Abundance and Composition of Targeted Reef Fish in an Unprotected Coral Reef Ecosystem: A Case Study of Oransbari Bay

Duaitd Kolibongso*, Toni Sitinjak, Roni Bawole

Department of Marine Science, Faculty of Fisheries and Marine Science, Universitas Papua
Jl. Gunung Salju, Amban, Manokwari, 98314 Indonesia
Email: d.kolibongso@unipa.ac.id

Abstract

Reef fisheries particularly those targeting specific fish species are integral to the coral reef ecosystem. Unprotected sites typically exhibit substantial declines in fish densities due to fishing pressure. We conducted an analysis to determine whether the abundance of target fish species correlates with benthic community structure and changes in composition resulting from fishing activities. The point intercept transect (PIT) method was employed to evaluate coral reef condition, while underwater visual census (UVC) was utilized to assess target fish species at three sites in Oransbari Bay. The mean live coral cover in Oransbari Bay was measured at 20.2% ± 2.37 (mean ± standard error). Benthic cover exhibited variation, with rubble comprising 27.6% ± 3.73%, sand 29.3% ± 2.58%, dead coral 9.44% ± 2.91%, and turf algae 4.33% ± 3.47%. The target species group displayed diversity, with 13 species identified across six families: Acanthuridae, Lutjanidae, Serranidae, Caesionidae, Balistidae, and Mullidae. Reef fish abundance ranged from 3,146.7 to 9,986.7 individuals per hectare, with the Acanthuridae family demonstrating the highest abundance and diversity, as it was present at all locations. This study elucidates that the abundance and diversity of target reef fish species in unprotected areas are significantly influenced by coral cover and fishing activities. These findings provide crucial insights into the status of fish resources beyond protected areas in the Bird's Head Peninsula, contributing valuable information for future management of coral reef ecosystems.

Keywords : composition, coral reef, diversity, target species, Oransbari

INTRODUCTION

The pivotal role of coral reef ecosystems in sustaining fisheries resources, a cornerstone of coastal community livelihoods, cannot be overstated. Nonetheless, this crucial role is jeopardized by the susceptibility of coral reefs to damage inflicted by both natural phenomena and human activities (Mcleod *et al*., 2019). Consequently, coral reef ecosystems continue to undergo degradation and decline, profoundly impacting the abundance and diversity of reef fishes (Pratchett *et al*., 2011). Reef fishes, comprising species inhabiting and closely associated with coral reefs (Coker *et al*., 2014; Woodhead *et al*., 2019), are categorized into functional groups based on trophic level, ecological role, body size, home range, habitat association, or a combination of these factors.

The Bird's Head Seascape of Papua (BHS) is renowned for its rich coral reef and reef fish diversity (Veron *et al*., 2011). However, over the past decade, environmental concerns leading to coral reef ecosystem degradation in the region have garnered significant attention from local, regional, and non-governmental authorities. This attention stems from the area's exceptional biodiversity and mounting apprehensions regarding human-induced threats. Destructive fishing practices and overfishing (Ainsworth *et al*., 2008), extensive coastal infrastructure development (Browne *et al*., 2022), and climate change are among the primary drivers of habitat degradation (Mangubhai *et al*., 2012). Numerous monitoring and research endeavors have been undertaken in this region to assess ecosystem health. However, these efforts have primarily focused on familiar and designated sites such as protected areas (Purwanto et al., 2021). Meanwhile, other locations within the area, particularly those outside protected zones, have received scant attention, despite their importance in providing a comprehensive understanding and assessment of ecosystem conditions across the

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entire region.

Research indicates a notable increase in the abundance, species diversity, and reproductive capacity of target fish species, families, and functional groups within protected areas. Observable positive impacts include a rise in abundance (20-30%), species diversity (11-23%), and reproductive success (Bergseth *et al*., 2016; Soler *et al*., 2015). While protected areas are presumed to safeguard certain species from exploitation, not all species exhibit positive responses to protection (McClanahan & Graham, 2015). Responses to protection vary extensively among fish taxa based on factors such as commercial value, body size, mobility, and life-history traits. Generally, target species with larger body sizes tend to demonstrate significantly better and quicker responses compared to those with smaller body sizes (Claudet *et al*., 2010). The response of target fish species to protected and unprotected areas is highly contingent upon life cycle, ecological traits, body size, habitat preferences, and schooling behavior (Claudet *et al*., 2010). Despite increasing recognition of the decline in reef fish species both locally and globally (Andradi-Brown *et al*., 2021), there exists a paucity of data regarding the status of fish resources at unprotected sites within the region (Putra *et al*., 2022).

