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Short Communication: Ecosystem resilience evidenced by reef fish diversity and coral cover in Uwedikan, Central Sulawesi, Indonesia

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Abstract. *Katili AS, Husain IH, Widodo ERS. 2025. Short Communication: Ecosystem resilience evidenced by reef fish diversity and coral cover in Uwedikan, Central Sulawesi, Indonesia. Biodiversitas 26: 4647-4653.* This study, conducted in the coastal waters of Uwedikan, Banggai District, Central Sulawesi, Indonesia, aims to examine the diversity of coral reef fish (rockfish) and their relationship with live coral cover. The research employed the Underwater Visual Census (UVC) method at three observation sites each located at a depth of 10 meters. A total of 748 individuals were identified, representing 14 species, 12 genera, and 11 families. The calculated Shannon-Wiener Diversity Index (H′) was 2.434, indicating a moderate to high level of species diversity. The Evenness Index (E) of 0.922 suggested a relatively uniform distribution among species. However, the percentage of live coral cover was relatively low, ranging from 2.7% to 21.4%, indicating a degraded reef ecosystem. The dominance of species such as *Priacanthus macracanthus* and *Siganus fuscescens* reflects their ecological tolerance to habitat stress. Conversely, the reduced presence of indicator species like *Chaetodon lunula* and apex predators such as *Epinephelus lanceolatus* highlights a decline in ecosystem health. Pearson's correlation analysis revealed a very weak and non-significant relationship between live coral cover and fish abundance (r: 0.189, p: 0.879). Similarly, Spearman's rank correlation showed no monotonic trend (ρ: 0.000, p: 1.000). These results indicate that community patterns are shaped more by species' ecological tolerance and functional traits than coral cover alone. Such findings highlight the resilience-erosion trade-off: while tolerant herbivores and generalists maintain certain ecological functions, the decline of coral-dependent taxa signals ongoing functional erosion. Conservation measures should prioritize habitat restoration, no-take zones, and long-term integrated monitoring, emphasizing the responsibility and commitment required from anyone interested in coral reef ecosystems.

Keywords: Coastal, coral reef cover, diversity, rockfish, Uwedikan

INTRODUCTION

Coral reef ecosystems are critical to marine biodiversity and human well-being. However, despite the Coral Triangle's recognition as the global center of marine biodiversity, site-specific studies in Uwedikan, Central Sulawesi, Indonesia, remain scarce. This knowledge gap is concerning, given the area's declining coral cover and its role as habitat for functionally important fish taxa. Previous studies in other parts of Sulawesi documented that herbivores and generalists dominate under coral decline (Richardson et al. 2020; McClanahan et al. 2021), but no baseline exists for Uwedikan. The study therefore provides the first detailed assessment of reef-associated fish diversity under low coral cover conditions in this area, filling a critical gap in baseline biodiversity data. These systems support essential ecological functions such as fisheries production, habitat provision, and nutrient cycling (Barbier 2017).

Among the reef-associated biota, reef fish play crucial roles in maintaining reef health through ecological functions, including herbivory, predation, and trophic regulation (Purcell et al. 2016). Their diversity and abundance are highly responsive to changes in reef structure, making them reliable indicators of coral reef condition (Graham and Nash 2016). Coral reefs with high structural complexity tend to support diverse fish assemblages by offering food, shelter, and breeding grounds. However, reef degradation—caused by bleaching, sedimentation, and overfishing—can erode this complexity and reduce the functional diversity of fish communities (Cinner et al. 2016; Hughes et al. 2017). The decline of herbivorous fish such as *Siganus fuscescens* and *Chlorurus microrhinos* often correlates with increased macroalgal cover, which limits coral recruitment and accelerates reef decline (Bellwood et al. 2019). Conversely, tolerant generalist species may mask underlying ecological deterioration, while apex predators like *Epinephelus lanceolatus* and *Plectropomus leopardus* are especially sensitive to habitat loss and fishing pressure (Frisch et al. 2021).

