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Coral Reef Ecosystem Conditions on Mambor Island, Mora District, Nabire Regency, Papua Province

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A B S T R A C T

Mambor Island has relatively high coastal and marine resource potential, particularly coral reef ecosystems, which play a crucial role in maintaining the ecological balance of the waters and supporting the livelihoods of coastal communities. Therefore, this study aims to assess the potential and health status of coral reefs in the waters of Mambor Island. The study was conducted from August to September 2022 in Mambor Village, Moora Islands District, Nabire Regency, Papua Province. Observations were conducted at three stations representing the distribution of coral reefs on Mambor Island: Station I in the southern part of the island, Station II in the western part, and Station III in the eastern part of the island. Data collection on the percentage of coral cover was carried out using the Point Intercept Transect (PIT) method with a 50-meter transect installed parallel or horizontally following the coral reef expanse at each observation station. Objects observed included coral growth forms along the transect line, including hard coral, soft coral, dead coral, algae, sand, and other fauna. Data from coral growth observations using the PIT method were then processed using Microsoft Excel software to obtain coral cover percentages. The results showed that in the waters south of Mambor Island (Station I), the Non-Acropora group had the highest coral cover percentage, at 30%. At Station II, located on the western side of the island, live coral cover was dominated by Acropora, reaching 72%. Meanwhile, in the waters east of Mambor Island (Station III), coral cover was 22%, dominated by Acropora and soft corals. The health of the live coral reefs in Mambor Island waters showed the highest value in the western waters (Station II), with a live coral percentage reaching 84%. In the southern waters (Station I), the live coral percentage was recorded at 50%, while in the waters east of the island (Station III) the live coral percentage reached 40%

INTRODUCTION

Mambor Village is part of the Moora Islands District. The district is located between 1350 40′ – 1360 15′ East Longitude and 20 50′ – 30 12′ South Latitude. It is bordered to the north by the Sairera Bay Sea, to the south by Napan, to the east by Wapoga District, and to the west by Yaur and Teluk Umar Districts. Moora Islands District has five villages: Arui Village, Moor Village, Kama Village, Mambor Village, and Hariti Village. As an archipelago district, these five villages are part of an archipelago, accessible only by sea. The total area of Moora Islands District is 59.40 km2, while Mambor Village itself covers 13.4 km2 (Moora Islands District figures, 2019).

Mambor Island has relatively high coastal and marine resource potential, particularly coral reef ecosystems, which play a vital role in maintaining the ecological balance of the waters and supporting the lives of coastal communities. Coral reefs serve as primary habitats for various species of reef fish and other marine life, providing shelter, feeding areas, spawning grounds, and nursery grounds for fish. Therefore, the condition of the coral reefs significantly impacts the availability and sustainability of fish resources, which the people of Mambor Village utilize as a source of food and livelihoods.

In addition to their role in supporting the fisheries sector, the beauty of coral reefs and their associated fish diversity also have economic value through the development of marine tourism, such as snorkeling and diving. This potential makes coral reefs not only ecologically valuable but also strategically important in supporting the development of Mambor Village as a tourist destination based on the sustainable use of coastal and marine resources. In addition to coral reefs, other potential coastal resources found in the waters of Mambor Village or on Mambor Island include mangrove and seagrass ecosystems. Five mangrove species have been recorded in this area: Sonneratia alba, Rhizophora stylosa, Xylocarpus mekongensis, Avicennia alba, and Sonneratia caseolaris.

LITERATURE REVIEW

The coral reefs found were described in terms of coverage percentage: 19% live coral, 31% dead coral, 31% coral rubble, and 19% sand. Seagrasses found on Mambor Island included Syringodium isoetifolium, Thalassia hemprichii, Enhalus acoroides, and Cymodocea serrulata. Organisms associated with the seagrass beds in this area included gastropods, jellyfish, sea cucumbers, and sea thorns. The seagrass cover percentage in this area was approximately 32.916%. (UNIPA, 2010).

The purpose of this study was to assess the potential and health status of coral reefs as a basis for supporting reef fish resources and developing ecotourism in Mambor Village, Moora Islands District. However, achieving this goal requires considering various existing issues, particularly those related to the condition of the coral reef ecosystem, the level of fish resource utilization by the community, and the region's readiness to develop ecotourism based on local potential.