Oransbari Bay, situated in the South Manokwari District within the Bird's Head Seascape (BHS), is noted for its high potential for coral reef fish diversity (Peck *et al*., 2021). The bay fulfills multiple functions, including foraging, transportation, port activities, recreation, tourism, and human settlement. The local economy is significantly driven by reef fisheries, with the bay also serving as a safe anchorage for fishing fleets (Amir *et al*., 2019). Reef fisheries - particularly those targeting specific fish species - are integral to the coral reef ecosystem and are commonly associated with small-scale fisheries. However, reef fish populations often decline due to localized fishing activities, especially for targeted species. High fishing pressure resulting from proximity to villages and various human activities, combined with the use of destructive fishing methods, further threatens these fish populations. Additionally, limitations in resources and the undervaluation of reef fish data hinder evidence-based conservation efforts. Our research investigated the relationship between target fish species abundance and benthic community structure at unprotected sites, assessed changes in fish assemblage composition, and evaluated fishing pressure on target species. The absence of target species frequently indicates overfishing. This study provides important insights into the status of fish resources in unprotected areas of the BHS, contributing to a broader understanding of regional ecosystem conditions.

MATERIALS AND METHODS

This study was conducted in Oransbari Bay, South Manokwari, in December 2022. The bay is located approximately 80 kilometers south of Manokwari and is a coastal area directly adjacent to Cenderawasih Bay. Oransbari Bay possesses a relatively complete coastal ecosystem, including mangrove forests (Amir *et al*., 2019), seagrass meadows (Kolibongso *et al*., 2023), and a coral reef ecosystem. These coastal ecosystems play crucial roles in shoreline protection, biodiversity conservation, and supporting local livelihoods through fisheries (Sembay *et al*., 2023; Waran *et al*., 2020). The bay also serves as a strategic anchorage point for fishing boats, tourism, and local transportation. Given the increasing pressure on the ecosystem health of Oransbari Bay, particularly on coral reefs and fisheries, this study aimed to assess the benthic community structure and reef fish diversity within the bay. While previous research in this region has primarily focused on mangrove and seagrass ecosystems, information regarding reef fish diversity remains limited. To address this knowledge gap, data were collected at three stations in Oransbari Bay, representing a variety of coral habitats commonly utilized by local communities. These stations, located close to shore, featured distinct reef structures: fringing reefs (Stations 2 and 3) and reef slope (Station 1).

Benthic community data collection

Coral data were collected using the Point Intercept Transect (PIT) method. The PIT method is one of the methods developed to monitor the condition of live corals and other supporting biota in a coral reef location in an easy and efficient manner (Hill & Wilkinson, 2004). Observations were conducted by stretching a 50 m long measuring tape (transect line) horizontally (parallel to the shoreline) at each observation station point. Observations were made along the transect line by recording all lifeform categories every 0.5 m with three repetitions.

Table 1. Location and geographic coordinates of sites location

Sites	Latitude	Longitude	Transect (Depth)	Location
Station 1	-1.351652	134.269507	7 meters	Sea port of Oransbari
Station 2	-1.346912	134.266102	5 meters	Beach of Waranggui
Station 3	-1.349616	134.260635	5 meters	Muari

