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Baseline Assessment of Coral Community Structure in a Disturbed Nearshore Reef in Dinagat Islands, Philippines

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ABSTRACT

Chronic local disturbances increasingly shape nearshore coral reefs in the Philippines, yet many remain poorly documented, particularly in small island settings. This study provides baseline ecological documentation of coral community structure in a shallow nearshore reef in Barangay Bilabid, Basilisa, Dinagat Islands, with attention to patterns of diversity and dominance under sustained anthropogenic pressure. Coral assemblages were surveyed using a transect–quadrat method across three sampling stations, and community structure was assessed using density, frequency, dominance, and genus importance values. A total of 274 coral colonies representing ten genera across eight families were recorded. Genus-level diversity was consistently low across stations, with a pooled diversity index of 0.6848. However, dominance indices indicated shared dominance rather than monopolization by a single genus. Acropora exhibited the highest importance values across all stations, followed by Turbinaria and Porites, while no single genus overwhelmingly dominated the assemblage. These results describe a coral community characterized by reduced diversity but retained internal organization, consistent with ecological filtering in disturbed nearshore environments. Rather than advancing new analytical metrics, this study demonstrates how dominance-based indicators can complement diversity measures in baseline assessments of reef condition. The findings establish an ecological reference point for a previously undocumented reef system and provide context for future monitoring and management in data-poor nearshore coastal environments.

INTRODUCTION

Coral reefs are among the most biologically diverse marine ecosystems. Nevertheless, they are increasingly shaped by the cumulative effects of local and global disturbances that alter community structure long before complete ecological collapse becomes evident (Hughes *et al.*, 2017; Jackson *et al.*, 2014). While global and regional assessments have documented widespread declines in coral cover and diversity, such metrics often provide limited insight into how reef communities reorganize internally under sustained pressure (Bruno & Valdivia, 2016). In many disturbed systems, coral assemblages persist in simplified forms, characterized by reduced taxonomic richness and altered dominance hierarchies rather than total loss of coral presence.

The Philippines, located at the center of the Coral Triangle, hosts some of the highest coral diversity globally (Carpenter & Springer, 2005; Veron *et al.*, 2011). At the same time, Philippine reefs are among the most threatened in the Indo-Pacific due to chronic stressors such as overfishing, sedimentation, coastal development, and unregulated tourism (Burke *et al.*, 2012). National-scale assessments consistently classify many nearshore reefs as being in poor to fair condition, particularly those adjacent to coastal communities (Licuanan *et al.*, 2017). However, these assessments often rely heavily on coral cover or diversity indices, which may obscure key insights into how coral communities are structured in degraded environments.

Recent reef ecology literature emphasizes that degradation does not proceed uniformly toward collapse but often results in transitional ecological states marked by reduced diversity, shifts in dominance, and functional reorganization (Darling *et al.*, 2012; McClanahan *et al.*, 2014). In such contexts, dominance patterns can provide complementary insight into reef condition, resilience, and potential trajectories that diversity metrics alone may not capture (Edmunds & Elahi, 2007). Shared dominance among multiple coral taxa, for example, may reflect ecological filtering under chronic disturbance rather than competitive exclusion or opportunistic takeover by a single genus (Madin *et al.*, 2016).

Nearshore reef systems are particularly important for understanding these dynamics. Exposed to intense human interaction and environmental variability, nearshore reefs often experience greater disturbance than offshore or protected reef environments, yet they remain underrepresented in coral reef research (Wedding *et al.*, 2018). In the Philippines, small islands and rural coastal reefs often lack baseline ecological data, limiting local governments' and conservation actors' ability to contextualize reef condition, detect ecological change, or design site-specific management interventions (White *et al.*, 2014). Where studies do exist, many focus on species inventories or coral cover estimates without examining how dominance and community structure shape reef

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persistence under nearshore disturbance.

Dinagat Islands, located off the northeastern coast of Mindanao, exemplify this research gap. Despite its proximity to biologically significant marine areas, ecological documentation of its nearshore reef systems remains limited. Increasing coastal settlement, reliance on small-scale fisheries, and emerging tourism activities suggest mounting pressure on local reefs, yet empirical data on coral community composition and structure are scarce. Establishing baseline information on coral diversity and dominance is, therefore, a necessary first step for understanding reef condition in this setting.