METHODOLOGY

This research was conducted in Mambor Village, Moora Islands District, Nabire Regency, Papua Province, from August to September 2022.

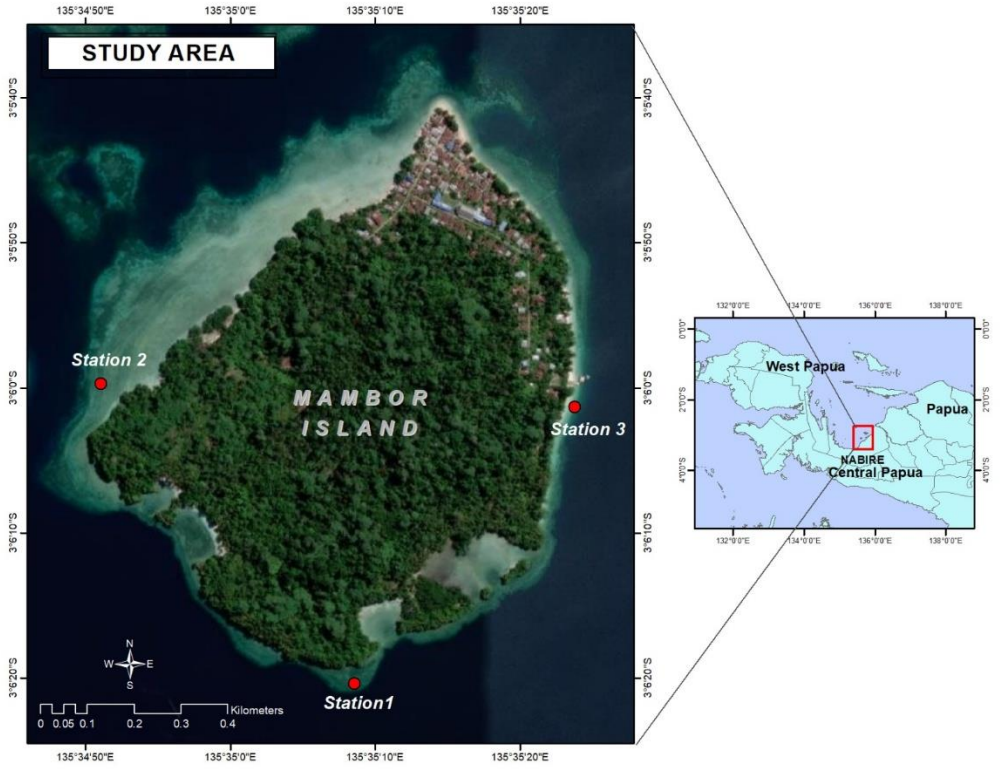

Figure 1. Map of Mambor Island

Observations were conducted at three stations: Station I on the southern part of Mambor Island, Station II on the western part of Mambor Island, and Station III on the eastern part of Mambor Island.

Coral Reef Ecosystem Data

Data collection on coral cover percentage was conducted using the Point Intercept Transect (PIT) method, as described by Hill and Wilkinson (2004). A 50-meter transect was installed parallel or horizontally following the coral reef at the observation point at each designated station. This study used three transect lines placed at different depths: Transect I at 3 m, Transect II at 7 m, and Transect III at 10 m.

The dives were conducted by two divers, each tasked with observing and recording the research objects, documenting the data collection process, and laying out a tape measure as the transect line. Observations included coral growth forms along the transects, including hard coral, soft coral, dead coral, algae, sand, and other fauna.

During the observation, divers conducted observations by following transects while recording each lifeform category directly below the measuring tape, starting from 0.5 meters to 50 meters, with observation intervals of every 0.5 meters.

Identification of coral growth forms was based on observations of the coral's color and external morphology, referring to the identification book by

English et al. (1994). Additionally, several dominant coral species in the waters were further identified using the book *Corals of the World* by Veron (2000).

Coral Cover Percentage

Observations of coral growth forms using the PIT method were then processed using Microsoft Excel to determine the coral cover percentage. The formula for coral cover percentage (Manuputty and Djuwariah 2009) is as follows:

$$\boldsymbol{PC = \frac{Jumlah\ titik\ tiap\ komponen}{Total\ komponen} \times 100\%}$$

Based on the results of this analysis, the condition of the reef or the level of coral reef damage will be determined based on the categories/criteria proposed by Gomez and Yap (1988) in Manuputty and Djuwariah (2009) in Table 1.

