves in 2017 – 2019 at Mobil. In the first trial, rhizophora stylosa is a specie of mangrove having a height of 113cm with a branch first spread of 35cm, and the second spread was 34cm. In the second trial, avicennia marina having a height of 118cm with a branch first spread of 136cm, and the second spread of 140cm. In the third trial, rhizophora stylosa having a height of 152cm with a branch first spread of 32cm, and the second spread of 17cm. In the fourth trial, rhizophora stylosa having a height of 206cm with a branch first spread of 50cm, and the second spread of 71cm. In the fifth trial, rhizophora apiculata having a height of 144cm with a branch first spread of 32cm, and the second spread of 56cm. In the sixth trial, rhizophora stylosa having a height of 197cm with a branch first spread of 50cm, and the second spread of 47cm. In the seventh trial, rhizophora apiculata having a height of 148cm with a branch first spread of 50cm, and the second spread of 25cm. In the eighth trial, rhizophora stylosa having a height of 194cm with a branch first spread of 68cm, and the second spread of 50cm. In the ninth trial, rhizophora stylosa having a height of 195cm with a branch first spread of 50cm, and the second spread of 64cm. In the tenth trial, rhizophora stylosa having a height of 195cm with a branch first spread of 84cm, and the second spread of 75cm. Overall, there were two kinds of mangrove species in the third plantation of 2017 – 2019 period; rhizophora stylosa, avicennia marina, and rhizophora apiculata.

In the study of Pototan et al. (2020), Rhizophoraceae is the most represented with eight different species. Apparently, these species are the most popular to locals and are promoted for mangrove planting subsequently influencing the abundance of the species.

According to Kalasuba et al. (2023), whether it is the extensive supporting roots of Rhizophora, the breathing roots of Avicennia, the salt-excreting leaves, or the water-dispersing viviparous seedlings, everything possesses a unique capacity to produce bioactive metabolites for survival and reproduction for both specie, providing them with ‘chemical signals’ to respond to, avoid, or defend against environmental cues.

According to Mori et al. (2021), the measurements, the tree height increases linearly with smaller DBH (<25 mm) and tends to be convergent around 300 cm for larger DBH (>30 mm) within the measured

DBH range (<50 mm). Both the tree heights and trunk diameter showed monotonically increasing relationships with the tree age.

Table 11: Mangrove Species, Height, and Spread Branches of the Planted Mangroves in 2015-2016 at Mobil, Dunggoan

Trial	Species of Mangrove	Height	Spread 1	Spread 2
1st Trial	Rhizophora apiculata	183cm	53cm	73cm
2nd Trial	Rhizophora stylosa	340cm	142cm	83cm
3rd Trial	Rhizophora stylosa	347cm	61cm	76cm
4th Trial	Rhizophora stylosa	322cm	87cm	84cm
5th Trial	Avicennia marina	296cm	307cm	278cm
6th Trial	Rhizophora stylosa	154cm	53cm	50cm
7th Trial	Rhizophora apiculata	250cm	45cm	50cm
8th Trial	Avicennia marina	197cm	150cm	100cm
9th Trial	Rhizophora apiculata	258cm	120cm	65cm
10th Trial	Rhizophora stylosa	288cm	85cm	56cm
Average		264cm	110cm	92cm

Table 11 presents the ten trials by measuring the mangrove species, the height and spread branches of the planted mangroves in 2015 – 2016 at Mobil. In the first trial, rhizophora apiculata is a specie of mangrove having a height of 183cm with a branch first spread of 53cm, and the second spread was 73cm. In the second trial, rhizophora stylosa having a height of 340cm with a branch first spread of 142cm, and the second spread of 83cm. In the third trial, rhizophora stylosa having a height of 347cm with a branch first spread of 61cm, and the second spread of 76cm. In the fourth trial, rhizophora stylosa having a height of 322cm with a branch first spread of 87cm, and the second spread of 84cm. In the fifth trial, avicennia marina having a height of 296cm with a branch first spread of 307cm, and the second spread of 278cm. In the sixth trial, rhizophora stylosa having a height of 154cm with a branch first spread of 53cm, and the second spread of 50cm. In the seventh trial, rhizophora apiculata having a height of 250cm with a branch first spread of 45cm, and the second spread of 50cm. In the eighth trial, avicennia marina having a height of 197cm with a branch first spread of 150cm, and the second spread of 100cm. In the ninth trial, rhizophora apiculata having a height of 258cm with a branch first spread of 120cm, and the second spread of 65cm. In the tenth trial, rhizophora stylosa having a height of 288cm with a branch first spread of 85cm, and the second spread of 56cm. Overall, there were two kinds of mangrove species in the second plantation of 2015 – 2016 period; rhizophora stylosa, avicennia marina, and rhizophora apiculata.