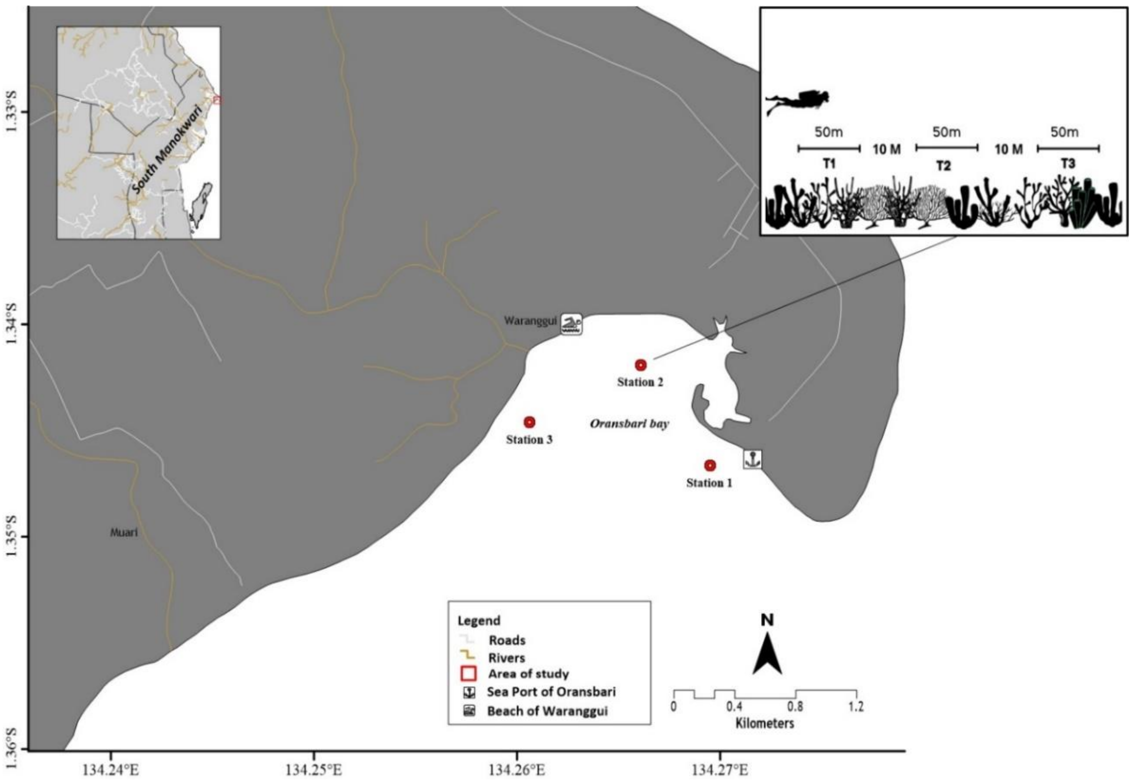


Figure 1. Map of sampling locations in Oransbari Bay, South Manokwari.

Species target data collection

We collected data on target reef fish species using the underwater visual census (UVC) method (Brock, 1954; Samoilys & Carlos, 2000) across 250 m² belt transects at each station, consistent with coral reef health monitoring in the Bird's Head Seascape. The UVC method is widely employed for estimating coral reef composition due to its efficiency and cost-effectiveness (Dwirama *et al*., 2018; Putra *et al*., 2021, 2022). It is particularly suited for dynamic target species (Hill & Wilkinson, 2004). Experienced and well-trained divers familiar with local fish species conducted the surveys.

Each station comprised three 50-meter long and 5-meter wide belt transects (2.5 meters on each side) (Figure 2), aligned with benthic transects. During the survey, divers counted individual fish for 1-2 minutes before moving sequentially along the transect line, minimizing the risk of double counting and reducing potential alterations in fish behavior due to diver presence (Ward-Paige *et al*., 2010). The study focused on economically important species commonly targeted by fishers in Oransbari Bay, including herbivorous groups (Acanthuridae, Scaridae, Siganidae, Caesionidae) and carnivorous groups (Nemiptheridae, Haemulidae, Lethrinidae, Lutjanidae, and Serranidae).

Data Analysis

Percent coral cover was calculated using the equation. (Facon et al., 2016): Percent cover = 100 × number of points where the benthic category was found / Total number of points on the transect. The percent coral cover at each station consisted of the average value at each transect. The average percent coral cover at each station was derived from individual transect measurements and categorized as follows: 0-24.9% (poor), 25-49.9% (fair), 50-74.9% (good), and 75-100% (excellent) (Gomez & Yap, 1988). The abundance of target reef fish species was calculated by dividing the number of individuals found by the area surveyed (Odum, 1971). Species identification followed standardized protocols, and each family was classified by functional group and assessed for International Union for Conservation of Nature (IUCN) Red List status (iucnredlist.org). Univariate analysis was conducted to describe the condition of target reef fish communities, focusing on diversity, uniformity, and dominance (Odum, 1971). The Shapiro-Wilk test assessed normality and homogeneity of variance to confirm data distribution. Significant differences in fish abundance across stations were evaluated using the Kruskal-Wallis test (non-parametric), with a significance threshold set at $p < 0.05$.

RESULT AND DISCUSSION

Coral condition

The characteristics of coral reefs in Oransbari Bay were found to exhibit considerable variability, with significance ($p < 0.05$) observed in coral cover, particularly when comparing different observation sites. The average live coral cover in Oransbari Bay was measured at 20.2% ± 2.37% (mean ± SE). Mean benthic cover dominance exhibited variations between rubbles (27.6% ± 3.73%) and sand (29.3% ± 2.58%), as well as between dead coral (9.44% ± 2.91%) and algal turf (4.33% ± 3.47%) (Figure 3). This characterization categorizes the condition of coral reefs in the waters of Oransbari Bay as "poor". Comparatively, coral reef cover in Oransbari Bay is lower than that observed in several locations within the Papua region, which are also not under protection; for instance, Rendani, Manokwari recorded 54.7% (Wanma *et al*., 2022), and Lemon Island, Manokwari recorded 45.8% (Algutomo *et al*., 2022). Coral reefs are intricate ecosystems that offer crucial services to coastal areas, serving as habitats for essential marine organisms, providing coastal protection, and supporting recreation and tourism (Woodhead *et al*., 2019). Particularly regarding reef fishes, corals play a pivotal role in maintaining population abundance and compositional characteristics of fishes (Jaroensutasinee *et al*., 2021). Conversely, reef fishes also impact coral recruitment and the structure of benthic communities (McClanahan & Muthiga, 2020).

