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STATUS REVIEW OF GUINAYANGAN QUEZON MANGROVE FOREST: AN ASSESSMENT OF SPECIES DIVERSITY AND HABITAT ANALYSIS

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STATUS REVIEW OF GUINAYANGAN QUEZON MANGROVE FOREST: AN ASSESSMENT OF SPECIES DIVERSITY AND HABITAT ANALYSIS

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Acceptance Page

This Special Problem of **CHARISSE ANGELIQUE M. ESCOBAL** titled: **"STATUS REVIEW OF GUINAYANGAN QUEZON MANGROVE FOREST: AN ASSESSMENT OF SPECIES DIVERSITY AND HABITAT ANALYSIS"** is hereby accepted by the Faculty of Management and Development Studies, U.P. Open University, in partial fulfillment of the requirements for the degree **Master of Environment and Natural Resources Management**.

KARL ABELARD EDBERTO L. VILLEGAS, JR. — 29 July 2026
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DECLARATION

This is to certify that:

I. The special problem comprises only my original work towards the MENRM except where indicated in the Preface

II. Due acknowledgment has been made in the text to all other material used

III. The special problem is fewer than 25,000 words in length, exclusive of tables, maps, bibliographies and appendices.

Charisse Angelique M. Escobal

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Abstract

This study was conducted to determine the status of the Mangrove Walk located in Brgy. Calimpak, Guinayangan, Quezon. Three main procedures were undertaken: species identification; habitat analysis using percent crown cover, regeneration per m², and average height; and the computation of diversity indicators such as species richness, relative abundance, Shannon–Wiener diversity index, and species evenness using PAST software. A total of 183 mangrove trees were recorded across three transect lines and two quadrats. Seven (7) out of the 23 mangrove species listed by the Zoological Society of London (ZSL) for the Municipality of Guinayangan, Quezon were identified at the study site, representing three families: Acanthaceae, Lythraceae, and Rhizophoraceae. In the habitat analysis using the parameters by Deguit et al. (2004), the results showed that the average percent crown cover of 5.63 falls under the poor condition category, as it lies within the 0–25% crown cover range. The average tree height of 9.04 meters is classified as excellent, as it exceeds the 5-meter threshold. For regeneration density, the computed value of 0.83 individuals per m² is considered good, as it falls within the range of 0.7 to less than 1 individual per m². In terms of diversity indices, relative abundance across all sampling stations showed that the dominant species were *Sonneratia alba* (39%), *Avicennia marina* (16.5%), and *Rhizophora mucronata* together with *Sonneratia apetala* (11.0%). *Sonneratia alba* was observed to dominate all three transects and two quadrats. In contrast, species with lower relative abundance included *Bruguiera cylindrica* (9.9%), *Bruguiera parviflora* (9.9%), and *Rhizophora apiculata* (2.7%). In terms of species richness, Transect Lines 1 and 3 recorded the highest values with seven species each, followed by Transect Line 2 with six species. Quadrats 1 and 2 recorded the lowest species richness, each with five species. For the Shannon–Wiener diversity index, Transect Line 3 obtained the highest value (1.83), followed by Transect Line 2 (1.71), Transect Line 1 (1.64), Quadrat 1 (1.43), and Quadrat 2 (1.42). Based on the interpretation scale, all transects, and quadrats exhibited a poor Shannon–Wiener diversity status. However, species evenness across all sampling units was balanced. In terms of species richness, all sampling units recorded values above five, indicating an integrated mangrove community structure.

Keywords: Status Assessment; Habitat Analysis; Mangrove Zonation; Guinayangan, Quezon; Mangrove Ecosystem

I. INTRODUCTION

The Philippine Islands are recognized as one of the world's top biodiversity hotspots, supporting approximately 1.9% of the world's endemic plant and vertebrate species (Myers et al., 2000) and is considered among the countries with the richest diversity of coastal plants globally (Calumpong & Menez, 1996).

Approximately 60–70 mangrove and mangrove-associated species belonging to 26 families are found in the Philippines. Of these, an estimated 40 species from 16 families are considered true mangroves (Primavera, 2004). True mangroves are species restricted to mangrove communities, while associated species may also occur in other habitats (Melana & Gonzales, 1996). The most common mangrove genera in the Philippines include *Rhizophora*, *Avicennia*, *Bruguiera*, and *Sonneratia* with at least 14 species previously recorded on Negros Island (Calumpong & Menez, 1996).

Mangroves play a vital role within coastal ecosystems, forming an interconnected system with coral reefs and seagrass beds (Viray-Mendoza, 2017). Mangrove ecosystems in the Philippines are highly diverse, hosting a significant number of the world's salt-tolerant mangrove species. Often described as the "rainforest of the sea," these coastal forests form part of an interconnected system with coral reefs and seagrass beds. They provide important ecological and economic benefits, including sustaining fisheries, supplying timber and non-timber resources, protecting coastlines from erosion and storm surges, and supporting ecotourism activities (Viray-Mendoza, 2017).

Mangrove forests are among the world's most vulnerable tropical ecosystems (Spalding et al., 2010). Historically, mangroves once covered more than 35% of the planet's coastal areas. However, in countries such as India, the Philippines, and

Vietnam, mangrove forests have declined by as much as 50% over the past century (Carugati et al., 2018). In the Americas, mangrove loss has occurred at a rate even faster than that of tropical rainforests (Romañach et al., 2018). While natural disturbances pose threats, anthropogenic activities, particularly pollution and land conversion, remain the primary drivers of mangrove degradation (Romañach et al., 2018) (Carugati et al., 2018).

Mangrove loss in the Philippines has been largely associated with the conversion of coastal areas to alternative land uses, particularly the expansion of aquaculture. Over time, large portions of mangrove forests have been cleared, contributing to a significant reduction in mangrove coverage. This trend led to the implementation of policies aimed at conserving remaining mangrove areas and limiting further conversion. Despite these measures, the continued demand for fishpond development has resulted in ongoing pressure on mangrove ecosystems, with illegal conversions persisting in some areas (Olsen et al., 1997).