Monitoring reef fish assemblages thus provides a valuable, non-destructive method to evaluate ecosystem health under increasing stressors. The Underwater Visual Census (UVC) is widely used because of its reliability and standardization (English et al. 1994), enabling researchers to quantify key metrics such as species richness, abundance, and dominance. These data help identify spatial and temporal shifts in fish communities and reveal ecological processes underpinning reef resilience. By linking fish composition with coral cover, site-specific baselines can support adaptive management and conservation interventions.

Indonesia, located at the core of the Coral Triangle, supports some of the world's richest reef fish assemblages and delivers vital ecosystem services for millions of coastal residents (Veron et al. 2015). Yet escalating threats, including destructive fishing, habitat conversion, and ocean warming, have contributed to widespread reef degradation (Molinos et al. 2016; Obura and Grimsditch 2020). This highlights the urgency of generating localized ecological evidence to inform marine policy and community-based management. Uwedikan, situated in Banggai District, Central Sulawesi, represents one of these under-researched systems. It integrates interconnected ecosystems such as mangroves, seagrass beds, and coral reefs that collectively support biodiversity. Still, coral cover in the area has declined due to overfishing and coastal development, although some fish species remain abundant, suggesting potential resilience.

This study is distinguished by its focus on reef fish diversity in a system under ecological stress but retaining functional attributes. Such a setting enables examination of how functional groups—herbivores, piscivores, and generalists—respond to declining habitat quality while maintaining key ecological processes. Herbivores may buffer coral loss by controlling macroalgae, while piscivores regulate prey populations and maintain trophic balance (Mellin et al. 2019). Identifying dominant species under low coral cover, such as *Priacanthus macracanthus*, *Caranx ignobilis*, and *Chaetodon lunula*, provides insight into ecosystem trajectories and conservation needs. These findings can support marine spatial planning and reinforce the design of Marine Protected Areas (Krueck et al. 2017), which are central to improving ecological outcomes and fishery sustainability.

In summary, the Uwedikan reef system offers a valuable natural laboratory to investigate how fish assemblages respond to habitat decline while retaining signs of resilience. By integrating ecological baselines with functional analysis, conservation strategies can be designed to balance biodiversity protection and local livelihoods. The main objective of this study is to assess the diversity of reef fish species in the Uwedikan coastal area and examine their ecological significance in the context of declining coral cover. Through analysis of species composition, abundance, and functional groups, the study aims to generate baseline evidence that informs adaptive management and contributes to biodiversity conservation in Central Sulawesi and the wider Coral Triangle.

MATERIALS AND METHODS

Study area

This study was conducted at three points within a 796.7-hectare area of the Uwedikan Coastal Region, Luwuk Timur Sub-district, Banggai District, Central Sulawesi Province, Indonesia, as shown in Figure 1.

