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MANGROVE FOREST HEALTH AND ITS RELATIONSHIP TO THE SUSTAINABILITY OF LOCAL FISHERIES

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ABSTRACT
This study evaluates the health condition of mangrove forests and its relationship to fisheries productivity in a selected coastal area of the Municipality of Cagwait. It utilizes a descriptive-correlational research design using mangrove assessment and survey data from 20 respondents. Findings revealed that the mangrove ecosystem was predominantly composed of *Rhizophora mucronata*, with 95% of the mangroves classified as healthy with minimal signs of degradation observed. Fish abundance in the area was generally high, manifested through reported respondents catch. Seasonal analysis showed that the Amihan season recorded the highest fish catch, while the Habagat season recorded the lowest. One-Way ANOVA results showed no significant difference in fish abundance across groups, $F(1,18)=2.867$, $p=.108$. However, Two-Way ANOVA revealed that mangrove condition significantly affected fish abundance, $F(1,17)=6.744$, $p=.019$, indicating that healthier mangrove ecosystems support greater fisheries productivity. The findings highlight the ecological importance of mangroves in sustaining fish populations, supporting coastal livelihoods, and maintaining coastal ecosystem stability. The study recommends to provide environmental education and awareness programs to promote community understanding of the importance of mangroves in fisheries sustainability and develop alternative livelihood programs such as ecotourism and sustainable aquaculture to reduce dependence on fishing during low catch seasons and the implementation of environmental monitoring programs for long-term sustainability of fisheries and coastal ecosystems in the locality.

KEYWORDS: Mangrove, Sustainability, Rhizophora mucronata, Local Fisheries

1. INTRODUCTION

The mangrove forests represent one of the most vital coastal ecosystems, it plays a multifunctional role in maintaining ecological stability and supporting human livelihoods. These unique intertidal forests serve as biological nurseries for a wide array of marine organisms, including commercially important fish, crustaceans, and mollusks. With their complex networks of aerial roots, the mangroves trap sediments, improve water quality, and creates sheltered habitats that is essential for early fish development. Moreover, the health of mangrove ecosystems has long been recognized as a fundamental driver of productive and resilient local fisheries.

Although existing studies acknowledge that healthy mangrove forests contribute to higher fish biomass, increased species diversity, and improved fisheries productivity. According by Maulana, I.,Safe'i, R., Febryano, I., Kaskoyo, H. and Ali Rahmat (2021) an assessment of the forest health condition needs to ensure the condition of mangrove forest health is maintained. Therefore, the condition of the mangrove forest needs to be in good condition. Tengku Mohd Zarawie Tengku Hashim, Engku Azlin Rahayu Engku Ariff & Mohd Nazip Suratman (2021) the major drivers of mangrove deforestation in recent times include aquaculture, agriculture, urban expansion, forest product extraction, salt pond conversion, and the oil and gas industry. Also, Ishtiaque, A., Myint, S. and Wang, C. (2016) identified certain anthropogenic stressors (i.e., oil pollution, shrimp farming) and natural stressors (i.e., increased salinity, cyclones, forest fire) which might be responsible for the observed degradation. Also, they provided sustainable planning options and policy transformation alternatives for those areas under pressure from these stressors. They anticipate that in their analysis of forest degradation will help management agencies, conservators, and policy makers achieve better management of this world's largest mangrove forest for a sustainable future.

Arangasa, Cagwait, Surigao del Sur is facing the Pacific Ocean. The area includes shoreline and estuaries which suitable habitats for mangrove forests. Mangroves in Arangasa provides nursery grounds for fish and marine life, protection from coastal hazards, livelihood support like fishing, eco-tourism potential and climate regulation through carbon storage. Not just local resources they are part of a globally important ecosystem that helps fight climate change and supports food security in communities in eastern Mindanao. Mangroves in Arangasa also provide nursery and breeding grounds for fish, crustaceans like crabs and shrimp directly sustain local fishing livelihoods. Thus, this study aims to evaluate the current status of mangrove forest health in term of tree density, amount of fish, sign of degradation and mangrove condition. It also assesses the perceptions and experiences of local fisher folks regarding the role of mangroves in sustaining fisheries resources in Arangasa, Cagwait, Surigao del Sur.

Finally, the findings of this study will support the local government units community-based organizations, fisher folk associations, and environmental agencies in crafting sustainable coastal resource management policies. The strengthening mangrove conservation and rehabilitation efforts will not only enhance biodiversity but also improves long-term fishery yields, promote climate resilience, and ensure that coastal communities continue to thrive for generations to come.

1.1. Objectives of the Study

To assess the health of mangrove forests and determine its influences in the sustainability of local fisheries.