Despite increased conservation initiatives and localized reforestation efforts, mangrove deforestation remains a significant environmental concern. In Southeast Asia and the Philippines, aquaculture development is widely recognized as a major driver of mangrove loss. In the Philippines, a substantial portion of mangrove deforestation has been associated with the conversion of mangrove areas into brackish-water fishponds. Continued degradation of mangrove ecosystems is still anticipated, highlighting the need for comprehensive assessment and monitoring of remaining mangrove forests to support effective conservation and protection strategies (Samson & Rollon, 2008).

II. REVIEW OF LITERATURE

Importance of Mangroves

Mangroves play an essential role in maintaining coastal ecosystem balance. They are closely linked with coral reefs and seagrass beds and are highly diverse in the Philippines, which hosts 46 mangrove species out of more than 70 worldwide (Viray-Mendoza, 2017) (Primavera, 2004) (Spalding et al., 2010). Often called the "rainforest of the sea," mangroves provide both ecological and economic benefits to coastal communities.

In fisheries, mangroves serve as breeding and nursery grounds for fish, crabs, shrimp, and other marine organisms, supporting food security and livelihoods (Primavera, 2004) (Samson & Rollon, 2008). Many reef species also depend on mangroves during early life stages, showing strong ecosystem interconnection.

Mangroves are also important sources of timber and plant products. Their wood is durable and used for housing, fuel, and charcoal, while other plant resources serve medicinal and livestock purposes (Melana & Gonzales, 1996) (Tomlinson, 1986).

In addition, mangroves provide coastal protection. Their root systems trap sediments, stabilize shorelines, and reduce damage from waves, storms, and flooding (Spalding et al., 2010). They also improve water quality by filtering sediments that could harm coral reefs and seagrass beds (Carugati et al., 2018).

Mangroves further support ecotourism through activities such as nature tours and snorkeling, especially in areas like Bicol and Palawan. These activities generate income while promoting environmental awareness (Viray-Mendoza, 2017).

Threats to Mangrove Ecosystems

Despite their importance, mangroves face major threats from human activities. Land conversion for agriculture, settlements, aquaculture, and infrastructure remains the leading cause of mangrove loss (Primavera, 2004) (Romañach et al., 2018). Overharvesting of mangrove resources has also contributed to their decline.

Changes in freshwater flow due to dams and irrigation systems alter salinity levels, which can stress or destroy mangrove forests. Sedimentation from upstream deforestation further disrupts ecosystem balance (Romañach et al., 2018). Overfishing and coral reef degradation also indirectly affect mangroves by weakening coastal protection and disrupting marine food chains (Carugati et al., 2018). Pollution from oil spills, agricultural runoff, sewage, and industrial waste damages mangrove roots and affects both plant and animal life (Carugati et al., 2018). Climate change adds further pressure, with rising sea levels and stronger storms threatening mangrove survival and distribution (Romañach et al., 2018).

Effects of Mangrove Forest Destruction

Mangrove cover in the Philippines has significantly declined from about 500,000 hectares in 1918 to 120,500 hectares in 1994 due to land conversion and overuse (Primavera, 2004). This loss reduces biodiversity, weakens coastal protection, and increases vulnerability to storms and flooding (Spalding et al., 2010) (Carugati et al., 2018). It also affects fisheries, food security, and livelihoods, since many coastal communities depend on mangrove-supported ecosystems (Romañach et al., 2018).

Because of these impacts, conservation efforts such as reforestation, protected areas, and improved management strategies are being implemented to ensure mangrove sustainability (Samson & Rollon, 2008).

III. STATEMENT OF THE STUDY

Mangrove loss in the Philippines has been largely driven by land conversion to other uses. Until 1981, remaining mangrove areas were still being converted until this practice was prohibited by law (Myers et al., 2000). Despite this, mangrove cover has continued to decline, from about 500,000 hectares originally, to 288,000 hectares in 1970, and further down to 123,400 hectares in 1993. A major contributor to this decline is the rapid expansion of aquaculture, particularly the conversion of mangrove areas into brackish water fishponds (Calumpong & Menez, 1996). Although mangrove protection policies exist, illegal conversion still continues in some areas (Primavera, 2004).

Mangrove deforestation remains a serious environmental concern in the Philippines and across Southeast Asia. One of the main drivers is aquaculture development, which has significantly reduced mangrove forests (Melana & Gonzales, 1996). In fact, about 50% of mangrove loss in the country has been directly linked to fishpond conversion (Primavera, 2004). Despite conservation efforts and localized reforestation initiatives, mangrove degradation is still expected to continue if not properly addressed (Samson & Rollon, 2008).

Given this situation, assessing the remaining mangrove forests is essential. Such assessment is necessary to support conservation efforts and ensure the protection and sustainable management of mangrove ecosystems in the Philippines.

IV. OBJECTIVES OF THE STUDY

This study generally aims to assess the status of the Mangrove Walk in Brgy. Calimpak, Guinayangan, Quezon. Specifically, the other objectives of this study are:

1. To identify the different mangrove species present in the area.
2. To assess the current mangrove habitat through percent crown cover, regeneration per m^2 and average height, and:
3. To calculate the present diversity indices such as species richness, relative abundance, Shannon-Wiener diversity index and evenness.

V. RATIONALE

Mangroves are one of the most important components of coastal ecosystems, commonly found in intertidal zones along shorelines. The Philippines once had about 500,000 hectares of mangrove forests in 1918, which significantly declined to around 100,000 hectares by 1994–1995 due to continuous degradation (Myers et al., 2000) (Primavera, 2004). A major cause of this decline is the conversion of mangrove areas into brackish water fishponds, accounting for about 50% of mangrove loss in the country (Calumpong & Menez, 1996). Despite conservation efforts and replanting initiatives, mangrove degradation continues to be a concern (Samson & Rollon, 2008). This highlights the need to assess and monitor remaining mangrove forests to support their protection and conservation.