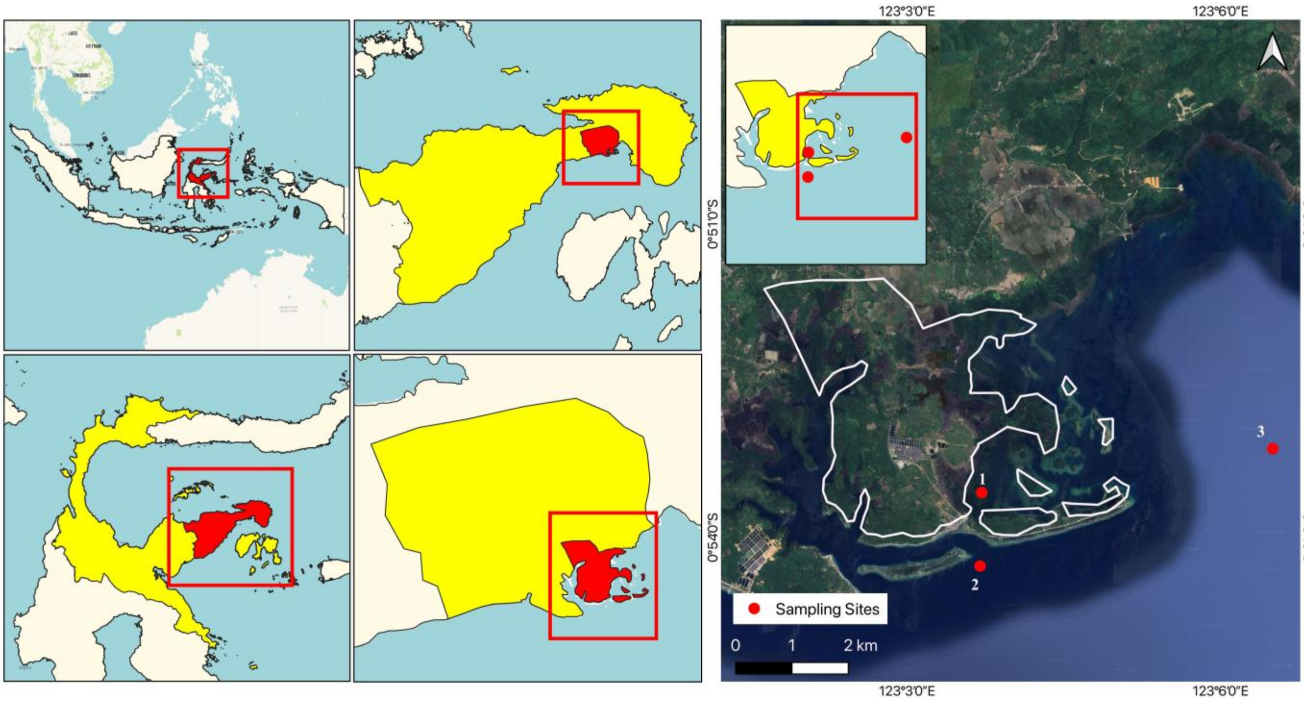

Figure 1. The study location in the coastal area of Uwedikan Village, Luwuk Timur Sub-district, Banggai District, Central Sulawesi Province, Indonesia, indicates the locations of Rockfish and Holothuroidea at Point 1 (0°54'16.3"S, 123°03'41.9"E), Point 2 (0°53'85.6"S, 123°03'62.1"E), and Point 3 (0°53'8.91"S, 123°06'30"E)

Procedure

The Data in this study were collected using a survey method with the Underwater Visual Census (UVC) technique, as described by English et al. (1994). At each observation site, three belt transects (50×5 m) were laid parallel to the reef edge, with 5 m spacing, replicated three times per site. Surveys were conducted in July and September 2023 during periods of good visibility (8-12 m). Fish were identified in situ and cross-validated with photographic documentation (Allen et al. 1999). To reduce observer bias, trained divers conducted surveys following standardized UVC protocols. Coral cover was quantified using the Line Intercept Transect (LIT) method (English et al. 1997). Data analysis included Shannon-Wiener (H'), Simpson, and Evenness indices, with Pearson and Spearman correlations applied to test fish-coral cover relationships.

Data analysis

The data were analyzed using a descriptive quantitative approach. The analysis aimed to obtain descriptive information on diversity index (H') (Krebs 1989), abundance (X) (Odum 1993), and dominance (C) (Odum 1993).

Biodiversity Index

$$H' = -\sum_{n=1}^{s} (\mathrm{Pi}\, Ln\ \mathrm{Pi})$$

Where, H': Species Diversity Index; Pi: ni/N (ni is the number of individuals of a particular species, and N is the total number of individuals of all species). The criteria for the diversity index are as follows: H'≤1: Low diversity; 1<H'≤3: Moderate diversity; H'≥3: High diversity.

Evenness Index

$$E = \frac{\mathrm{H}'}{Ln\ s}$$

Where, E<0.4 indicates low evenness; 0.4<E<0.6 indicates moderate evenness; E>0.6 indicates high evenness.