1. To evaluate the current health status of mangrove forests in the selected coastal area, based on indicators such as tree density, species diversity and signs of degradation.
2. To determine the extent to which mangrove forest health is associated with local fisheries productivity, as measured by fish abundance, catch volume and seasonal variations.
3. To provide recommendations for enhancing mangrove conservation to ensure long-term fisheries sustainability and community livelihood stability.

2. CONCEPTUAL FRAMEWORK OF THE STUDY

This study assessed mangrove forests health and its relationship to the sustainability of Local Fisheries. To evaluate the current health status of mangrove forests in the selected coastal area based on indicators such as tree density, species diversity and signs of degradation. Also, to assess the perceptions and experiences of local fisher folk regarding the role of mangroves in sustaining fisheries resources. A survey questionnaire was used to assess the fisher folks in terms of sustainability of local fisheries, fish catch and resource availability. Lastly, identify existing conservation, protection, and management practices that help maintain or improve mangrove forest health.

Randomly selected mangrove trees for assessment and determination of health status of mangrove. To determine the tree density in terms of DBH measure 1.3 meters from the ground, wrap a measuring tape around the trunk and record the diameter in centimeters. In measuring estimated height, used a measuring tape or meter stick. Measure from the base of the tree up to the topmost point. Record the height in meters. In assessing the health condition of the mangrove these are indicators healthy, slightly damaged, severely damaged, diseased and dead as indicator to know the status of mangrove.

Figure 1: Methodology of the Study

3. RESULTS AND DISCUSSION

To assess the health of mangrove forests and determine how their condition influences the sustainability of local fisheries. **To evaluate the current health status of mangrove forests in the selected coastal area based on indicators such as tree density, amount of fish catch, signs of degradation and mangrove condition.**

Table 1: Tree density of Mangrove Trees

No.	Tree Species	DBH	Estimated Height
		(cm)	(m)
1	Rhizophora mucronata	41.70	7.27
2	Rhizophora mucronata	25.46	5.03
3	Rhizophora mucronata	41.70	4.64
4	Rhizophora mucronata	35.65	5.48
5	Rhizophora mucronata	39.47	4.96
6	Rhizophora mucronata	23.55	5.14
7	Rhizophora mucronata	16.87	3.75
8	Rhizophora mucronata	23.87	4.70
9	Rhizophora mucronata	17.83	4.50
10	Rhizophora mucronata	23.24	4.80
11	Rhizophora mucronata	18.46	3.60
12	Rhizophora mucronata	39.79	5.93
13	Rhizophora mucronata	7.32	3.50
14	Rhizophora mucronata	9.55	3.70
15	Rhizophora mucronata	11.46	4.10
16	Rhizophora mucronata	18.78	5.00
17	Rhizophora mucronata	17.19	4.70
18	Rhizophora mucronata	10.82	3.80
19	Rhizophora mucronata	9.55	4.06
20	Rhizophora mucronata	15.92	5.30

The mangrove assessment reveals that all sampled trees mostly are Rhizophora mucronata, indicating species dominance within the study area. The diameter at Breast Height (DBH)values ranges from 7.32 cm to 41.70 cm, while estimated heights range from 3.50 m to 7.27 m, suggesting the presence of both regenerating and mature trees. Most trees were classified as healthy (95%), with only one recorded as slightly damaged. The coexistence of varying DBH and height classes reflects structural diversity and continuous regeneration, that indicates a stable and resilient mangrove ecosystem. Previous studies have shown that mature and healthy mangrove stands enhance coastal protection, carbon storage, and fisheries productivity by providing nursery habitats for marine organisms (Alongi, 2008; FAO, 2020).

Table 2: Amount of Fish

Amount of Fish						
		Frequency	%	Valid %	Cumulative %
Valid	Very Low	2	10.0	10.0	30.0
	Low	1	5.0	5.0	100.0
	Moderate	3	15.0	15.0	45.0

	Abundant	10	50.0	50.0	95.0
	>20	4	20.0	20.0	20.0
	Total	**20**	**100.0**	**100.0**	

The data revealed that in terms of Amount of Fish the majority of the respondents answered Abundant with 50% and >20 with 20%, total of 70%. This indicates that fish availability in the study area is generally high as manifested in the abundant number of fish caught as closely associated with the condition and presence of mangrove plants. Respondents also reported that fishes caught in areas were healthy and dense. This finding underscores the importance of mangrove ecosystems in sustaining fish abundance, increasing fish productivity and supporting the long term sustainability of coastal fisheries.