This study aims to provide relevant information on the status of selected mangrove sites, including mangrove species composition, habitat condition, and biodiversity status. The findings will be beneficial to different stakeholders in the following ways:

Coastal Environment

The study results on mangrove species composition, habitat condition, and diversity indices can support conservation planning and management strategies. Mangroves play a critical ecological role by serving as breeding grounds, nurseries, and feeding areas for various marine species while also protecting coastlines from erosion and storm damage (Spalding et al., 2010) (Carugati et al., 2018).

Stakeholders

For local communities, especially fisherfolk, the study will increase awareness of the importance of mangroves. These ecosystems not only support fisheries but also protect communities from waves, storms, and coastal erosion, making them vital for both livelihood and safety (Spalding et al., 2010).

Municipal Environment and Natural Resources Office (MENRO)

The findings may contribute to existing initiatives such as the Mangrove Boardwalk project in Guinayangan, Quezon. Information on mangrove species and ecological conditions can enhance ecotourism awareness among visitors and support future environmental planning and conservation programs.

Government Officials

Local government officials can use the findings as a basis for informed decision-making, particularly in developing policies, conservation programs, and funding allocations for mangrove protection and sustainability.

Future Researchers

This study may serve as a reference for future research on mangrove assessment, biodiversity monitoring, and coastal ecosystem management.

VI. SCOPE AND LIMITATIONS

This study focuses on the assessment of selected mangrove sites in Guinayangan, Quezon. It aims to determine the status of mangroves in the area using recent studies and literature as basis for analysis and interpretation.

Specifically, it includes the identification of mangrove species present in the selected sites and the assessment of habitat conditions in terms of percent crown cover, regeneration per square meter, and average height. It also evaluates biodiversity through species richness, relative abundance, Shannon-Wiener diversity index, and evenness.

However, this study does not include the assessment of water quality through physical parameters and total organic carbon content. It also excludes conservation effectiveness and long-term sustainability assessment. The scope is limited to one selected mangrove site in Guinayangan, Quezon and does not represent the entire mangrove forest of the municipality.

Definition of Terms

Assessment – The systematic process of collecting and analyzing information to evaluate conditions, used in this study to determine mangrove status.

Brackish – Water with salinity levels between freshwater and seawater, commonly found in estuarine areas where river and sea water mix.

Conservation – The protection and sustainable management of natural resources to prevent depletion and maintain ecological balance.

Evenness – A measure of how evenly individuals is distributed across different species in a community.

Mangrove – Salt-tolerant trees and shrubs that grow in coastal intertidal zones and form ecosystems that support diverse marine life.

Regeneration – The natural process of growth or recovery of plants or organisms after disturbance or damage.

Richness – The number of different species present in a given area, indicating biodiversity level.

Sustainability – The ability to maintain ecological systems and resources over time without causing depletion or long-term damage.

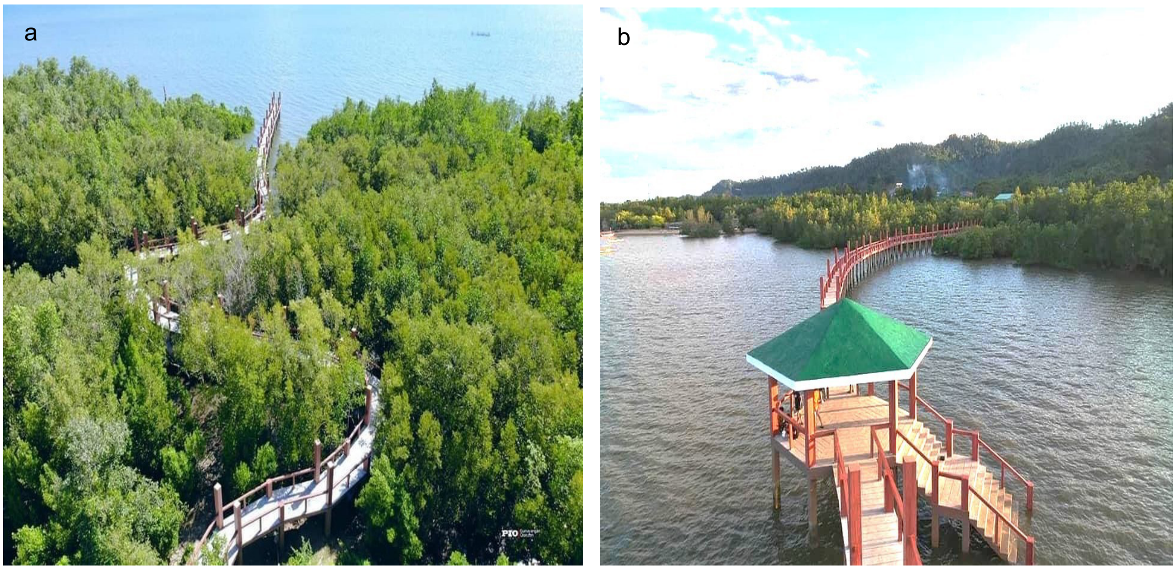
VII. DESCRIPTION OF THE STUDY AREA

Study Site

The Mangrove Walk is a local tourist destination in Guinayangan, Quezon where visitors can walk along a concrete trail passing through a mangrove ecosystem. It offers a scenic view of the mangrove forest and ends with a view of Ragay Gulf, making it both an ecological and recreational site. According to Diego Tañafranca (Calumpong & Menez, 1996), it provides visitors with a close-up view of different mangrove species and surrounding vegetation. The area is also a habitat for various aquatic birds, making it suitable for nature observation and ecotourism activities such as birdwatching.

The specific study site was selected by the Municipal Environment and Natural Resources Office (MENRO) of Guinayangan, Quezon under the supervision of Mr. Arnel Puno. The area is part of a broader initiative titled *Improving Coastal Resilience and Ecosystem Services through Biodiversity Restoration (ICORE)*, a collaborative project between the Guinayangan LGU, Zoological Society of London (ZSL), and International Institute of Rural Reconstruction (IIRR). Although 14 sites are included in the ICORE project, the Mangrove Walk itself is not part of the designated study sites, making it a unique area for assessment (Primavera, 2004).