Table 1. Coral Cover Categories

Tutupan Karang Hidup	Kriteria
0 – 24,9 %	Buruk/Sangat Rusak
25 – 49,9%	Sedang
50 – 74,9%	Baik

RESULTS AND DISCUSSION

Percentage of Biota Cover in the Marine Waters of Mambor Village

The presence of coral reefs around Mambor Village has a significant positive impact on the lives of the surrounding community. The pristine condition of the waters, coupled with the abundant potential of marine resources, encourages most residents around Mambor Village to choose fishing over other side jobs such as farming or animal husbandry. Furthermore, the village is surrounded by the sea, so the community relies heavily on the sea for their livelihoods and daily needs. According to Isdianto et al. (2020), coral reefs are highly complex ecosystems and play a crucial role in supporting the sustainability of marine life. Ecologically, coral reefs serve as feeding grounds, breeding grounds, nursery grounds, and protective habitats for various species of fish and other invertebrates (Candri et al., 2019). Coral reef ecosystems and all the organisms that live within them constitute a highly valuable natural resource. The existence of coral reefs provides significant benefits and has a direct impact on coastal communities and the surrounding environment (Salim, 2012).

Coral life forms are classified into two main groups, Acropora and non-Acropora, which are distinguished by their morphological characteristics. These differences include several growth types, including branching, massive, encrusting, foliose, tabulate, and mushroom-shaped (Isdianto et al., 2020).

The same coral growth forms were also found in the waters around Mambor village. Several growth forms of coral reefs and other biota around Mambor village vary significantly based on identification using coral life forms. The results of the analysis of the percentage (%) cover of biota components found at each observation station are shown in Table 2 and Figure 1.

Table 2. Percentage Cover of Biota Components at Station I (South Mambor)

Code	Kategori Biota	Tutupan	(%) Tutupan Komponen
AC	*Acropora*	10	20.0
NA	*Non-Acropora*	15	30.0
DC	*Death Coral*	2	4.0
DCA	*Death Coral Algae*	12	24.0
SC	*Soft Coral*	0	0
FS	*Fleshy Seaweed*	0	0
R	*Rubble*	11	22.0
RK	*Rock*	0	0
S	*Sand*	0	0
SI	*Silt*	0	0
Total		**50**	**100**

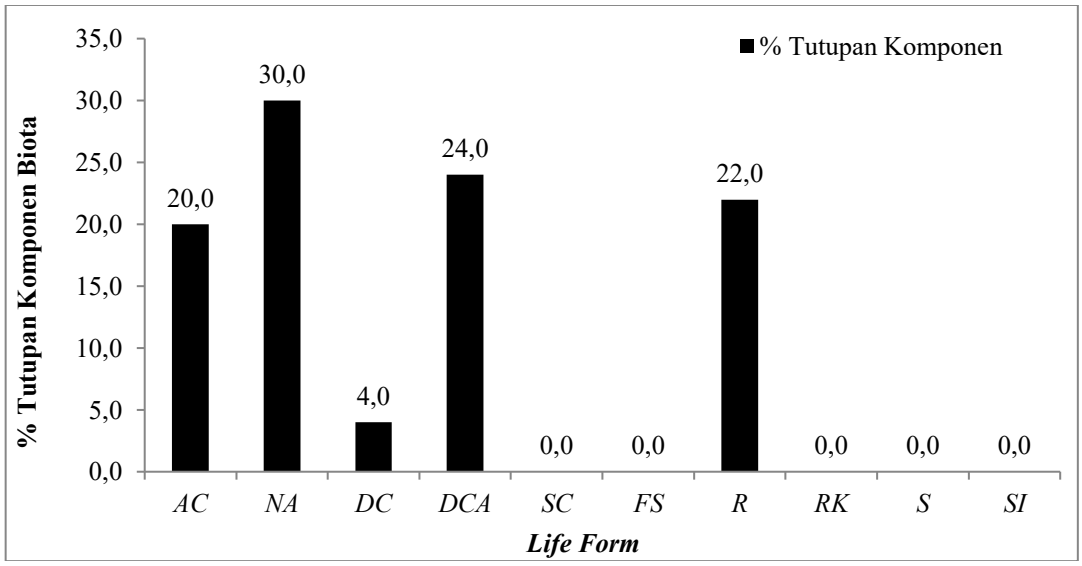

Figure 2. Graph of Percentage Coverage of Biotic Components at Station DI (South Mambor)