Within the benthic substrate category, station 1 exhibited a relatively complex composition, with no single substrate category dominating, as sand (43.3%), dead coral (19.7%), and algal turf (12.7%) constituted the top three benthic substrate covers. In contrast, station 2 displayed rubble cover (46.0%), which dominated nearly half of the other benthic substrate categories. Station 3 was characterized by the dominance of sand and rubble, with percentage covers of 29.3% and 29.7%, respectively (Figure 4). Regarding benthic complexity, diverse or more intricate benthic communities can influence the

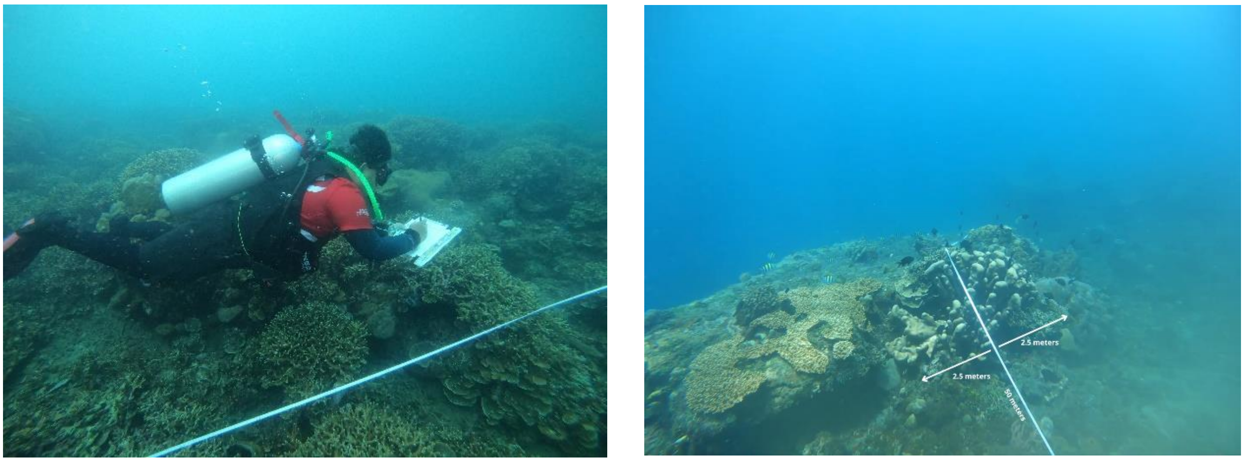


Figure 2. Coral reef fishes data collection in Oransbari bay

composition and abundance of reef fish (McClanahan & Muthiga, 2020). Furthermore, Reverter *et al*. (2022) observed that habitats lacking complexity often fail to support large herbivorous fish populations.

Live coral cover at station 1 exhibited significant damage, with the lowest percentage recorded at 8.7%, followed by a relatively high cover of dead corals and algal turf. The substantial presence of turf algae may indicate the initiation of a post-damage succession process (Roth *et al*., 2020). Algal turf observed in this area grew atop old and dead coral rubble. Further degradation of coral habitat was evidenced by low live coral and high dead coral cover, providing favorable conditions for turf algae proliferation. Algal turfs represent benthic pioneer communities that typically thrive in dead or degraded coral reef environments, colonizing substrates once occupied by coral tissue (Roth *et al*., 2020). Although turf algae cannot fully replace the ecosystem functions provided by corals, these pioneer communities play a role in maintaining coral reef nutrient cycling by accumulating biomass and importing macronutrients following coral loss (Roth *et al*., 2020). Live coral cover at station 2 was the highest (29.7%) among the three stations. However, coral breaks were also prevalent at this location, indicating active human activities in the area. Situated within the protected bay, the location of station 2 facilitates human utilization, with the high percentage of coral breaks often indicating the use of explosives in the waters (Paulangan *et al*., 2019). Station 3 exhibited a live coral cover of 22.3%, along with a considerable presence of coral and sand fractures. The elevated percentage of broken coral and sand may signify disturbance or degradation within the coral reef ecosystem. Natural events such as storms, hurricanes, or coral bleaching episodes can inflict damage on coral structures, resulting in the accumulation of coral breaks (Jaroensutasinee *et al*., 2021). Anthropogenic disturbances such as explosive fishing, trawling, or anchoring can also cause substantial harm to coral reefs, leading to the accumulation of coral breaks (Woodhead *et al*., 2019). Additionally, excessive sedimentation in the water column can smother coral reefs, burying corals under layers of sand and coral breaks. Elevated sedimentation levels, often stemming from land runoff carrying sediment, can diminish light penetration and hinder coral photosynthesis, ultimately leading to coral mortality and the prevalence of substrates dominated by sand and coral breaks (Bellwood *et al*., 2004).