Figure 7.1. Study Site aerial (a) and sea view (b).



VII. METHODOLOGY

Research Design

This study employed a quantitative descriptive research design to assess mangrove species composition, habitat condition, and diversity indices. Descriptive research involves the systematic collection, organization, and analysis of data to describe existing conditions and characteristics of a phenomenon. In this study, it was used to assess mangrove species composition, habitat condition, and biodiversity indices without manipulating any variables.

Data Gathering Procedure

A. Coordination with Guinayangan, Quezon Local Government Unit (LGU)

Five procedural steps were undertaken in this investigation. On March 11, 2023, a formal request letter was submitted to the Municipal Environment and Natural Resources Office (MENRO) of Guinayangan, Quezon, seeking permission to conduct the study, following coordination with the Sangguniang Bayan Secretary. Upon approval, an initial meeting was held on March 19, 2023, to discuss the criteria and process for finalizing the study site.

Subsequently, MENRO designated the final research location and assigned a staff member, along with the site caretaker, to assist during data collection. This arrangement was made as the MENRO representative was scheduled to travel to the Visayas the following week for a benchmarking activity.

B. Species Identification

Using the Field Guide Manual to Philippine Mangroves by Primavera (Primavera, 2009) the mangrove species present at the site were identified and classified in situ. The distance between the gate and the Mangrove Walk was measured at 75 meters using an industrial measuring tape. A straw rope was then used to establish three 75-meter transect lines. Along these transects, two 15 × 15-meter quadrats were laid out, with each quadrat containing three 1 × 1 meter regeneration plots.

Mangrove sampling along each transect line was conducted from the shoreline toward the landward direction. Individual mangrove trees encountered along the transects were recorded sequentially. Species identification was based on the examination of leaves, bark, and flowers to ensure accurate differentiation among individuals. For each tree, measurements of trunk diameter (cm), tree height (m), crown diameter (m), and crown height (m) were recorded. When morphological distinctions were evident, but species identity was not immediately confirmed, individuals were temporarily labeled as Species A, B, C, and so on, following the mangrove field identification guide by Primavera

Quadrat sampling was carried out using the 15 × 15-meter plots established between the transect lines. All mangrove species identified within the transects were also recorded inside each quadrat, and the same biometric parameters (trunk diameter, tree height, crown diameter, and crown height) were measured. In addition, the 1 × 1 meter regeneration plots within each quadrat were used to count and record the number of regenerating mangroves.

To further support and verify species identification, interviews and consultations were conducted during fieldwork with Mr. Zosimo Rom, the caretaker of the Mangrove Walk, and Mr. Aivan Lester Gonzales, a staff member of the Municipal Environment and Natural Resources Office (MENRO) of Guinayangan, Quezon.

C. Habitat Analysis

Habitat analysis was conducted using three parameters: percent crown cover, regeneration per square meter (m²), and average tree height. Computations followed the standard procedures outlined in the habitat analysis guide. The condition of mangrove regeneration per square meter was evaluated using the criteria established by Deguit et al. (2004).

$$\text{Percent crown cover} = \frac{\text{Total crown cover of all trees}}{\text{Total area sampled}} \quad (1)$$

$$\text{Regeneration per m2} = \frac{\text{Total regeneration count}}{\text{Total no. of regeneration plots}} \quad (2)$$

$$\text{Average height} = \frac{\text{Total height of all trees recorded}}{\text{Total number of trees recorded}} \quad (3)$$

D. Diversity Indices

Species diversity was assessed using the Shannon – Wiener diversity index (H'), along with species richness, relative abundance, and species evenness. These indices were computed using the Paleontological Statistical Software Package (PAST), a widely used free software for biodiversity analysis of flora and fauna, including mangrove ecosystems, developed by Hammer and colleagues (Hammer et al., 2001). Diversity index values were then interpreted using a rating scale from Deguit et al. (2004) as shown in Table 7.

Table 7.1

Criteria for determining the condition of mangrove

Condition	Criteria
Excellent	76% and above in % Crown Cover 1 Regeneration per m^2 Above 5m in Average Tree Height Undisturbed to negligible disturbance
Good	51% - 75% Crown Cover 0.76 - <1 Regeneration per m^2 3m - <5m Average Tree Height Slight disturbance and few cuttings
Fair	26% - 50% Crown Cover 0.50 – 0.75 Regeneration per m^2 2m - <5m Average Tree Height Moderate disturbance and noticeable cuttings
Poor	0% - 25% Crown Cover <0.5 Regeneration per m^2 <2m Average Tree Height Heavy disturbance / cuttings / pollution, rampant conversion to other uses, nearly destroyed

Note: Adapted from the Participatory Coastal Resource Assessment Training Guide (Deguit et al., 2004).

VIII. RESULTS

Measurements were taken for trunk diameter (cm), tree height (m), crown diameter (m), and crown height (m) for individuals along the three transect lines and within the two quadrats, each containing three regeneration plots. Each mangrove was examined by observing its leaves, bark, and flowers to determine species identity and to distinguish it from previously recorded individuals, using the Primavera field guide as a reference. Field data were then recorded in tabular form after being transferred from data sheets or writing slates.

IX. ANALYSIS AND DISCUSSION

A. Species Identification

A total of 183 mangrove trees were recorded across the three transect lines and two quadrats established in the study site. Of the 23 mangrove species listed by the Zoological Society of London (ZSL) for the Municipality of Guinayangan, Quezon, seven species were identified, representing three families: Acanthaceae, Lythraceae, and Rhizophoraceae. The list of observed mangrove species is presented in Table 2.

As presented in Table 9.1, based on the International Union for Conservation of Nature (IUCN) Red List, all mangrove species documented in the sampling sites are classified as Least Concern (LC), indicating that they are relatively widespread and not currently at significant risk of extinction globally. Notably, the endangered species *Camptostemon philippinensis*, which has been reported in Guinayangan, Quezon, was not observed in the study site.