Dominance Index

$$D = Sum\left(\frac{\mathrm{ni}}{N}\right)\hat{}2$$

Where: D: Dominance Index. ni: Number of individuals of species *i.* N: Total number of individuals of all species

RESULT DAN DISCUSSION

Species composition and identification of reef fish

Based on observations conducted at three sampling points in the coastal waters of Uwedikan, a total of 748 individual reef fish were recorded. These reef fish represent 14 species, 12 genera, 11 families, 4 orders, and 2 classes. The relatively low species richness (14 species) recorded in this study is likely due to methodological and ecological constraints. The UVC method was conducted exclusively at 10 m depth during daylight hours, which inherently underrepresents cryptic, nocturnal, or deep-reef species that are common in coral triangle ecosystems. Additionally, the observed sites exhibited low live coral cover (≤17%) and simplified reef structures, conditions that reduce niche availability for coral-dependent taxa and may have contributed to the lower-than-expected diversity compared to regional baselines. The taxonomic classification of the identified reef fish is presented in Table 1.

The coral reef fish identified in the coastal waters of Uwedikan belong to various taxonomic levels, specifically the classes Actinopterygii (ray-finned fishes) and Chondrichthyes (cartilaginous fishes). The dominant orders include Perciformes, Carangiformes, Labriformes, and Myliobatiformes, encompassing 11 families, with Serranidae, Lutjanidae, Lethrinidae, and Priacanthidae being the most prominent. The most abundant species was *P. macracanthus* (bigeye fish) with 160 individuals, followed by *S. fuscescens* (rabbitfish) with 103 individuals, and *C. ignobilis* (giant trevally) with 75 individuals. The high abundance of *P. macracanthus* and *S. fuscescens* suggests the possible dominance of generalist and/or herbivorous species in disturbed habitats (Emslie et al. 2020).

Species from the family Serranidae, such as *E. lanceolatus*, *E. fuscoguttatus*, and *Cromileptes altivelis*, although observed in smaller numbers, possess high ecological and economic value. These apex predators rely heavily on complex coral reef structures (Frisch et al. 2021), and their population declines are often correlated with coral habitat degradation. Butterflyfish species such as *C. lunula*, which feed exclusively on coral polyps, are highly sensitive to changes in coral health. Despite their limited presence (21 individuals), their occurrence remains important as an indicator of coral reef ecosystem condition (Keith et al. 2019).

Functionally, the fish community reflects a range of ecological roles: herbivores (*S. fuscescens*, *C. microrhinos*), piscivores (*C. ignobilis*, *P. leopardus*), and omnivores (*Lutjanus altifrontalis*, *Lethrinus obsoletus*). The presence of herbivorous fish is essential for controlling algal growth on reefs (Richardson et al. 2020). The dominance of tolerant species, accompanied by the declining presence of ecologically valuable species, indicates a shift in community structure due to environmental stress. As noted by Robinson et al. (2023), such shifts often signal the early stages of coral reef ecosystem degradation.

Diversity, dominance, and abundance of reef fish species

The Shannon-Wiener Diversity Index (H': 2.434) indicated moderate to high diversity, supported by the Simpson index (D: 0.79) and high Evenness (E: 0.922). Dominance was low (C<0.05), suggesting no single species monopolized the community. These values reflect that the ecosystem in the Uwedikan coastal area is still capable of supporting a complex and diverse reef fish community. High diversity indices are often positively correlated with coral ecosystem health (Mellin et al. 2019), the Evenness

Index (E), suggesting a relatively balanced distribution of individuals across species. High evenness indicates the absence of strong dominance by a single species and serves as an indicator of a stable community structure (Coker et al. 2020). The highest dominance index values were found in *P. macracanthus* and *C. ignobilis*, each with a value of 0.045. However, overall dominance was low (<0.05 for all species). This low dominance aligns with findings from many tropical coral reef ecosystems, where environmental pressures have not yet triggered population explosions of opportunistic species (Robinson et al. 2023).