This study provides baseline ecological documentation of coral community structure in a disturbed nearshore reef system in Barangay Bilabid, Dinagat Islands, Philippines. Using established diversity and dominance metrics, the study examines how coral genera are distributed within a low-diversity assemblage and assesses whether dominance is monopolized or shared among taxa. Rather than proposing new analytical frameworks, the study demonstrates how dominance-based indicators can complement diversity measures in baseline assessments of reef condition in data-poor nearshore environments. The findings establish an ecological reference point for future monitoring and contribute localized evidence to broader discussions of reef degradation and persistence in human-impacted coastal systems.

MATERIALS AND METHODS

Study Area

The study was conducted in a shallow nearshore reef system located in Barangay Bilabid, Municipality of Basilisa, Dinagat Islands, Philippines (Figure 1). The Dinagat Islands lie off the northeastern coast of Mindanao and are characterized by narrow reef flats that fringe small island communities (ADB & GEF, 2014). The study area consists of an exposed nearshore reef flat that partially emerges at low tide and is subject to pronounced environmental variability, including fluctuations in temperature, turbidity, and wave exposure. The reef system is situated adjacent to a coastal settlement and is regularly accessed for small-scale fishing, gleaning, and recreational activities, placing it under chronic local anthropogenic pressure. These nearshore conditions contrast with offshore or protected reef environments, making the site representative of many human-dominated coastal reefs in the Philippines. Despite its proximity to coastal livelihoods and growing human activity, no prior ecological documentation of coral community structure has been reported for this reef system.

Three sampling stations were established along the reef flat to capture spatial variability within the nearshore environment. Stations were positioned approximately 50 m apart and selected to represent comparable depth and exposure conditions while remaining within the same geomorphological setting. The spatial arrangement of the sampling stations and the orientation of the transects relative to the reef front are shown in Figure 2, which illustrates the study area and the location of transect–quadrat deployments.

All surveys were conducted during daytime low tide, when the reef flat was accessible, and visibility allowed accurate identification and measurement of coral colonies. The study area was not located within a designated marine protected area at the time of sampling, and no active reef restoration or formal management interventions were in place. As such, the site provides an opportunity to document coral community structure in a nearshore reef system shaped primarily by ongoing local use and environmental exposure rather than by formal conservation measures.

Figure 1: Vicinity Map of the Sampling Area

Figure 2: Study area and location of the transects

Sampling Design

Coral assemblages were surveyed using a uniform transect–quadrat method during daytime low-tide conditions. At each station, two transect lines were laid perpendicular to the reef front, with transects spaced five meters apart. Along each transect, three (3) 2×2m quadrats were placed alternately on either side of the transect line at one-meter intervals.

All coral colonies within each quadrat were counted, measured, and identified to the genus level using standard taxonomic references. A single coral colony was considered one individual. Identification of the corals was limited to the genus level based on descriptions by Nemenzo (1986) and Veron (2000).

Data Analysis

Coral community structure was analyzed using a suite of established ecological metrics to characterize composition, diversity, and dominance at both station and pooled levels. Analyses were conducted at the genus level, reflecting the taxonomic resolution of field identification and the study's objective of providing baseline structural information for a data-poor nearshore reef system.

For each sampling station, coral density was calculated as the number of colonies per square meter based on quadrat counts. Relative density was computed as the proportion of total colonies contributed by each genus. Frequency was determined as the proportion of quadrats in which a given genus occurred, and relative frequency was expressed as the percentage contribution of each genus to total frequency across all quadrats. These measures were used to describe the spatial distribution and prevalence of coral genera within and among stations. Dominance was estimated based on colony surface area, derived from field-measured mean colony diameters. Estimated colony areas were summed by genus to obtain total dominance values, and relative dominance was calculated as the proportion of total coral area occupied by each genus within a station. While this approach provides a simplified estimate of spatial contribution, it allows for comparison of dominance patterns among genera in the absence of species-level or three-dimensional structural data.

Genus Importance Values (GIV) were calculated for each genus by summing relative density, relative frequency, and relative dominance. GIVs were used as an integrative measure of each genus's contribution to overall community structure, capturing both numerical abundance and spatial influence. These values were examined at the station level to assess consistency or variation in dominance patterns across the nearshore reef system.