Table 9.1

List of Identified Mangroves in the Study Site

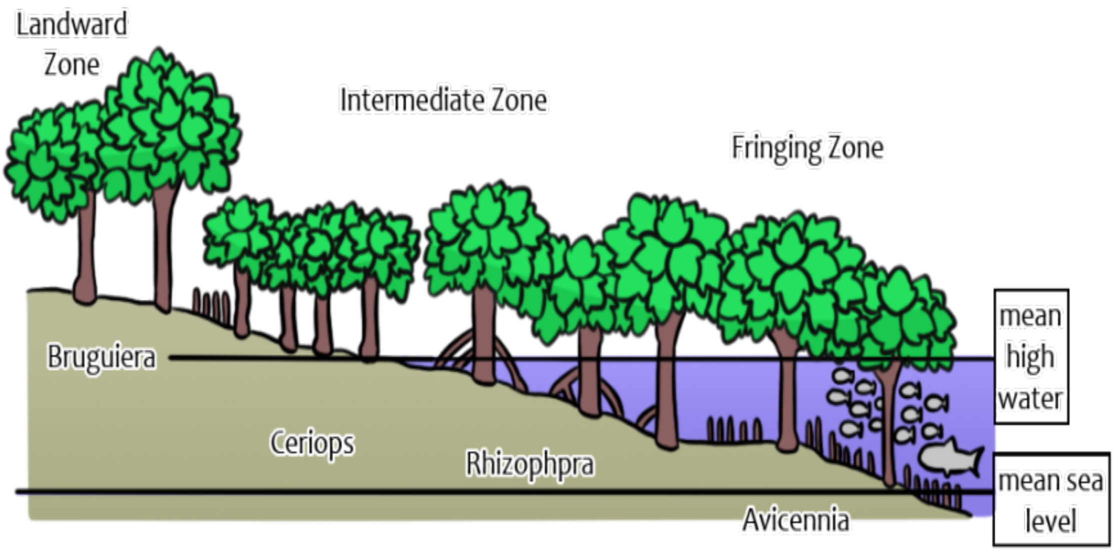
Scientific Name	Common Name	Local Name	IUCN Status
Avicennia marina	Grey Mangrove	Miapi, Api-api	Least Concern (LC)
Sonneratia alba	Mangrove Apple	Pagatpat	Least Concern (LC)
Rhizophora mucronata	Red Mangrove	Bakhaw – Babae	Least Concern (LC)
Sonneratia apetala	Mangrove Apple	Pagatpat	Least Concern (LC)
Bruguiera cylindrica	Black Mangrove	Pototan, Busain	Least Concern (LC)
Bruguiera parviflora	Small-Leaved Orange Mangrove	Langarai	Least Concern (LC)
Rhizophora apiculata	Tall Stilt Mangrove	Bakhaw-Lalaki	Least Concern (LC)

B. Mangrove Zonation

Mangrove zonation refers to the occurrence of distinct biological groupings within a mangrove forest, where areas are dominated by species belonging to the same family, genus, or species (Tomlinson, 1986). Both natural and human-managed mangrove forests may exhibit such zoning patterns as shown in Figure 9.1.

Based on the data obtained from the three transects and two quadrats, the observed species distribution generally followed the typical zonation pattern of natural mangrove habitats. Species of *Avicennia* and *Sonneratia* were found in the fringing zone, while *Rhizophora* and *Bruguiera* species were more commonly observed in the inland zones.

Figure 9.1. Mangrove Species Zonation.



Note: Adapted from https://www.coast.ph/ccef-news/04/mangroves-a-link-between-the-land-and-the-sea/

C. Habitat Analysis

Based on the evaluation outcomes of the three criteria, percent crown cover, average height, and regeneration per m², the overall condition of the mangroves in the study area was determined.

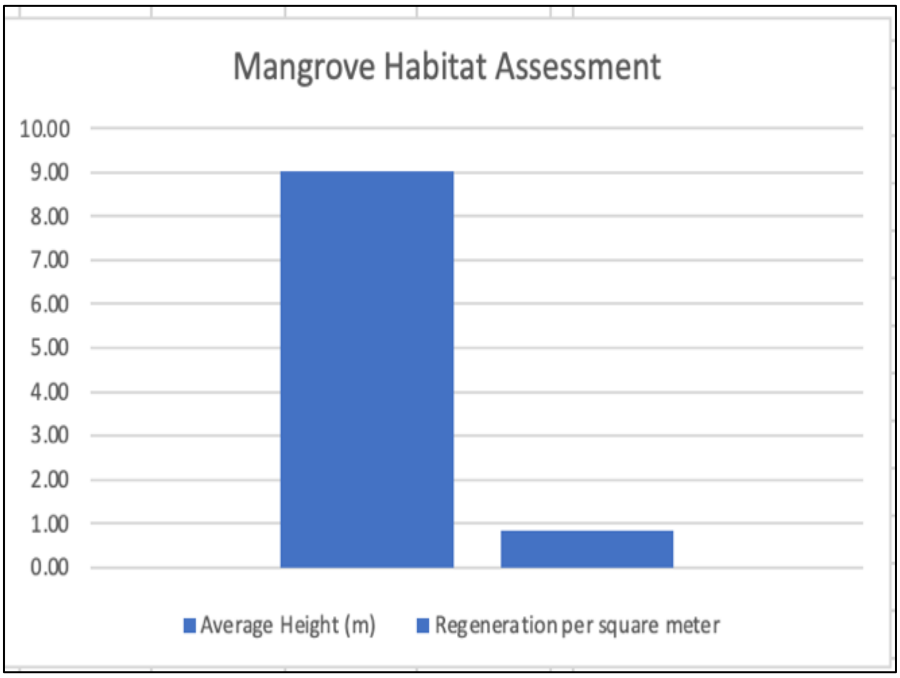
Table 9.2

Average Percent Crown Cover and Average Height Summary

	Transect Line 1	Transect Line 2	Transect Line 3	Quadrat 1	Quadrat 2	Average
Percent Crown Cover (%)	5.21	4.85	7.00	4.83	6.26	5.63
Average Height (m)	8.97	10.92	8.76	8.35	8.20	9.04

Based on the parameters by Deguit et al. (2004) presented in Table 7.1, the average percent crown cover of 5.63 falls under the *poor* condition category, as it is within the 0–25% crown cover range. Using the same reference, the average tree height of 9.04 meters is classified as *excellent*, since it exceeds the threshold of 5 meters in average tree height. For regeneration density, the computed value of 0.83 individuals per square meter is considered *good*, as it falls within the range of 0.7 to less than 1 individual per square meter. A summary of these results is presented in Table 9.3 and Figure 9.2.