The highest abundance indices were recorded for *P. macracanthus* (0.2139), *S. fuscescens* (0.1377), and *C. ignobilis* (0.1002). These high values indicate that these species possess a high level of adaptability to stressed habitat conditions and exhibit considerable ecological tolerance. As described by McClanahan et al. (2021), herbivorous and generalist species such as *S. fuscescens* often become dominant in degraded habitats due to damage to coral reef structure. Figure 2 illustrates the composition of coral reef fish species in the Uwedikan coastal area based on their relative abundance. The figure highlights the dominance of several key species, notably *P. macracanthus* and *S. fuscescens*, which together constitute a substantial proportion of the total reef fish community. These species are recognized for their ecological tolerance and adaptability to disturbed habitats. Other species, such as *C. ignobilis*, *L. altifrontalis*, and *L. obsoletus*, also contributed notably to the community structure, albeit in smaller proportions. The chart indicates a skewed distribution, where a few dominant species account for a large portion of individual counts, while the remaining species are represented in lower numbers. This pattern suggests the potential onset of ecological imbalance driven by environmental stressors, such as coral habitat degradation. Notably, species from the Serranidae family and obligate coral feeders such as *C. lunula* were present in lower abundances, reflecting their sensitivity to habitat quality. Overall, the composition shown in Figure 2 supports the quantitative indices discussed earlier and reinforces the inference that the reef fish assemblage in Uwedikan is shifting toward communities dominated by generalist and herbivorous species. The highlights on the importance of monitoring shifts in species composition as an early indicator of ecosystem health and resilience.

The relationship between reef fish diversity and coral cover in the Uwedikan coastal area

Coral reef ecosystems are globally recognized for their biological richness and ecological complexity, providing essential habitats for a vast array of marine organisms, including reef-associated fish species. However, their structural integrity is highly dependent on the health and extent of live coral cover. In the Uwedikan coastal area, survey data revealed that all three monitored sites exhibited alarmingly low percentages of live coral cover: Site 1 had 17% live coral and 52% dead coral, Site 2 showed 13% live coral and 30% dead coral, while Site 3 recorded only 11% live coral and 35% dead coral. These figures place all locations below the 25% threshold, which, according to the classification by Gomez and Yap (1988), indicates a "damaged" reef condition. This status reflects considerable ecological degradation, likely driven by a combination of local anthropogenic pressures and broader environmental stressors.

Table 1. Classification of reef fish in the coastal area of Uwedikan, Banggai District, Central Sulawesi Province, Indonesia

Class/Order/ Family	Genus	Species	Local name	Ecological roles	No. individuals	% of total
Actinopterygii						
Perciformes						
Siganidae	*Siganus*	*Siganus fuscescens*	*Baronang*	Herbivore (grazer)	103	21.4
Serranidae	*Plectropomus*	*Plectropomus leopardus*	*Sunu*	Piscivore (apex)	47	6.3
Mullidae	*Mullus*	*Mullus surmuletus*	*Ikan bajanggut*	Benthic invertivore	45	6.0
Lutjanidae	*Lutjanus*	*Lutjanus altifrontalis*	*Kakap merah*	Carnivore (piscivore/invertivore)	52	8.6
Lethrinidae	*Lethrinus*	*Lethrinus obsoletus*	*Katamba*	Benthic invertivore/omnivore	64	8.6
Serranidae	*Epinephelus*	*Epinephelus lanceolatus*	*Kerapu*	Piscivore (apex)	32	4.3
		Epinephelus fuscoguttatus	*Kerapu tiger*	Piscivore	20	2.7
		Cromileptes altivelis	*kerapu tikus*	Piscivore	26	3.5
Chaetodontidae	*Chaetodon*	*Chaetodon lunula*	*Ikan kepe-kepe*	Corallivore	21	2.8
Priacanthidae	*Priacanthus*	*Priacanthus macracanthus*	*Ikan mata besar*	Carnivore (nocturnal piscivore/invertivore)	160	21.4
Caesionidae	*Caesio*	*Caesio erythrogaster*	*Ikan ekor kuning*	Planktivore	53	7.1
Carangiformes						
Carangidae	*Caranx*	*Caranx ignobilis*	*Bubara*	Benthic invertivore/omnivore	75	8.6
Labriformes						
Scaridae	*Chlorurus*	*Chlorurus microrhinos*	*Kaka Tua*	Herbivore (scraper/excavator)	30	4.0
Chondrichthyes						
Myliobatiformes						
Dasyatidae	*Neotrygon*	*Neotrygon kuhlii*	*Pari*	Benthic invertivore	20	2.7