Community-level diversity was assessed using a modified Shannon diversity index (H) applied to genus-level data to describe taxonomic diversity within and across stations. Dominance at the community level was evaluated using a dominance index to assess the extent to which coral assemblages were monopolized by one or a few genera versus characterized by shared dominance. Lower dominance values were interpreted as indicative of more evenly distributed dominance among taxa, while higher values suggested increasing concentration of dominance. To provide an overall characterization of the reef system, data from all stations were pooled to calculate cumulative diversity and dominance indices and pooled Genus Importance Values. This pooled analysis was intended to summarize nearshore community structure at the site level rather than to infer broader spatial patterns. Given the limited spatial replication and single-time sampling design, analyses were descriptive and comparative, and no inferential statistical tests were applied. Results are therefore interpreted as a baseline snapshot of coral community structure, suitable for future comparison and monitoring rather than for hypothesis testing or generalization beyond the study area.

RESULTS AND DISCUSSION

Coral Composition

Coral surveys recorded a total of 274 coral colonies across three nearshore sampling stations in Barangay Bilabid, Dinagat Islands. The assemblage comprised 10 coral genera across 8 families, reflecting the reef's taxonomic composition at the time of sampling. All colonies were identified to the genus level, consistent with the study's objective of providing baseline documentation for a previously undocumented nearshore reef system.

The recorded genera were Acropora, Montipora, Pavona, Madracis, Favia, Favites, Cycloseris, Galaxea, Porites, and Turbinaria. Genus occurrence varied among stations. Six genera (Acropora, Cycloseris, Galaxea, Pavona, Turbinaria, and Montipora) were present in all three stations, while Madracis was recorded only in Station 3. Favia and Favites occurred in two stations and were absent from one station each. The total number of colonies per station ranged from 65 to 107 individuals, indicating spatial variability in coral abundance within the nearshore reef system.

The numerical distribution of coral genera across stations is summarized in Table 1, which presents the total number of colonies per genus and the station-level occurrence of each. Representative images of the recorded coral genera are shown in Figure 2 to provide visual documentation of the taxa present during the survey. No attempt was made to infer temporal trends, ecological condition, or resilience from composition alone, as the data represent a single-time snapshot intended to establish a site-specific ecological reference point.

Table 1: List of coral genera in the three (3) stations with the total number of each genus

Genus	Station 1	Station 2	Station 3	Total
Acropora	22	17	43	82
Cycloceris	17	4	10	31
Favites	6	10	-	16
Favia	6	-	7	13
Galaxea	10	5	2	17

Pavona	5	3	7	15
Porites	11	-	15	26
Turbinaria	20	16	11	47
Montipora	5	10	7	22
Madracis	-	-	5	5
Total	102	65	107	274

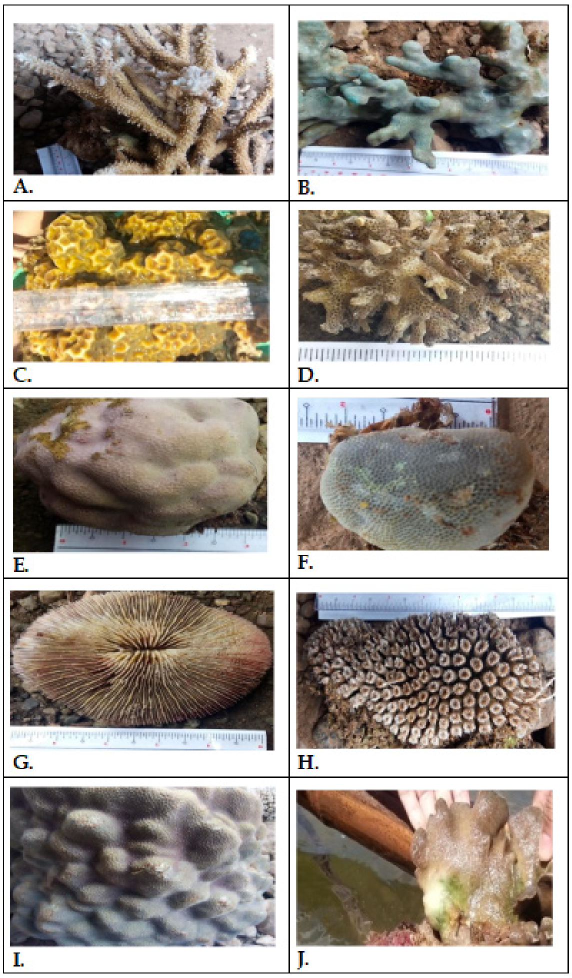

Figure 2: Representative coral genera recorded in the nearshore reef system of Barangay Bilabid, Dinagat Islands, Philippines: (a) Acropora, (b) Montipora, (c) Pavona, (d) Madracis, (e) Favia , (f) Favites, (g) Cycloseris, (h) Galaxea, (i) Porites, and (j) Turbinaria.