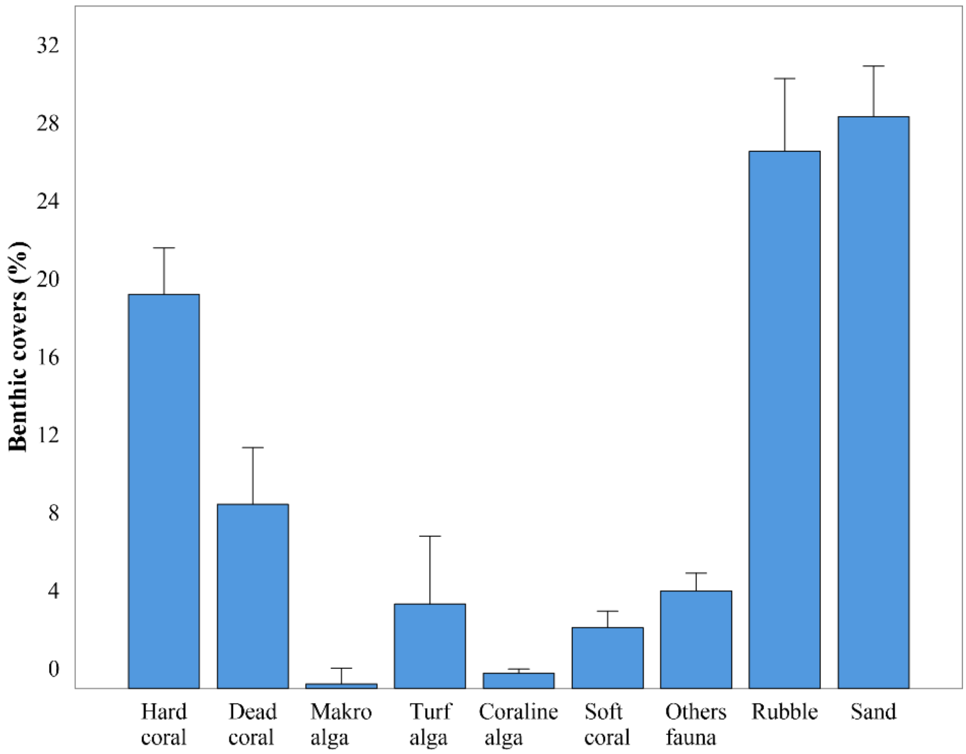


Figure 1. Distribution of benthic substrates in Oransbari Bay

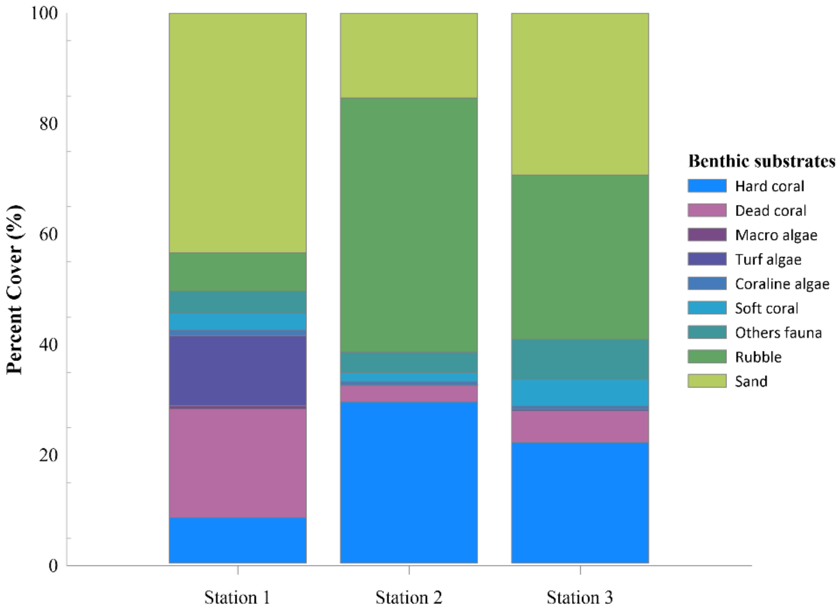


Figure 2. Percentage of benthic subtrates between stations in Oransbari Bay.