Table 3. Percentage of Biota Component Coverage at Station II (East Mambor)

Code	Kategori Biota	Tutupan	(%) Tutupan Komponen
AC	*Acropora*	36	72
NA	*Non-Acropora*	6	12
DC	*Death Coral*	0	0
DCA	*Death Coral Algae*	2	4
SC	*Soft Coral*	3	6
FS	*Fleshy Seaweed*	0	0
R	*Rubble*	3	6
RK	*Rock*	0	0
S	*Sand*	0	0
SI	*Silt*	0	0
Total		**50**	**100**

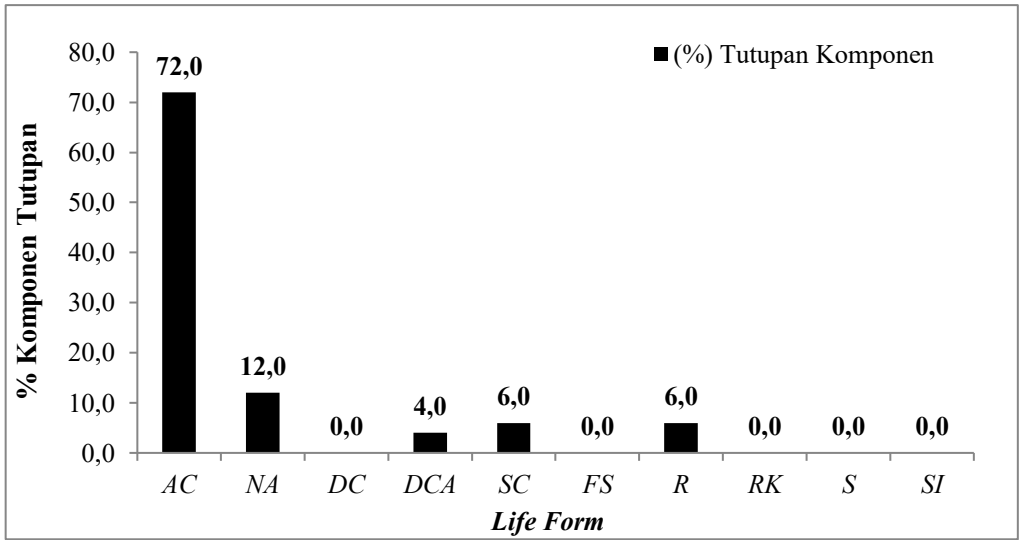

Figure 3. Graph of Percentage Coverage of Biota Components at Station II (Western Part of Mambor)

Table 4. Percentage of Biota Component Coverage at Station III (East Mambor)

Code	Kategori Biota	Tutupan	(%) Tutupan Komponen
AC	*Acropora*	11	22
NA	*Non-Acropora*	9	18
DC	*Death Coral*	1	2
DCA	*Death Coral Algae*	7	14
SC	*Soft Coral*	11	22
FS	*Fleshy Seaweed*	0	0
R	*Rubble*	2	4
RK	*Rock*	0	0
S	*Sand*	9	18
SI	*Silt*	0	0
Total		**50**	**100**

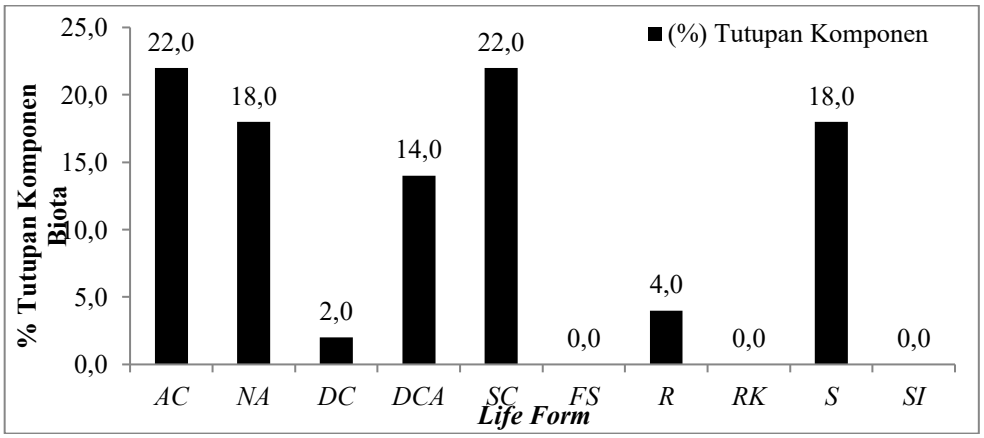

Figure 4. Graph of Percentage Coverage of Bita Components at Station III (Western Part of Mambor)