Figure 9.2. Mangrove habitat assessment based on average height and regeneration per sqm.



D. Diversity Indices

Based on Table 9.3, in terms of relative abundance across all sampling stations, the three most dominant species were *Sonneratia alba* (39%), *Avicennia marina* (16.5%), and *Rhizophora mucronata* together with *Sonneratia apetala* (11.0%). *Sonneratia alba* was observed to dominate all three transects and two quadrats, which may be attributed to the characteristics of its propagules. Its lightweight seeds are easily dispersed by water currents, contributing to its wide distribution within the study area (Chen et al., 2021).

Table 9.3

Relative Abundance Summary

SPECIES	Transect Line 1		Transect Line 2		Transect Line 3		Quadrat 1		Quadrat 2		In all sampling stations	
	No.	% RA	No.	% RA	No.	% RA	No.	% RA	No.	% RA	No.	% RA
A	2	0.069	4	0.154	5	0.172	11	0.224	8	0.163	30	16.5%
B	13	0.448	7	0.269	9	0.310	20	0.408	22	0.449	71	39.0%
C	4	0.138	3	0.115	3	0.103	10	0.204	0	0.000	20	11.0%
D	2	0.069	6	0.231	4	0.138	4	0.082	4	0.082	20	11.0%
E	2	0.069	4	0.154	3	0.103	4	0.082	5	0.102	18	9.9%
F	4	0.138	2	0.077	2	0.069	0	0.000	10	0.204	18	9.9%
G	2	0.069	0	0.000	3	0.103	0	0.000	0	0.000	5	2.7%

Note: Specific names of species

***A** - Avicennia marina*

***B** - Sonneratia alba*

***C**. Rhizophora mucronata*

***D** - Sonneratia apetala*

***E** - Bruguiera cylindrica*

***F** - Bruguiera parviflora*

***G** - Rhizophora apiculata*

In contrast, the species with lower relative abundance shown on Figure 9.3 included *Bruguiera cylindrica* (9.9%), *Bruguiera parviflora* (9.9%), and *Rhizophora apiculata* (2.7%), indicating comparatively less representation within the sampling sites.

Figure 9.3. Percent relative abundance of seven identified species.