According to Auni et al. (2020), this plant is able to grow to a height of 3 meters with 50 cm in diameter. In the study of Lillo et al. (2022), Rhizopohoraceae was the most recorded Family, and Rhizophora was the most dominant genus. According to the study of Castillo et al. (2022), over a three-year period, they discovered that the 5 – year – old plantation had the highest rate of elevation.

Table 12: Mangrove Species, Height, and Spread Branches of the Planted Mangroves in 2013-2014 at Mobil, Dunggoan

Trial	Species of Mangrove	Height	Spread 1	Spread 2
1st Trial	Sonneratia alba	367cm	217cm	196cm
2nd Trial	Rhizophora stylosa	357cm	101cm	67cm
3rd Trial	Avicennia marina	351cm	315cm	242cm
4th Trial	Rhizophora stylosa	394cm	124cm	90cm
5th Trial	Rhizophora stylosa	391cm	65cm	52cm
6th Trial	Rhizophora apiculata	296cm	34cm	39cm
7th Trial	Avicennia marina	270cm	147cm	324cm
8th Trial	Avicennia marina	410cm	228cm	262cm
9th Trial	Avicennia marina	540cm	442cm	462cm
10th Trial	Avicennia marina	556cm	490cm	466cm
Average		393cm	216cm	220cm

Table presents the ten trials by measuring the mangrove species, the height and spread branches of the planted mangroves in 2013 – 2014 at Mobil. In the first trial, sonneratia alba is a specie of mangrove having a height of 367cm with a branch first spread of 217cm, and the second spread was 196cm. In the second trial, rhizophora stylosa having a height of 357cm with a branch first spread of 101cm, and the second spread of 67cm. In the third trial, avicennia marina having a height of 351cm with a branch first spread of 315cm, and the second spread of 242cm. In the fourth trial, rhizophora stylosa having a height of 394cm with a branch first spread of 124cm, and the second spread of 90cm. In the fifth trial, rhizophora stylosa having a height of 391cm with a branch first spread of 65cm, and the second spread of 52cm. In the sixth trial, rhizophora apiculata having a height of 296cm with a branch first spread of 34cm, and the second spread of 39cm. In the seventh trial, avicennia marina having a height of 270cm with a branch first spread of 147cm, and the second spread of 324cm. In the eighth trial, avicennia marina having a height of 410cm with a branch first spread of 228cm, and the second spread of 262cm. In the ninth trial, avicennia marina having a height of 540cm with a branch first spread of 442cm, and the second spread of 462cm. In the tenth trial, avicennia marina having a height of 556cm with a branch first spread of 490cm, and the second spread of 466cm. Overall, there were two kinds of mangrove species in the fourth plantation of 2013 – 2014 period; rhizophora stylosa, avicennia marina, sonneratia alba, and rhizophora apiculata.

According to Pasiec (2019) , rhizophora apiculate, this mangrove tree can reach heights of more than 80 feet (25 meters) under ideal conditions. Furthermore, for the 5, 10, and 25-year-old plants, the mean soil carbon current sequestration rate was 226, 123, and 8.9 g C m2 year 1 (Castillo et al., 2022). The study of Benitez & Perez (2019) showed that S. alba has a higher structural characteristic with mean GBH of 43.57 cm, mean height of 5.18 m, biomass of 19.02 t/ha, and carbon stock of 8.56 t/ha. On the other hand, A. marina has a mean GBH of 29.2 cm, a height of 4.15 m.