The result implies that mangroves provide essential ecological functions that contribute to the increase in fish population. Wherein the complex root structures of mangrove plants serve as breeding grounds, nursery habitats, feeding areas, and protective shelters for various fish species, particularly juvenile fishes. These environments reduce predation risks and provide abundant food resources, thereby enhancing fish survival and growth. Consequently, areas with healthier mangrove conditions tend to exhibit greater fish abundance compared to areas with degraded mangrove ecosystems. This confirms by Pauly & Zeller (2016) found that coastal fisheries in tropical regions (like the Philippines) can maintain high catch levels when Mangroves are healthy.

The study area reveals generally high fish availability, as reported by most respondents from abundant to very high catch levels. This indicates favorable ecological conditions and potentially sustainable fishery practices. However, the presence of moderate and low responses reflects inherent variability in fish catch, likely influenced by environmental and seasonal factors. These findings align with fisheries research, emphasizing that while high abundance signals ecosystem productivity, variability remains a natural characteristic of coastal fisheries systems.

Table 3: Signs of Degradation

	None	Low	Moderate	High
Tree cutting/stumps	12	1		
Charcoal/wood collection evidence	13	1		
Garbage/plastics accumulation	13	1		
Oil/chemical odor or sheen	15			
Erosion/scouring	15			
Sedimentation/burial of roots	15			
Pest/disease (leaf yellowing, dieback, borers)	15			
Conversion (ponds, houses, roads)	15			
Boat scars/trampling	15			
Fire/burn marks	15			
None observed	12			

The assessment of anthropogenic and environmental disturbance indicators revealed that most observed conditions were classified as "None,". Wherein it indicates minimal ecological disturbance within the mangrove ecosystem. Only isolated low-level evidence of tree cutting, charcoal collection, and garbage accumulation were recorded. In addition, there were no signs of oil contamination, erosion, sediment burial, pest infestation, land conversion, boat scarring, or fire damage observed. These findings greatly show that the mangrove ecosystem remains relatively intact and ecologically stable. And the low disturbance levels likely contribute to the healthy condition of the mangroves and support fisheries productivity by maintaining nursery habitats, shoreline stability, and ecological connectivity. And it is supported as the previous studies have shown that intact mangrove ecosystems significantly enhance fish abundance, biodiversity, and coastal resilience (Alongi, 2008; FAO, 2020).

Table 4: Mangrove Condition

Mangrove Condition					
		Frequency	**%**	**Valid %**	**Cumulative %**
Valid	Healthy	19	95.0	95.0	95.0
	Slightly damage	1	5.0	5.0	100.0
	Total	20	100.0	100.0	

The findings demonstrate that the mangrove ecosystem within the study area remains predominantly healthy, as perceived by most respondents. And this suggests the continued functionality of mangroves as critical ecological support systems for coastal fisheries. Healthy mangroves are widely recognized as essential nursery and feeding habitats for juvenile fish and invertebrates, thereby contributing to fisheries productivity and biodiversity conservation. The observed high fish abundance in the area may therefore be directly linked to the positive condition of mangrove habitats. Nevertheless, the presence of slight mangrove damage, although minimal, still highlights the need for proactive conservation efforts to prevent future ecological degradation. Given the increasing threats posed by climate change, coastal development, and anthropogenic activities, maintaining the mangrove integrity remains crucial for sustaining fisheries resources and coastal livelihoods.

The result is supported by the study of Alongi, D. (2022) who highlighted that the exceptional productivity of mangrove forests stems from their ability to recycle nutrients and provide critical resources for fisheries. Similarly, Mumby, P. (2004) found that mangrove ecosystems significantly enhance fish biomass and abundance in nearby coastal habitats. Furthermore, research on resilient mangrove ecosystems revealed that healthier mangroves are directly associated with higher fish biomass and fish abundance, emphasizing the ecological importance of mangrove conservation.

The findings further implies that the conservation and rehabilitation of mangrove forests are essential for sustaining fisheries and maintaining coastal ecological balance. In protecting mangrove ecosystems, it does not only preserve marine biodiversity but also supports the livelihood and food security of coastal communities' dependent on fishing activities. Therefore, effective mangrove management programs and community-based conservation initiatives are necessary to prevent further degradation and ensure the sustainability of marine resources.

To determine the extent to which mangrove forest health is associated with local fisheries productivity, as measured by fish abundance, catch volume and seasonal variations.