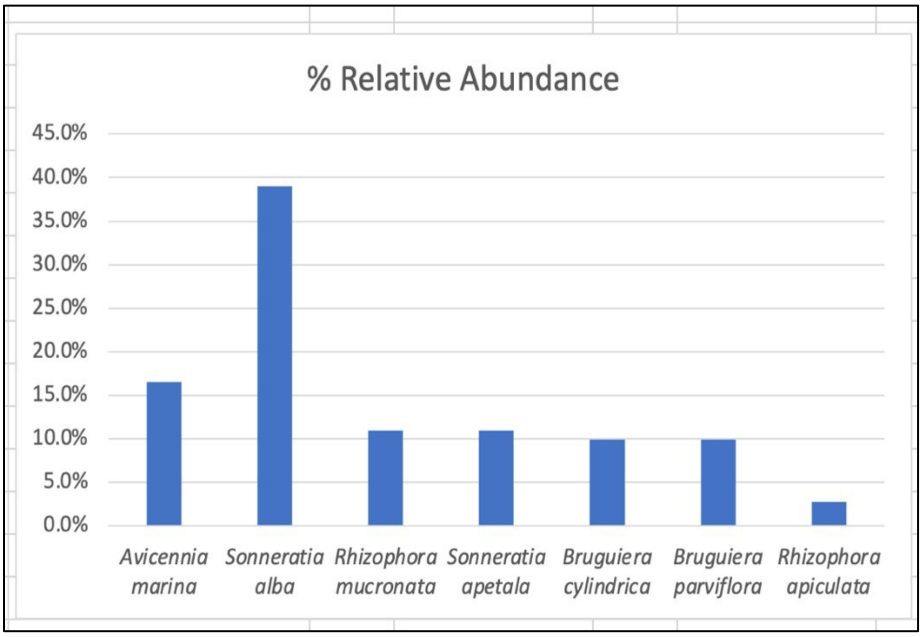


Table 9.4

Diversity Indices Data

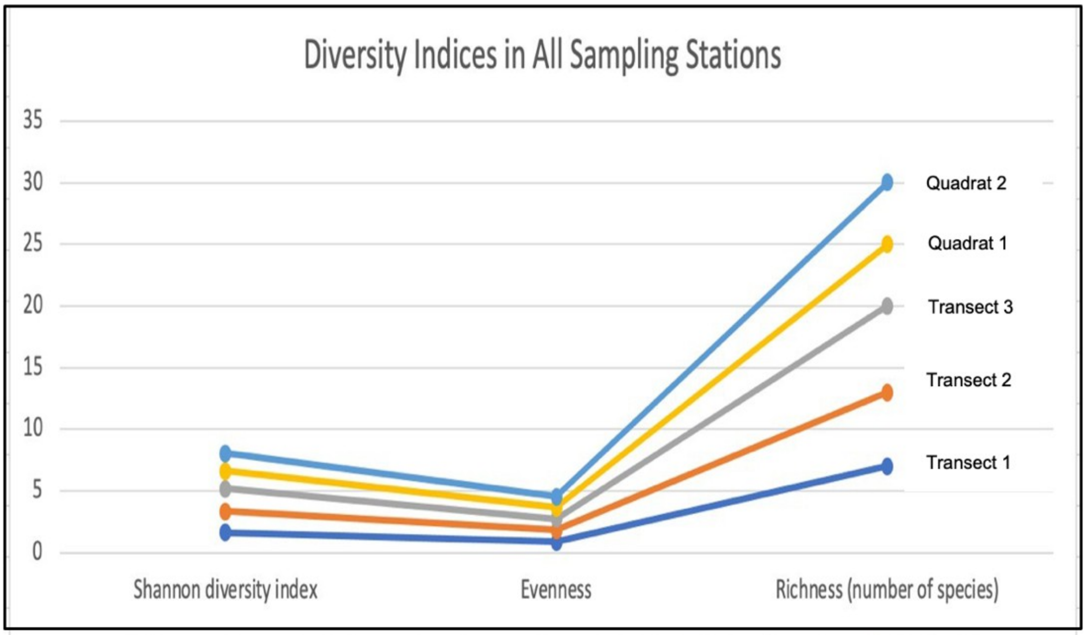
Diversity Indices	Transect Line 1	Transect Line 2	Transect Line 3	Q1	Q2	Average
Shannon-Wiener	1.64	1.71	1.83	1.43	1.42	1.606
Evenness	0.845	0.957	0.939	0.891	0.881	0.9026
Richness	7	6	7	5	5	6

Based on Table 9.4 and Figure 9.4, Transect Lines 1 and 3 exhibited the highest species richness. This was followed by Transect Line 2 with six species, while Quadrats 1 and 2 recorded the lowest species richness, each with five species observed.

In terms of the Shannon–Wiener diversity index, Transect Line 3 had the highest value (1.83), followed by Transect Line 2 (1.71) and Transect Line 1 (1.64). Quadrat 1 recorded a value of 1.43, while Quadrat 2 had the lowest diversity index of 1.42.

The Shannon–Wiener diversity index typically ranges between 1.5 and 3.5 and rarely exceeds 4.5. Its primary purpose is to provide a quantitative measure of biological diversity that allows comparison across different sites or over time. Using the scale presented in the methodology, the obtained diversity index values were interpreted accordingly.

Figure 9.4. Diversity indices in all sampling stations.



Based on the interpretation on Table 7.1, all transects and quadrats were classified as having a poor status in terms of the Shannon–Wiener diversity index.

In terms of species evenness, all transects and quadrats exhibited a *balanced* distribution. Lastly, for species richness, all sampling sites recorded values above five, indicating an *integrated* condition.

X. RECOMMENDATION AND CONCLUSION

Recommendation

Overall, the assessment of the Mangrove Walk in Brgy. Calimpak, Guinayangan, Quezon provides valuable information that can support appropriate management, conservation, and rehabilitation efforts aimed at maintaining and improving the biological condition of the site.

Despite the relevance of the findings, several recommendations are proposed to strengthen future studies and management initiatives. First, the low percent crown cover and Shannon–Wiener diversity index values may be partly attributed to the limited number of transect lines and quadrats used in the methodology. Increasing the number of transects and establishing additional quadrats between existing lines may yield a more comprehensive representation of vegetation structure and species diversity.

Second, the use of advanced technologies such as high-resolution cameras with zoom lenses would improve documentation of flowers, propagules, and other elevated plant structures. The integration of unmanned aerial vehicles (drones) could also provide aerial imagery for more accurate assessment of crown cover and spatial distribution.

Third, the results of this study can serve as baseline data for long-term management interventions, including informed decisions on suitable mangrove species for future planting and rehabilitation programs.

Fourth, the findings may assist the Municipal Environment and Natural Resources Office (MENRO) and the Tourism Office of Guinayangan, Quezon in planning the sustainable development of the Mangrove Walk as an ecotourism destination, potentially incorporating a minimal entrance fee to support site maintenance and conservation.

Lastly, future research may incorporate additional parameters such as water and soil quality analysis, hazard assessment, and conservation and sustainability evaluations to provide a more comprehensive understanding of the mangrove ecosystem and further support effective resource management.

Conclusion

Based on the results and findings of the study, the following conclusions are drawn:

Seven (7) of the 23 mangrove species listed by the Zoological Society of London (ZSL) for the Municipality of Guinayangan, Quezon were recorded at the study site. These species belong to three families: Acanthaceae, Lythraceae, and Rhizophoraceae.

The dominant mangrove species identified were *Sonneratia alba*, *Avicennia marina*, *Rhizophora mucronata*, and *Sonneratia apetala*. The observed mangrove zonation pattern generally followed the typical natural zonation characteristic of mangrove ecosystems.

Habitat analysis based on the criteria of Deguit et al. (2004) indicated contrasting structural conditions. The average percent crown cover of 5.63% was classified as *poor*, while the average tree height of 9.04 m reflected an *excellent* condition. Regeneration density, with a mean value of 0.83 individuals per m^2, was classified as *good*.

Analysis of diversity indices showed that all transects and quadrats exhibited a poor Shannon–Wiener diversity index. However, species evenness across all sampling units was *balanced*, and species richness values exceeded five species in all cases, indicating an *integrated* mangrove community structure.

REFERENCES

Calumpong, H. P., & Menez, E. G. (1996). Field guide to the common mangroves, seagrasses and algae of the Philippines. Bookmark Inc.

Carugati, L., Gatto, B., Rastelli, E., Martire, M. L., Coral, C., Greco, S., et al. (2018). Impact of mangrove forests degradation on biodiversity and ecosystem functioning. Scientific Reports, 8, 13298. https://doi.org/10.1038/s41598-018-31683-0

Chen, L., Chen, Y., Peng, Y., Li, H., & Zhang, Y. (2021). Latitudinal gradients and climatic controls on reproduction and dispersal of the non-native mangrove *Sonneratia apetala* in China. Estuarine, Coastal and Shelf Science, 248, 107090. https://doi.org/10.1016/j.ecss.2020.107090

Deguit, E. T., Smith, R. P., Jatulan, W. P., & White, A. T. (2004). Participatory coastal resource assessment: Training guide. Coastal Resource Management Project, Department of Environment and Natural Resources.