Table 13: Significant Relationship between the Height and Spread of the Mangrove Planted in the following Plantation Period

	First Plantation (2013-2014)	Second Plantation (2015-2016)	Third Plantation (2017-2019)	Fourth Plantation (2020-2024)	Average
Height of mangroves	393 cm	264 cm	166 cm	251 cm	269 cm
Spread of mangroves	218 cm	101 cm	59 cm	134 cm	128 cm

Table above shows the significant relationship between the height and spread of the mangroves in the following plantation period. It turned out that in first plantation period, the average height of mangroves has 393 cm and the spread of mangroves with 218 cm. In second plantation period, the average height of mangroves has 264 cm with a mangroves' spread of 101 cm. In third plantation period, which its average height has 166 cm and the spread of mangroves having an average of 59 cm. The average height of the fourth plantation is 251 cm and the average of the spread is 134 cm. Furthermore, the total average of height and spread of mangroves during in three plantation period have a 269 cm and 128 cm, respectively.

NASA Earth Observatory (2019) highlights the significant correlation between mangrove height and various environmental factors, including rainfall, temperature, and broader ecological conditions. According to the findings, these primary factors account for approximately 74% of the observed variations in mangrove height across different regions. These localized factors can either enhance or limit the growth potential of mangroves, thereby contributing to the remaining 26% of the variation that is not explained by rainfall, temperature, and general environmental conditions alone.

According to Anton et al. (2020), there is a significant correlation between mangrove height and spread and the nitrogen levels in their leaves. The study found that mangroves in nitrogen-rich environments exhibited greater height and a more extensive spread compared to those in nitrogen-poor conditions.

Mangroves are important in protecting and stabilizing coastal zones. It highlights how the height of mangrove trees, which ranges from 1.35 to 16.5 meters, correlates with biomass. This variability is crucial for understanding the growth dynamics and spatial distribution of mangroves.

Harishma et al. (2020) state that this relationship is significant because it reflects the overall health and productivity of mangrove forests. Taller trees typically indicate a greater accumulation of biomass, which contributes to the forest's ability to sequester carbon, support diverse wildlife habitats, and enhance the resilience of coastal areas to climate change. Understanding the variability in mangrove height and biomass is essential for comprehending the growth dynamics and spatial distribution of these vital ecosystems.

Table 14: Recommendation Ranking of Action Plan can be Drafted to Improve the Mangrove Rehabilitation Project at Mobil Cove

Recommendation	Rank
Mangroves Clean-up drive	1
Community Awareness Program	2
Waste Management (garbage, other pollution factors)	3

Recommendation	Rank
Mangroves Clean-up drive	1
Mangrove Restoration Projects	4
Impose Strict Policies (for any illegal activities)	5
Strict Monitoring Management	6

The table above represents the highest to lowest rank of recommendation of action plan can be drafted to improve the Mangrove Rehabilitation Project at Mobil Cove. Based on the data represented, Mangroves Clean-up drive ranked as 1 recommended by the residents.

According to Quevedo et al. (2019), to enable more holistic and sustainable management, this study suggests the value of including coastal communities in contextualizing management plans, particularly for the areas often visited by natural hazards.

According to Cappa et al. (2023), land-based waste management that prevent plastics entering rivers will reduce marine plastic pollution in Southeast Asia. According to Camacho et al. (2020) ensuring sustainable and effective mangrove rehabilitation, active collaboration among government, non-government organizations, funding agencies, and research institutions and, most importantly, by local communities is vital.

4. Conclusion

Based on the findings, the researchers concluded that out of 4000 planted mangroves, 36% of it survived, having Rhizophora stylosa and Rhizophora apiculata as the dominant mangrove species. These planted mangroves are also helpful to the people who live nearby, in terms of personal consumption and livelihood. The level of importance of mangrove ecosystems in Mobil, Dunggoan is very important, in terms of shoreline protection, prevent erosion, aquatic habitat, water quality maintenance, and aesthetic. Lastly, the people in Mobil depend heavily on selling the fish they caught for their livelihoods.

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