Targeted reef fish assemblages

A total of 1.249 individuals belonging to the target species of reef fishes were observed across an area of 2.250 m^2 during three underwater surveys, encompassing 13 species from 6 families (Table 2). Analysis revealed that the composition of reef fishes within the target species did not exhibit significant variations across different survey stations ($p > 0.05$). Among the observed families, Acanthuridae was represented by three genera, namely Ctenochaetus with two species, Acanthurus with two species, and Zebrazoma with one species. The family Lutjanidae was solely represented by the genus Lutjanus, comprising three species. Similarly, the family Serranidae was represented exclusively by the genus Cephalopholis, hosting two species. Additionally, the families Caesionidae, Balistidae, and Mullidae each featured one genus: Caesio, Odonus, and Parupeneus, respectively. Notably, *Ctenochaetus striatus* emerged as the dominant species among the target species, accounting for 38.2% of the observed individuals. Remarkably, the majority of identified target fish species in the waters of Oransbari Bay still fall within the "Least Concern" (LC) category according to the International Union for Conservation of Nature (IUCN). Our results indicate that *Ctenochaetus striatus* was the predominant target species observed in the waters of Oransbari Bay. *C. striatus* is a detritivorous fish known for its preference for feeding on detritus-rich surface algal turf. Oransbari Bay exhibits elevated levels of inorganic particulates (sediment) and organic matter (detritus) in its waters, attributed to inputs from river discharge and surrounding mangrove ecosystems. The distribution of herbivorous fish, particularly detritivores, is known to be influenced by the abundance of algal turf production in the water (Tootell & Steele, 2016), as they target nutrient-rich detrital components prevalent in shallow reef crest and slope zones (Wilson *et al*., 2003). Marshell and Mumby, (2015) *C. striatus* has a wide distribution and thrives in shallow coral reef habitats due to its feeding behavior, with its presence significantly impacting algal turf dynamics. Consequently, the presence of this species can serve as an indicator in monitoring coral reef resilience. The presence of herbivorous fishes has been found to be positively correlated with the establishment of new coral colonies, owing to their role in controlling algal blooms (Cheal *et al*., 2012). However, the overexploitation of this group of fish is poised to significantly impact coral community resilience, given their pivotal role in regulating algal growth. Following *C. striatus*, *Caesio cuning* emerged as the next most frequently encountered species. *C. cuning* is a semi-pelagic fish closely associated with coral reefs, boasting a widespread habitat across the Indo-West Pacific region (Ayodya *et al*., 2021). In Indonesia, this species holds considerable economic importance and constitutes a primary target for fishing activities, with some fishermen employing non-selective fishing gear and, in certain instances, resorting to compressor gear (Yuliana *et al*., 2016), leading to a decline in population levels in specific areas (Nursalim *et al*., 2022).

Based on trophic classification, four distinct groups were identified in Oransbari Bay: herbivores, carnivores, detritivores, and planktivores. The herbivore group encompasses species from the Acanthuridae and Balistidae families, while the carnivore group comprises fish species from the Lutjanidae and Serranidae families. Species from the Caesionidae family constitute the planktivore group, whereas detritivores, known as organic matter eaters, are represented by the Mullidae and Acanthuridae families. Analysis of reef fish group diversity among target species revealed variations across locations, with the lowest diversity recorded at station 1, comprising 7 target species from 3 families. Conversely, station 2 exhibited the highest diversity, hosting 11 target fish species from 5 families, while station 3 recorded 9 species from 4 families. Notably, the Acanthuridae and Lutjanidae families emerged as the two predominant fish groups in Oransbari Bay. Trophic analysis revealed that station 1 was predominantly inhabited by detritivorous and herbivorous fish, with no presence of carnivorous species. In contrast, stations 2 and 3 were dominated by carnivorous and detritivorous fish, respectively, with herbivores also present (see Table 1). The trophic status of reef fish, alongside coral cover, serves as key indicators for evaluating the quality and health of coral reefs in marine ecosystems (Edrus & Lestari, 2020). The absence of large carnivorous fish typically signals fishing pressure, as they represent a crucial target for fisheries. Furthermore, the presence of large carnivorous fish helps regulate herbivorous fish populations and serves as an indicator of ecosystem health (Obura & Grimsditch, 2009). According to (Claudet *et al*., 2010), populations of large carnivorous fish have declined in unprotected areas, with smaller carnivorous species dominating. This underscores the varied responses of different fish groups to environmental conditions. Large carnivorous species tend to exhibit more rapid recoveries in protected environments. The assertion aligns with findings from studies conducted by Yulianto *et al*., (2015) and Putra *et al*., (2021), indicating that large carnivorous species exhibit greater responsiveness to protected areas, often demonstrating notable population recoveries in such environments. Nonetheless, the absence of carnivorous fish points to compromised coral reef conditions in Oransbari Bay. As highlighted by Cole *et al*. (2008), the presence of corallivorous fish is a distinctive feature of a healthy coral reef ecosystem. Corallivores rely on corals for both sustenance and shelter.