Hammer, O., Harper, D. A. T., & Ryan, P. D. (2001). PAST: Paleontological statistics software package for education and data analysis. Palaeontologia Electronica, 4(1), 9. https://palaeo-electronica.org/2001_1/past/issue1_01.htm

Melana, D. M., & Gonzales, H. I. (1996). Mangrove management handbook. Department of Environment and Natural Resources, Coastal Resource Management Project.

Myers, N., Mittermeier, R. A., Mittermeier, C. G., da Fonseca, G. A. B., & Kent, J. (2000). Biodiversity hotspots for conservation priorities. Nature, 403(6772), 853–858. https://doi.org/10.1038/35002501

Olsen, S. B., Tobey, J., & Kerr, M. (1997). A common framework for learning from ICM experience. Coastal Resources Center, University of Rhode Island.

Primavera, J. H. (2004). Philippine mangroves: Status, threats and sustainable development. In M. Vannucci (Ed.), Mangrove management and conservation: Present and future (pp. 192–207). United Nations University Press.

Primavera, J. H. (2009). Field guide to Philippine mangroves. Zoological Society of London–Philippines.

Romañach, S. S., DeAngelis, D. L., Koh, H. L., Feijóo, A., Silverio, D. V., et al. (2018). Conservation and restoration of mangroves: Global status, perspectives, and prognosis. Ocean & Coastal Management, 154, 72–82.

Samson, M. S., & Rollon, R. N. (2008). Growth performance of planted mangroves in the Philippines: Revisiting forest management strategies. Ambio, 37(4), 234–240. https://doi.org/10.1579/0044-7447(2008)37[234:GPOPMI]2.0.CO;2

Spalding, M., Kainuma, M., & Collins, L. (2010). World atlas of mangroves. Earthscan.

Tomlinson, P. B. (1986). The botany of mangroves. Cambridge University Press.

Viray-Mendoza, V. (2017). Mangrove ecosystems and their role in coastal protection and biodiversity. Department of Environment and Natural Resources.

Appendices

APPENDIX A

Letter to the Municipal Environment and Natural Resources Office (MENRO) of Guinayangan, Quezon

UNIVERSITY OF THE PHILIPPINES OPEN UNIVERSITY
Los Baños Laguna

March 17, 2023

MR. ARNEL B. PUNO
Environment and Natural Resources Officer
Guinayangan, Quezon

Dear MENRO Puno,

Greetings of peace!

I am **CHARISSE ANGELIQUE MANALO-ESCOBAL**, a resident of Barangay Calimpak, Guinayangan Quezon and currently working as a Science Department Head and Faculty at University of Cabuyao (Pamantasan ng Cabuyao).

At present, I am on my last 3.0 units to finish my Masters Degree in Environment and Natural Resources Management (Major in Coastal Ecosystem Management) at the University of the Philippines Open University (UPOU).

In line with the said graduate studies mentioned above, I would like to ask your good office to allow me to conduct my Special Problem (Thesis) titled: ***Current Status Assessment : Species Identification, Habitat Analysis and Diversity Indices of Guinayangan Quezon Mangrove Forest.***

My study will specifically involve the following methods:

1. **Initial Data Gathering:** Coordination with Environment and Natural Resources Office (DENRO) of Guinayangan, Quezon will be done for permit acquisition and to gather initial information on the current mangrove status and projects related to mangrove conservation.

2. **Assessment and Habitat Analysis:** This process will start with the identification of mangrove site/s that will be used in the study. After that, identification and classification of the mangrove species present in the site/s (in situ) will be done using the field guide manual to Philippine Mangroves by Primavera et al (2004). Further habitat analysis will be done through the following procedures: percent crown cover, regeneration per m^2 and average height.

3. **Calculation of Diversity Indices:** Such as species richness, relative abundance, Shannon-Weiner diversity index and evenness. The said indices above will be calculated using the Paleontological Statistical Software Package (PAST) developed by Hammer et al (2001).The diversity values for Shannon-Weiner will be classified based on a scale developed by Fernando (1998).

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4. **Statistical Analysis of Data:** The gathered data will be statistically analyze using PAST (PAleontological STatistics) tool.

Note: Study site/s will depend on the LGU's current information on mangroves.

If ever you will permit, I would like to conduct my data gathering next week, March 20-21, 2023. Your current data on mangroves, recommendation on which site/s needs to be assessed and analyzed as well as manpower help while I conduct my data gathering will be of great help.

Thank you very much and more power.

Padayon!

Sincerely, [redacted]

CHARISSE ANGELIQUE M. ESCOBAL
MENRM Student, UPOU
camescobal@gmail.com
09989503009

Noted by:

DR. CONSUELO D. HABITO
Special Problem Adviser, UPOU

APPENDIX B

Meeting With the Guinayangan, Quezon LGU Regarding Permit

COMMUNICATION WITH THE MENRO OF GUINAYANGAN QUEZON

Date: March 19, 2023

This is to certify that Mr/Ms **Charisse Angelique M. Escobal** appeared on Sunday (day, time and date) at 4 pm on Brgy. Manlayo (place visited)

Purpose of Visit: To specifically discuss the methods that will be conducted and specifiy the place of study.

Name of Person Interviewed/Visited/Signature [redacted]

MENRO Arnel Puno
Guinayangan, Quezon

APPENDIX C

Data gathering with the Municipal Environment and Natural Resources Office

(MENRO) of Guinayangan, Quezon.

DATA GATHERING PROPER

Date: March 20-22, 2023

This is to certify that Mr/Ms Charisse Angelique M. Escobal appeared on Monday to Tuesday (day, time and date) at 8 am to 12 noon in Mangrove Boardwalk. (place visited)

Purpose of Visit: To conduct the data gathering procedures stated on the study.

Name of Person Interviewed/Visited/Signature

[redacted]

Aivan Lester Gonzales
MENRO Staff - Guinayangan, Quezon

APPENDIX D

Oral Defense Presentation