The table and figure above show the results of the analysis of coral life forms and non-coral substrate cover at each observation station. In this study, observations were conducted at 3 observation stations, namely station I located

in the southern part of Mambor village, station II located in the western part of Mambor village and station III located in the eastern part of Mambor village. Observations conducted at 3 different observation stations, have quite a variation in the results of biota component cover for the coral life form category and the non-coral substrate category. From the results of the analysis of the biota category at station I or in the southern part of Mambor Island, it was found that Non-Acropora (NA) biota had the highest component cover percentage value of 30% and Acropora (AC) of 20% for the coral life form category, while for other biota in the non-coral substrate category, the highest percentage value was found in the Dead Coral Algae (DCA) biota category with a component cover percentage of 24%, then followed by the cover percentage of other biota components such as Death Coral (DC) of 4% and Rubble of 22% (Figure 2).

In the western part of Mambor Island (Station 2), different coverage percentages of biota components were found compared to the southern part of Mambor Island. At Station II, the bottom topography is a continental slope (topography with a slightly steep bottom shape). Observations were conducted at a depth of 10 meters, precisely on the slope area, so the transect was stretched along the slope's contour. The continental slope topography significantly influences variations in biota cover. The analysis showed that the highest coverage percentages were found in the coral lifeform category, with values of 72% for Acropora (AC) and 12% for Non-Acropora (NA). Meanwhile, other biota in the non-coral substrate category had relatively low coverage percentages, including Soft Coral (SC) and Rubble (R) at 6%, and Dead Coral Algae (DCA) at 4% (Figure 3).

In the eastern part of Mambor Island (Station III), component cover percentages were found in almost all biota categories, except Fleshy Seaweed (FS), Rock (RK), and Silt (SI) (Figure 4). The analysis of the component cover percentages showed that the coral lifeform categories, Acropora (AC) and Non-Acropora (NA), had similar component cover percentages to the non-coral substrate categories, Soft Coral (SC) and Silt (SI), at 22% and 18%, respectively. This was followed by cover values for other non-coral biota components, such as Dead Coral Algae (DCA) at 14%, Rubble (R) at 4%, and Dead Coral (DC) at 2%.

Coral Reef Health in the Waters of Mambor Village

Coral reef ecosystem conditions are determined based on the percentage of live coral cover, as proposed by Gomez and Yap (1998). Coral reef health is assessed through physical and ecological indicators expressed as the percentage of live coral cover (LC) (Manuputty & Djuwaria, 2009). Furthermore, the physical condition of coral reef ecosystems is also influenced by the presence of other biota substrates besides coral, such as DCA (dead coral overgrown with fine algae), DC (dead coral or recently dead white coral), FS (fleshy seaweed or macroalgae), SC (soft coral), R (rubble or branching coral fragments), and abiotic substrates including sand, silt, and rock (Manuputty & Djuwaria, 2009).

The live coral cover categories per observation station in this study had varying percentage coverage criteria based on the results of coral lifeform identification and analysis. According to Gomez and Yap (1998), the criteria for live coral cover are said to be damaged if they have a live coral cover percentage

of 0-24.9%, moderate (25-49.9%), good (50-74.9%), and very good (75-100%). The results of coral life form identification and analysis prove that the hard coral around the sea waters of Mambor village has moderate and good criteria at stations III and I, and has very good criteria at station II (Table 3). The percentage value of live coral cover per observation station is presented in Figure 5 below.