Table 2. Composition, trophic status, and relative frequency of target species found at each station in Oransbari Bay waters.

No	Species	Family	Trophic status	IUCN	CITES	Relative frequency (%)
1	*Ctenochaetus striatus*	Acanthuridae	Detritivores	LC	NE	38.2
2	*Ctenochaetus tominiensis*	Acanthuridae	Herbivores	LC	NE	5.1
3	*Acanthurus auranticavus*	Acanthuridae	Herbivores	LC	NE	5.3
4	*Acanthurus pyroferus*	Acanthuridae	Herbivores	LC	NE	5.5
5	*Zebrazoma scopas*	Acanthuridae	Herbivores	LC	NE	0.5
6	*Lutjanus boutton*	Lutjanidae	Karnivores	LC	NE	12.4
7	*Lutjanus gibbus*	Lutjanidae	Karnivores	LC	NE	0.8
8	*Lutjanus kasmira*	Lutjanidae	Karnivores	LC	NE	12.0
9	*Cephalopholis miniate*	Serranidae	Planktonivores	LC	NE	0.4
10	*Cephalopholis urodeta*	Serranidae	Karnivores	LC	NE	0.2
11	*Caesio cuning*	Caesionidae	Karnivores	LC	NE	17.6
12	*Odonus niger*	Balistidae	Herbivores	LC	NE	1.4
13	*Parupeneus bifasciatus*	Mullidae	Detritivores	LC	NE	0.5

Targeted Reef Fishes Abundances

The estimates of total abundance of target species at the three stations exhibited varying values, ranging from 3.147 to 9.987 ind/ha^{-1} (Figure 5), with the highest total abundance recorded at station 2 and the lowest at station 1. The elevated abundance of reef fish target species at station 2 is believed to be linked to the relatively high coral reef cover observed at this location. Research by (Jaroensutasinee *et al*., 2021) indicates that coral loss significantly impacts reef fish abundance and diversity. Indeed, both coral loss and degradation of coral reef habitats exert a profound influence on the abundance and diversity of reef fish species (Pratchett *et al*., 2011). The abundance of target species observed in this study are comparable to findings from other studies in the some unprotected waters in Indonesia, target reef fish abundance in Oransbari waters was reported between 46.960 to 202.000 ind/ha^{-1} (Parenden *et al*., 2018), while Sala *et al*., (2020) reported a range of 960 to 1240 ind/ha^{-1} for reef fish target species abundance in the waters of Wayaban, Raja Ampat. In Kotania Bay, Maluku the abundance of target reef fish ranged from 4.920 to 16.480 ind/ha^{-1} (Huliselan *et al*., 2019), while in Melingkau island, South Kalimantan ranged from 40 to 23.160 ind/ha^{-1} (Tony *et al*., 2020). The response of target reef fish to protected versus unprotected areas is highly contingent upon various factors including life cycle, ecological traits, body size, habitat preference, and group behavior (Claudet *et al*., 2010).

Abundance estimates by family group also exhibited varying values (Figure 5), with the Acanthuridae family recording the highest abundance (9.093 ind/ha^{-1}) and the Mullidae family the lowest (80 ind/ha^{-1}) in Oransbari Bay waters. The Acanthuridae family emerged as the most representative family among reef fish target species in terms of both abundance and composition, with species from this family observed across all stations. As noted by Bellwood *et al*., (2014) and Cheal *et al*., (2012), the Acanthuridae family comprises a highly abundant and diverse group of reef fishes, occupying primarily shallow coral habitats across the Indo-Pacific region. The comparison of species abundance by family revealed notable variations among families at specific locations. For instance, in Alor, the Scombridae family exhibited the highest abundance of target reef fish, with a density of 9,240 ind/ha^{-1}. In Southwest Maluku, the Caesionidae family had a density of 4.654 ind/ha^{-1}, while in East Flores, the Scombridae family recorded a density of 6.080 ind/ha^{-1} (Setiawan *et al*., 2019). Reef fish abundance can vary significantly from region to region; however, high fishing pressure resulting from localized fishing activities, particularly targeting specific groups and the use of destructive fishing methods, such as cyanide and blast fishing, can lead to declines in reef fish populations or even their local extinction. In our investigation, we identified fish family groups