Table 5: Season Highest Catch

Season Highest Catch					
		Frequency	%	Valid %	Cumulative %
	Amihan	13	65.0	65.0	65.0
	Dry Season	7	35.0	35.0	100.0
	Total	20	100.0	100.0	

The findings indicate that the Amihan season serves as the primary period or the peak season in catching fish, as reported by most respondents. This pattern reflects the influence of monsoon-driven oceanographic processes that enhance marine productivity through nutrient enrichment and trophic interactions. As Longhurst & Pauly (2007) show monsoon-driven productivity pulses in tropical shelves. Also, FAO (2022) reports that monsoon dynamics strongly regulate catch variability in Southeast Asian small-scale fisheries. However, the substantial proportion of respondents identifying the dry season as their highest catch period suggests the presence of secondary productivity cycles and species-specific seasonal dynamics. These results highlight the inherently variable nature of coastal fisheries and underscore the importance of considering both environmental and anthropogenic factors in fisheries management. Furthermore, reliance on a dominant fishing season may expose local fisheries to risks associated with climate variability and concentrated fishing pressure.

Table 6: Season Lowest Catch

Season Lowest Catch					
		Frequency	%	Valid %	Cumulative %
Valid	Habagat	20	100.0	100.0	100.0

The study assessed the number of fish caught and seasonal variations in fisheries productivity. The results reveal a clear seasonal pattern, with strong consistency among respondents regarding peak and low fishing periods. This unanimous response indicates a strong and consistent seasonal constraint on fisheries. During Habagat like heavy rainfall increases water turbidity, strong waves disturb coastal habitats, freshwater influx alters salinity levels and fishing effort is reduced due to unsafe sea conditions. Environmental stressors such as turbidity and habitat disturbance significantly reduce fish availability and catch efficiency. Alongi (2020) and FAO (2022) confirm that monsoon disturbances lead to reduced fish aggregation, lower fishing activity and decline in catch volume. Also, Cheung et al. (2018) emphasize that marine fisheries in tropical regions are highly sensitive to seasonal and climatic variability. **One Way Anova (Amount of Fish) and Health Condition of Mangroves)** The Table presents a One-Way Analysis of Variance (ANOVA) conducted to determine whether there is a statistically significant difference in the amount of fish across the compared groups or conditions.

Table 7: Amount of Fish

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	134.411	1	134.411	2.867	.108
Within Groups	843.789	18	46.877		
Total	**978.200**	**19**			

The One-Way ANOVA revealed no statistically significant difference in the amount of fish across the compared groups, $F(1,18) = 2.867$, $p = .108$. Since the p-value exceeded the 0.05 significance level, the null hypothesis was accepted. This indicates that the observed variation in fish abundance may be attributed to natural environmental fluctuations rather than systematic group differences. The large within-group variability further suggests that fish abundance is influenced by multiple interacting ecological and anthropogenic factors, including habitat conditions, fishing pressure, and seasonal variability. As cited from the previous studies, these findings are consistent with fisheries literature emphasizing the dynamic and heterogeneous nature of fish populations (FAO, 2020; Hilborn & Walters, 1992).

3.1. Univariate Analysis of Variance (TWO WAY ANOVA)

Table 8: Mangroves Health Condition affecting Seasons Highest and Lowest Catch

Descriptive Statistics				
Dependent Variable: Amount of Fish				
Season Highest Catch	**Season Lowest Catch**	**Mangrove Condition**	**Mean**	**Std. Deviation**
Amihan	Habagat	Healthy	17.25	5.879
		Slightly damage	2.00	.
		Total	16.08	7.041
	Total	Healthy	17.25	5.879
		Slightly damage	2.00	.
		Total	16.08	7.041
Dry Season	Habagat	Healthy	17.86	5.178
		Total	17.86	5.178
	Total	Healthy	17.86	5.178
		Total	17.86	5.178
Total	Habagat	Healthy	17.47	5.491
		Slightly damage	2.00	.
		Total	16.70	6.367
	Total	Healthy	17.47	5.491
		Slightly damage	2.00	.
		Total	16.70	6.367

The descriptive statistics revealed that healthy mangrove conditions were consistently associated with higher amounts of fish across seasons. During the Amihan season, healthy mangroves recorded a mean fish amount of 17.25 (SD = 5.879), while in dry season it recorded a slightly higher mean of 17.86 (SD = 5.178). In contrast, slightly damaged mangrove areas has a record of substantially lower mean fish amount of 2.00, indicating severe reductions in fisheries productivity. These findings imply that mangrove ecosystem health plays a critical role in supporting fish abundance. Healthy mangrove forests provide essential nursery habitats, feeding grounds, and ecological protection for marine organisms, thereby it enhances fish recruitment and survival. As cited, the results are consistent with previous studies emphasizing the strong ecological relationship between mangrove integrity and fisheries productivity (Alongi, 2008; FAO, 2020).