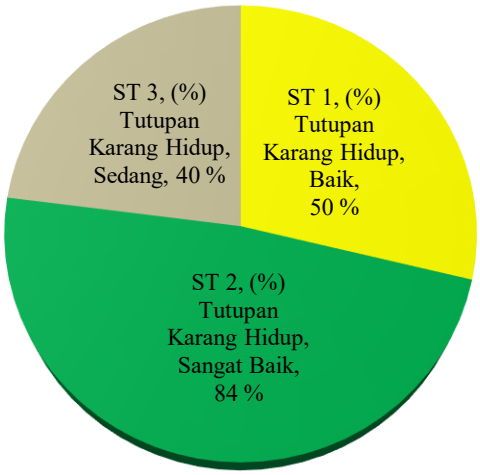

Figure 5. Live Coral Reef Health Conditions per Observation Station in the Marine Waters of Mambor Village.

Figure 5 above illustrates the coral reef health conditions around Mambor Village, Nabire Regency, based on the percentage of live coral cover per observation station. The analysis shows that the coral reef health at Station II, western Mambor Island, is categorized as very good, as indicated by a live coral cover percentage of 84%. Meanwhile, at Station I, southern Mambor Island, the coral reef health is categorized as good, with a cover percentage of 50%. This is compared to Station III, eastern Mambor Island, which only has a moderate coral health score of 40% (Figure 5).

The results of the coral reef health conditions presented above demonstrate that the health of the live coral reefs at the observation sites is significantly influenced by various environmental factors and fishing community activities. Stations I and III tend to have lower coral cover percentages compared to Station II. Based on identification results during direct observations of coral reef conditions at Station I, numerous coral fragments and dead coral were found. Station III, located adjacent to the village harbor and with currents, exhibited a high concentration of non-coral substrate biota, significantly impacting the live coral cover at the observation station. In general, the Porites genus is known as a coral group with a high capacity to withstand the effects of waves and currents. This is due to its massive, dense, and large colony size, making it stronger than corals of the Acropora genus, which have a branching growth pattern (Aris, 2011; McClanahan et al., 2001; Robin, 1981).

Station I, located in the southern region of the island, is an area with high levels of fishing activity, particularly fishing with nets and spears, as well as activities directly on the coral reef. This is because the site is located directly in

front of a residential area, in the southern part of Mambor Village. The continuous activities carried out by the fishing community have a significant impact on the level of damage to the living coral reefs around the location.

According to Amin (2009), rubble is an indicator of physical damage to coral reefs, which can increase the overall percentage of coral damage. Coral reef damage is influenced by various factors, one of which is human activity, both directly and indirectly. Human activity also impacts coral growth. Suharsono (1996) noted that various human activities in coral reef areas, particularly during anchor drop, can cause coral reefs to be destroyed or fractured.

Overall, the health of the coral reefs around the waters of Mambor Village remains in the good category, as evidenced by the total percentage of live coral cover calculated from all observation stations, which was 58%. Coral reef health significantly influences the ecological vulnerability of a body of water because it serves as a resilient ecosystem for marine life. In maintaining the resilience of marine ecosystems, coral reefs play a crucial role in the survival of various organisms. Coral reefs serve as natural coastal protection from strong wave energy and currents, as well as providing habitat, feeding areas, nursery grounds, and spawning grounds for marine life (Arini, 2013).

Damage or loss of coral reefs can disrupt crucial ecological functions, not only through the loss of marine habitat but also through reduced protection of islands from the impacts of sea level rise. If stony coral, which produces limestone sediment, is unavailable, the reef's ability to dampen waves will decrease. This condition will cause waters to deepen, leading to a gradual increase in coastal abrasion (Suryanti et al., 2011).

CONCLUSIONS AND RECOMMENDATIONS

- The coral reef potential on Mambor Island, Moora District, Nabire Regency, Papua, in the southern waters of Mambor Island (Station I), non-Acropora corals have the highest coverage percentage (30%). At Station II, or the western part of Mambor Island, the highest percentage of live coral is Acropora corals, at 72%. In the eastern waters of Mambor Island, the coral cover percentage is 22%, with Acropora and soft corals.
- The health of the live coral reefs in Mambor Island waters is highest in the western waters (Station II), at 84%. In the southern waters (Station I), live corals are found at 50%, and in the eastern waters (Station III), the percentage of live corals is 40%.
- The recommended location for developing diving tourism is the western part of Mambor Island, as it has the best potential for live corals and soft corals compared to the other two observation stations.

FURTHER STUDY

This research still has limitations, so it is necessary to conduct further research related to the topic of Coral Reef Ecosystem Conditions on Mambor Island, Mora District, Nabire Regency, Papua Province in order to perfect this research and increase insight for readers.

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