Diversity and Dominance Patterns

Indices of genus-level diversity and dominance were calculated for each sampling station and for pooled data to describe baseline community structure in the nearshore reef system. Diversity values (H) varied only modestly among stations, from 0.78961 to 0.913114 (Table 2), indicating a consistently low-diversity assemblage despite differences in total colony counts among stations. Station 1 recorded the highest diversity (H = 0.913114) while Station 2 recorded the lowest (H = 0.78961), suggesting that Station 2 was more unevenly structured at the genus level than the other stations. When all stations were pooled, the diversity index decreased to 0.6847681 (Table 3). This reduction at the site level is consistent with an assemblage where a small number of genera contribute disproportionately to overall abundance and/or area across the entire reef system, even if within-station diversity appears slightly higher.

Dominance indices ranged from 0.1335 to 0.18617 across stations (Table 2), with Station 1 showing the lowest dominance (0.1335) and Station 3 the highest (0.18617). The pooled dominance index (0.148229; Table 3) indicates that, at the overall site scale, dominance was present but not extreme. Interpreted descriptively, these values suggest that a single genus did not monopolize the coral community within any station; instead, dominance was distributed across a small set of genera whose relative importance shifted by location.

Table 4 clarifies how diversity and dominance co-existed by showing the component structure of each station in terms of relative density (RD), relative frequency (RF), relative dominance (RDom), and the integrated Genus Importance Value (GIV). In Station 1, Acropora had the most significant structural footprint across all three dimensions (RD = 40.19; RF = 15.02; RDom = 44.69), resulting in a very high GIV (99.99). However, Station 1 did not collapse into a single-genus assemblage because secondary genera still contributed meaningfully, especially Porites (RD = 14.02; RF = 15.02; RDom = 22.15; GIV = 51.19) alongside mid-range contributors such as Pavona (GIV = 28.06), Turbinaria (GIV = 27.61), and Montipora (GIV = 27.15). This combination is consistent with Station 1's comparatively higher diversity (Table 2) and lower dominance index, because importance is concentrated in one leading genus but not to the exclusion of several additional genera that remain frequent and/or spatially substantial.

Station 2 shows a more "shared dominance" profile among the top genera, which helps explain its lower diversity value (Table 2) despite the absence of absolute monopolization. Acropora remained the single most important genus (GIV = 64.80), but Porites (GIV = 45.28) and Turbinaria (GIV = 44.38) were close behind, reflecting substantial contributions in density, quadrat occurrence, and estimated area. In practical terms, Station 2's community structure appears to be organized around a small cluster of high-importance genera, with a longer tail of lower-importance genera (for example, Favites GIV = 17.79; Favia GIV = 18.36; Montipora GIV = 21.29). This pattern can depress diversity values because, even when several genera are present, the assemblage becomes more uneven when community contributions are concentrated in a few leading taxa.

Station 3 illustrates a slightly different configuration in which multiple genera combine high occurrence with substantial dominance values. Acropora remained highly important (GIV = 83.23), driven by consistently high frequency (F = 1.00; RF = 18.18) and high relative dominance (RDom = 38.92). However, Station 3's dominance index was the highest among stations (0.18617; Table 2), and Table 4 suggests why: Turbinaria (GIV = 58.22) and Montipora (GIV = 55.70) also contributed strongly to the station's spatial structure, mainly through relative dominance (Turbinaria RDom = 15.42; Montipora RDom = 25.22) and high frequencies (Turbinaria F = 1.00; Montipora F = 0.83). In addition, Favites had a notable presence in Station 3 (GIV = 36.58), which is important because it indicates that the station's higher dominance did not come solely from one genus, but from several genera that were both widespread within quadrats and collectively influential in estimated area.

The station-level indices (Tables 2–3) and the component metrics (Table 4) indicate a reef system characterized by low genus richness and uneven representation, but with dominance distributed among a small set of structurally important genera whose contributions vary spatially across stations. The combined use of diversity, dominance, and GIV therefore strengthens the baseline description: diversity indices summarize the constrained genus-level variety, dominance indices show that concentration is present but not extreme, and Table 4 identifies which genera drive those patterns through abundance, occurrence, and spatial contribution within each station.