3.2. Levene's Test of Equality of Error Variances[a]

Table 9: Dependent Variable: Amount of Fish

F	df1	df2	Sig.
.623	2	17	.548

The Levene's Test of Equality of Error Variances was test to examine the assumption of homogeneity of variance for the dependent variable "Amount of Fish." The test yielded a non-significant result, $F(2,17) = 0.623$, $p = .548$, this means that the variances among the groups were statistically equal, since the significance value exceeded the 0.05 threshold, which means that the assumption of homogeneity of variance was satisfied. Thus, this suggests that the variability in fish abundance across groups was relatively consistent, supporting the validity and robustness of the ANOVA results. This finding is important in ecological and fisheries studies where natural environmental variability often affects data distribution and statistical reliability

3.3. Tests of Between-Subjects Effect

Table 10: Dependent Variable: Amount of Fish

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	229.093[a]	2	114.546	3.599	.050
Intercept	697.120	1	697.120	21.901	.000
SeasonHighestCatch	1.630	1	1.630	.051	.824
SeasonLowestCatch	.000	0	.	.	.
MangroveCondition	214.673	1	214.673	6.744	.019
SeasonHighestCatch * SeasonLowestCatch	.000	0	.	.	.
SeasonHighestCatch * MangroveCondition	.000	0	.	.	.
SeasonLowestCatch * MangroveCondition	.000	0	.	.	.
SeasonHighestCatch * SeasonLowestCatch * MangroveCondition	.000	0	.	.	.
Error	541.107	17	31.830		
Total	6348.000	20			
Corrected Total	770.200	19			

a. R Squared = .297 (Adjusted R Squared = .215)

The results revealed that the overall model was statistically significant, $F(2,17) = 3.599$, $p = .050$, it indicates that the predictor variables collectively influenced the amount of fish. Among the independent variables, the mangrove condition showed a statistically significant effect on fish abundance, $F(1,17) = 6.744$, $p = .019$, while the season of highest catch did not significantly affect fish abundance, $F(1,17) = 0.051$, $p = .824$. These findings suggest that the health of mangrove ecosystem plays a more substantial role in determining fish abundance than seasonal variability. As healthy mangrove forests provide essential nursery grounds, feeding habitats, and ecological protection for fish species, thereby it enhances fisheries productivity. As cited, the results are consistent with previous studies demonstrating that intact mangrove ecosystems significantly contribute to fish biomass, recruitment success, and coastal fisheries sustainability (Alongi, 2008; Mumby et al., 2004).

1. **To provide recommendations for enhancing mangrove conservation to ensure long-term fisheries sustainability and community livelihood stability.**

- Strengthen mangrove conservation and rehabilitation programs to maintain healthy coastal ecosystems and sustain fisheries productivity.
- Implement community-based coastal resource management to encourage local participation in mangrove protection and sustainable fishing practices.
- Conduct regular monitoring and assessment of mangrove health and fish abundance to support evidence-based environmental management.
- Enforce environmental policies against illegal cutting, waste disposal, and destructive coastal activities that may damage mangrove ecosystems.
- Provide environmental education and awareness programs to promote community understanding of the importance of mangroves in fisheries sustainability.
- Develop alternative livelihood programs such as ecotourism and sustainable

aquaculture to reduce dependence on fishing during low catch seasons.

4. SUMMARY OF FINDINGS AND CONCLUSION

The study assessed the health condition of mangrove forests and their relationship with fisheries productivity in the selected coastal area. The findings revealed that the mangrove ecosystem was dominated by *Rhizophora mucronata* with varying DBH and height measurements, indicating the presence of both young and mature trees. Most mangroves which cover 95% of its totality were classified as healthy, while only 5% were slightly damaged, and this suggests that the ecosystem remains stable and resilient. However, minimal signs of degradation such as tree cutting, charcoal collection, and garbage accumulation were observed, while there is no evidence of oil contamination, erosion, pest infestation, land conversion, or fire damage recorded.

The results further shows that fish abundance in the area was generally high, as majority of the respondents reported the range from abundant to very high fish catch. On the other hand, seasonal analysis indicated that the Amihan season had the highest fish catch, whereas the Habagat season consistently recorded the lowest catch due to unfavorable environmental conditions. The statistical analysis using One-Way ANOVA revealed no significant difference in fish abundance across groups. However, the Two-Way ANOVA showed that mangrove condition significantly influenced fish abundance, indicating that healthier mangrove ecosystems support greater fisheries productivity. Overall, the findings emphasizes the ecological importance of mangrove forests in sustaining fish populations, protecting coastal habitats, and supporting the livelihoods of fishing communities.

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