Note: Species were recorded across Sites 1-3 (coordinates provided in the Materials and Methods). Ecological role (herbivore, piscivore, omnivore, corallivore, and generalist) are included to clarify ecological roles. Site-specific data are available in the raw dataset

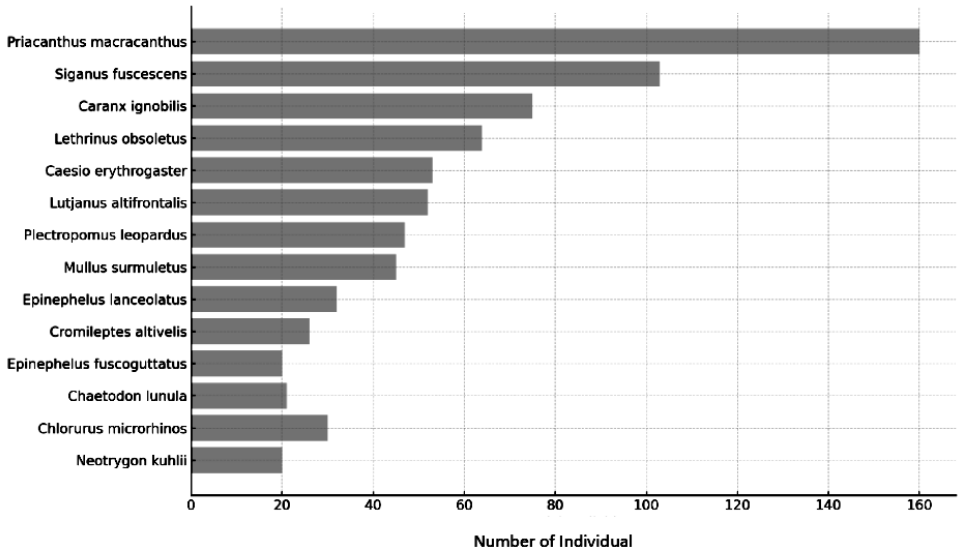

Figure 2. Composition of coral reef fish species based on abundance

Healthy coral reefs provide intricate three-dimensional structures that create a mosaic of microhabitats, offering refuge, foraging grounds, and breeding sites for various reef fish species. The complexity of coral structures supports high levels of biodiversity by minimizing interspecific competition and enhancing niche differentiation. However, when coral cover declines, structural complexity diminishes, leading to habitat homogenization. This simplification of habitat architecture reduces the availability of ecological niches, thereby negatively impacting both the abundance and diversity of reef fish (Graham and Nash 2016). Degraded coral habitats often exhibit a marked shift in community composition, characterized by a decline in specialist species and an increase in generalist and opportunistic taxa (Richardson et al. 2020).

Despite the evident degradation in coral cover across the Uwedikan sites, the reef fish diversity index recorded in this study remained moderate to high (H': 2.434). This apparent contradiction suggests that certain fish species are either resilient to habitat degradation or capable of adapting to suboptimal environmental conditions. Notably, the presence of generalist and herbivorous species such as *S. fuscescens*, a rabbitfish known for its tolerance to environmental fluctuations, may help explain the observed diversity levels. These species are able to thrive in degraded habitats by exploiting alternative food sources, such as macroalgae, which often proliferate following coral loss (Bellwood et al. 2019).