Discussion

This study provides baseline ecological documentation of coral community structure in a disturbed nearshore reef system in Barangay Bilabid, Dinagat Islands,

Table 2: Index of Dominance and General Diversity (H) of the Coral Genera in the Three Stations

Station 1	**Station 2**	**Station 3**	**Station 3**
Index of Dominance	0.1335	0.18043	0.18617
Index of General Diversity (H)	0.913114	0.78961	0.84623

Table 3: Pooled Index of Dominance and Pooled Index of General Diversity (H)

Pooled Value	
Index of Dominance	0.148229
Index of Diversity	0.6847681

Table 4: Density (D), Relative Density (RD), Frequency (F), Relative Frequency (RF), Dominance (Dom), Relative Dominance (RDom), and Genus Importance Values (GIV) of Corals in each station.

STATION 1							
Genus	D	RD	F	RF	Dom	RDom	GIV
Acropora	1.792	40.19	1.00	15.02	0.04756	44.69	99.99
Cycloceris	0.42	9.3	0.83	12.46	0.00462	4.32	26.13
Favites	-	-	-	-	-	-	-
Favia	0.29	6.55	0.67	10.06	0.00351	3.29	19.90
Galaxea	0.08	1.86	0.33	4.95	0.00059	1.00	7.81
Pavona	0.29	6.55	0.67	10.06	0.01217	11.45	28.06
Porites	0.63	14.02	1.00	15.02	0.02358	22.15	51.19
Turbinaria	0.46	10.27	0.83	12.46	0.00520	4.88	27.61
Montipora	0.29	6.55	0.83	12.46	0.00866	8.14	27.15
Madracis	0.21	4.67	0.5	7.1	0.00059	1.00	13.18
Total	4.458	100	6.66	100	0.106498	100	300.9
STATION 3							
Genus	D	RD	F	RF	Dom	RDom	GIV
Acropora	0.71	26.14	1.00	18.18	0.01909	38.92	83.23
Cycloceris	0.17	6.16	0.5	9.09	0.00185	3.76	19.01
Favites	0.48	15.39	1.00	18.18	0.00148	3.01	36.58
Favia	-	-	-	-	-	-	-
Galaxea	0.21	7.68	0.67	12.18	0.00149	3.03	22.89

Pavona	0.13	4.61	0.5	9.09	0.00522	10.63	24.33
Porites	-	-	-	-	-	-	-
Turbinaria	0.67	24.62	1.00	18.18	0.00756	15.42	58.22
Montipora	0.42	15.39	0.83	15.09	0.01234	25.22	55.70
Madracis	-	-	-	-	-	-	-
Total	2.709	100	5.5	100	0.049059	100	299.99
STATION 2							
Genus	D	RD	F	RF	Dom	RDom	GIV
Acropora	0.92	21.58	1.00	13.05	0.024	30.17	64.80
Cycloceris	0.71	16.66	0.83	10.84	0.0079	9.73	37.23
Favites	0.25	5.88	0.83	10.84	0.0009	1.07	17.79
Favia	0.25	5.88	0.67	8.75	0.0030	3.72	18.36
Galaxea	0.42	9.81	0.83	10.84	0.0029	3.69	24.35
Pavona	0.21	4.89	0.83	10.84	0.0086	10.78	26.51
Porites	0.46	10.78	1.00	13.05	0.0173	21.45	45.28
Turbinaria	0.83	19.60	1.00	13.05	0.0076	11.72	44.38
Montipora	0.21	4.89	0.67	8.75	0.0123	7.65	21.29
Madracis	-	-	-	-	-	-	-
Total	4.25	100	7.66	100	0.04906	100	299.99

Philippines. The results indicate consistently low genus-level diversity across sampling stations, accompanied by patterns of shared dominance among multiple coral genera. Rather than suggesting methodological or conceptual innovation, these findings are best interpreted as a localized case illustrating how established diversity and dominance metrics can be used to contextualize reef condition in data-poor nearshore environments.