Herbivorous fish play a pivotal role in coral reef ecosystems, especially in regulating algal populations that compete with corals for space and light. In the absence of adequate herbivory, algae can rapidly overgrow dead coral substrates, preventing coral larvae from settling and inhibiting reef recovery. Recent studies further support this trend, showing that coral reef fish communities in degraded habitats often exhibit resilience driven by functional redundancy (Keith et al. 2019; Robinson et al. 2023). Such evidence underscores the importance of monitoring functional groups rather than relying solely on species richness. The functional presence of herbivores like *S. fuscescens* is therefore essential for maintaining ecological processes such as coral recruitment and succession. Their role becomes even more critical in degraded systems, where natural coral resilience is already compromised (Coker et al. 2020). However, the persistence of herbivorous fish populations in Uwedikan cannot be assumed to be stable. Overfishing, particularly targeting easily accessible species such as rabbitfish, poses a significant threat to their sustainability. Local fishing pressures, often unregulated and intensified by socio-economic reliance on marine resources, may reduce herbivore biomass to levels insufficient for effective ecosystem functioning. The loss of herbivory services can lead to feedback loops of degradation, whereby unchecked algal dominance further suppresses coral regeneration, driving reefs toward alternative, less diverse stable states (McClanahan et al. 2021).

Moreover, the loss of coral cover has cascading effects on fish species that depend on live coral for food or shelter. Obligate corallivores, such as species from the genus *Chaetodon* (e.g., *C. lunula*), exhibit strong declines in abundance when live coral declines. Similarly, apex predators like *E. lanceolatus* rely on structurally complex habitats for ambush hunting and shelter. Their reduced presence in Uwedikan suggests that coral degradation may already be affecting higher trophic levels, signaling potential disruptions in food web stability and ecosystem resilience (Frisch et al. 2021). The pattern observed in Uwedikan, low coral cover yet moderate fish diversity, may represent a transitional community phase, in which functionally important species have not yet been completely extirpated. However, this balance is precarious. Without effective management interventions, continued habitat degradation and resource extraction are likely to push the ecosystem toward a threshold beyond which recovery becomes unlikely. Ecological theory suggests that such tipping points are often marked by non-linear responses and abrupt changes in community structure (Obura and Grimsditch 2020).

Live coral cover was found to be low at all three sites: 17% (Site 1), 13% (Site 2), and 11% (Site 3). Correspondingly, fish abundances were estimated at 253, 242, and 253 individuals, respectively. These values suggest a relationship between live coral cover and overall fish abundance, as shown in Figure 3. The graph indicates that although live coral cover is low across all sites, fish abundance remains relatively high, an early indication of possible fish community resilience. Still, it may also reflect the dominance of ecologically tolerant species.

Pearson correlation analysis showed no significant relationship between live coral cover and fish abundance (r: 0.189, p: 0.879), while Spearman's rank correlation confirmed no monotonic trend (ρ: 0.000, p: 1.000). These results underscore that fish community structure in Uwedikan is not directly dependent on coral cover within the low range observed. Given this context, the relationship between reef fish diversity and coral cover in Uwedikan underscores the importance of integrating fish and benthic monitoring data in ecosystem assessments. While fish diversity indices offer valuable insights into community health, they must be interpreted alongside habitat metrics to avoid misjudging ecosystem status. High fish diversity in degraded coral habitats may reflect a temporary phase of resilience rather than long-term stability (Robinson et al. 2023). To mitigate further degradation and foster recovery, targeted conservation actions are required. These include the establishment of no-take Marine Protected Areas (MPAs), regulation of artisanal fisheries, community education on sustainable practices, and active habitat restoration through coral transplantation and artificial reef deployment. In addition, long-term monitoring programs that track both fish and coral indicators are essential for detecting early warning signs of ecosystem collapse and guiding adaptive management (Mellin et al. 2019).

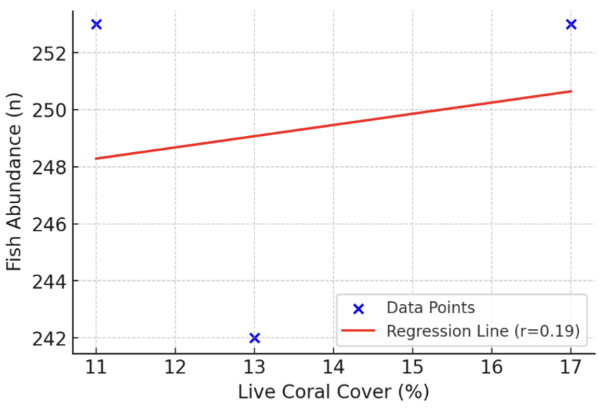

Figure 3. The relationship between live coral cover (%) with fish abundance at each observation site along the Uwedikan coastal area, Banggai District, Central Sulawesi Province, Indonesia

Discussion

This study shows that Uwedikan reefs, despite being classified as 'damaged' (2.7-21.4% live coral cover; Gomez and Yap 1988), still maintain moderate fish diversity. This pattern resembles findings from degraded Caribbean reefs (Mumby et al. 2017) and other Coral Triangle sites (Abesamis et al. 2020), where tolerant herbivores and generalists dominate while coral specialists decline. However, the sharp reduction in apex predators (e.g., *Epinephelus* spp.) indicates trophic downgrading, consistent with global reports of predator depletion under reef degradation (Frisch et al. 2021). This resilience-erosion trade-off suggests that while functional roles such as herbivory persist, the long-term sustainability of the system is threatened unless management interventions are implemented. The reef fish assemblage in Uwedikan reflects a still-functioning, yet vulnerable, ecological system composed of herbivores, piscivores, and omnivores. While generalist herbivores like *S. fuscescens* and *C. microrhinos* support key ecosystem functions, the declining presence of coral-dependent species such as *C. lunula* and apex predators like *E. lanceolatus* highlights a concerning trend of habitat simplification and trophic downgrading (Keith et al. 2019; Frisch et al. 2021). This emerging shift illustrates the resilience-erosion trade-off: while the persistence of tolerant herbivorous and generalist species may indicate resilience in certain ecological functions (e.g., algal control), this should not be interpreted as long-term stability. The absence or decline of coral-dependent specialists and apex predators suggests ongoing functional erosion. Without targeted restoration and fisheries management, this transitional community state may shift toward a less diverse and functionally degraded system. Such community transitions are consistent with broader patterns observed in other degraded tropical reefs, where functional diversity becomes compressed and recovery potential diminishes (Robinson et al. 2023).

Furthermore, the correlation between live coral cover and fish abundance across sites suggests a transitional community state. Species richness may persist temporarily due to the adaptability of tolerant taxa, but this can obscure underlying instability. Without intervention, continued habitat degradation and resource exploitation could drive the system past a tipping point, where rapid biodiversity loss and ecosystem collapse become likely outcomes. From a conservation perspective, these findings highlight the urgency of proactive management. Habitat restoration efforts, such as coral transplantation and artificial reef deployment, should be prioritized to restore structural complexity, which underpins species richness (Graham and Nash 2016). Simultaneously, the establishment of no-take Marine Protected Areas (MPAs) is critical to buffer fish populations from overfishing and to allow natural ecosystem processes to recover. Regulations aimed at controlling artisanal fisheries, especially targeting herbivores and predators, are essential to maintain functional balance. Importantly, effective conservation will depend not only on top-down regulation but also on community engagement and the integration of local ecological knowledge. While this study emphasizes the coral-fish relationship, it is important to acknowledge that multiple environmental factors, such as water quality, nutrient availability, and fishing intensity, may also shape community structure (Calvo et al. 2016). Thus, future research should adopt a more integrative approach to capture the multifaceted drivers of reef fish diversity.

In conclusion, the findings underscore that the Uwedikan coastal reef system demonstrates both ecological resilience and emerging vulnerability. Persistent anthropogenic pressures, such as overfishing and habitat degradation, threaten the long-term stability of the ecosystem. While the continued presence of functionally important reef fish species signals ongoing ecological function, observed declines in trophic specialists and apex predators reveal a transition toward a simplified community structure. The trend emphasizes the urgency of implementing ecosystem-based conservation strategies that safeguard habitat complexity, sustain biological diversity, and support comprehensive long-term monitoring. Integrated management efforts are essential for preserving the functional sustainability of coral reef ecosystems like Uwedikan amid increasing human and environmental pressures.

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