Low coral diversity observed in this study is consistent with patterns reported from many Philippine nearshore reefs, where chronic local stressors such as fishing pressure, sedimentation, coastal development, and physical disturbance constrain coral recruitment and persistence (Licuanan *et al.*, 2017). Reef flats, particularly those exposed during low tide, experience pronounced environmental variability, including temperature fluctuations, increased turbidity, and episodic physical stress, which selectively filter coral taxa based on tolerance thresholds and life-history traits (Fabricius, 2005; Rogers, 1990). In such settings, reduced diversity does not necessarily indicate imminent ecological collapse but may reflect long-term adjustment to persistent disturbance.

Despite low diversity, dominance indices in this study remained moderate, indicating that no single genus monopolized the coral assemblage. Instead, dominance was shared primarily among Acropora, Turbinaria, and Porites, with other genera contributing smaller but measurable proportions to community structure. Similar configurations have been documented in disturbed reef systems where community reorganization occurs without complete coral loss (Darling *et al.*, 2012; McClanahan *et al.*, 2014). Shared dominance in these contexts may reflect ecological filtering rather than competitive exclusion, as disturbance-tolerant taxa persist alongside faster-growing or opportunistic forms (Edmunds & Elahi, 2007; Madin *et al.*, 2016).

The prominence of Acropora across stations likely reflects its rapid growth and colonization capacity, traits that can confer short-term advantages following disturbance (Darling *et al.*, 2012). However, Acropora dominance was not absolute, as massive and foliose genera such as Porites and Turbinaria also exhibited substantial Genus Importance Values. This mixed dominance structure suggests that the reef assemblage retains internal organization shaped by multiple ecological strategies rather than being driven by a single opportunistic taxon. Such configurations have been described as transitional states in which coral communities persist in simplified but structured forms under sustained stress (McClanahan *et al.*, 2014; Mumby & Steneck, 2008).

Importantly, the dominance patterns documented here should not be interpreted as evidence of resilience or stability. The study does not assess functional redundancy, reproductive output, or recovery potential, nor does it directly measure the intensity of local stressors. Instead, the findings illustrate how dominance-based metrics can complement diversity indices in describing reef condition where more detailed ecological data are unavailable. In data-poor nearshore systems, such baseline assessments provide necessary context for interpreting future change, particularly when long-term monitoring programs are absent (Bruno & Valdivia, 2016; Wedding *et al.*, 2018).

Nearshore reef systems remain underrepresented in coral reef research despite their ecological and social importance. In the Philippines, monitoring efforts have historically prioritized offshore reefs and marine protected areas, leaving small island and rural coastal reefs comparatively undocumented (White *et al.*, 2014). By documenting coral community structure in a previously unstudied nearshore reef system, this study provides localized ecological evidence to support site-specific management discussions and future comparative research. The results underscore the value of descriptive, dominance-informed baseline studies as foundational components of reef assessment in human-impacted coastal environments.

Several limitations should be acknowledged. Coral identification was conducted at the genus level, which may obscure species-level variation and functional differences among taxa (Veron, 2000). In addition, the study represents a single temporal snapshot and limited spatial replication, restricting inference about temporal dynamics or broader spatial patterns. Future research incorporating species-level identification, functional trait analysis, and repeated surveys would provide deeper insight into reef trajectories in the Dinagat Islands. Nonetheless, the present study establishes an ecological reference point for a data-poor nearshore reef system. It demonstrates the continued relevance of established dominance and diversity metrics in baseline coral reef assessment.

CONCLUSION

Baseline ecological data remain limited for many nearshore reef systems in the Philippines, particularly in small island settings. This study addresses that gap by documenting coral community composition, diversity, and dominance in a nearshore reef in Dinagat Islands using established, reproducible metrics.

The contribution of this work lies in providing site-specific ecological documentation rather than in advancing new analytical approaches. By integrating dominance-based indicators with conventional diversity measures, the study offers a practical framework for describing reef condition in data-poor coastal environments where detailed taxonomic or long-term datasets are unavailable. Such baseline information is essential for situating future monitoring results and for supporting locally relevant management discussions.

The results represent a single temporal snapshot and are necessarily constrained by spatial scale and taxonomic resolution. They should therefore be interpreted as an ecological reference point rather than as an assessment of resilience, recovery potential, or long-term reef dynamics. Future research incorporating repeated surveys, species-level identification, and environmental measurements will be needed to evaluate temporal change and inform adaptive management strategies.

Nonetheless, this study provides foundational ecological evidence for a previously undocumented nearshore reef system. It reinforces the importance of descriptive baseline assessments as a starting point for understanding reef condition in human-impacted coastal regions.

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