Table 3. Comparison of target reef fish abundance in some unprotected waters in Indonesia

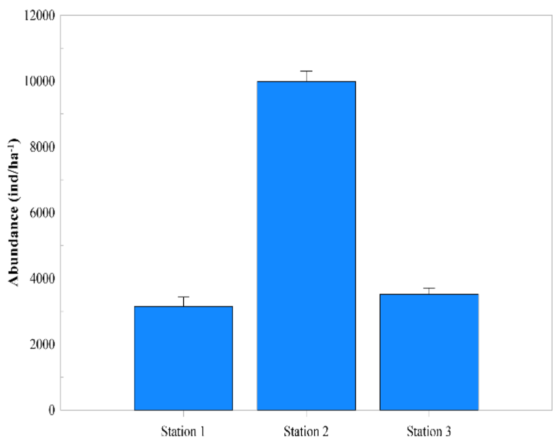
Locations	Number of Stations	Species numbers	Abundance (ind/ha^{-1})	Reference
Wayaban, Raja Ampat	2	38	960 – 1.240	(Sala *et al*., 2020)
Oransbari waters, South Manokwari	2	22	46.960 – 202.000	(Parenden *et al*., 2018)
Kotania bay, Maluku	11	105	4.920 – 16.480	(Huliselan *et al*., 2019)
Alor, NTT	24	47	4.300	(Setiawan *et al*., 2019)*
East Flores, NTT	18	45	1.502	(Setiawan *et al*., 2019)*
Southwest Maluku, Maluku	20	52	13.668	(Setiawan *et al*., 2019)*
Melingkau Island, South Kalimantan	6	25	40 – 23.160	(Tony *et al*., 2020)
Oransbari bay, South Manokwari	3	13	3.146 – 9.987	This study

* mean of abundance (ind/ha^{-1})

among target species that appear particularly susceptible to acute disturbances and coral loss within Oransbari Bay waters. Notably, families reliant on coral habitats, such as the Scaridae family, were conspicuously absent across all stations. This observation raises significant concern, as a decline in the abundance of these fish groups can profoundly impact the ecosystem function and resilience of coral reef habitats due to their crucial ecological roles (Graham *et al*., 2011). Parrotfishes are recognized as pivotal contributors to reef dynamics, possessing the capacity to modify benthic communities and influence the composition of various reef fish groups (Elumba *et al*., 2019). Unfortunately, a number of areas in Indonesia have witnessed a decline in the population of this group of fish due to high market demand, making them a prime fishing target (Sitorus *et al*., 2020; Zulfahmi *et al*., 2024).

Moreover, we observed the absence of several families of reef fishes, which are significant target species for fisheries and commonly encountered in shallow coral reef ecosystems throughout Indonesia. Specifically, fishes belonging to the Siganidae and Haemulidae families were notably absent. These families typically inhabit shallow waters within coral reef, seagrass, and mangrove ecosystems. However, their complete absence suggests considerable pressure from fishing activities within Oransbari Bay. Economically, these target fish groups hold substantial market demand owing to their flavorful and nutritious meat. Both Siganidae and Haemulidae are primary targets for small-scale fishers who engage in daily fishing operations within the waters of Oransbari Bay. This target fish group is typically captured by fishermen employing a variety of methods including traps, gill nets, handlines, and kalawai (spears). The Siganidae family, characterized by herbivorous behavior, plays a critical role in coral reef ecosystems. These fish are renowned for their coral-cleaning activities, which are instrumental in algae control. Moreover, their feces serve as a vital nutrient source, promoting coral growth and enhancing overall reef diversity (Anam *et al*., 2020). On the other hand, the Haemulidae family is recognized as a carnivorous group. Their diet primarily consists of small fishes and various invertebrates, highlighting their ecological significance in maintaining the balance of reef ecosystems (Burhanuddin & Iwatsuki, 2012).

The ecological community of target reef fishes in Oransbari Bay is currently experiencing environmental stress, characterized by low diversity (ranging from 1.145 to 1.812) and unstable community structures. This condition is further evidenced by the absence of several families of target reef fish species typically found in coral reef ecosystems. Notably, the community has no dominant species (Table 4). To assess the environmental pressures affecting the ecological structure of target reef fishes in Oransbari bay, we compared various ecological index values from our study with those from prior research conducted in 2018 (Parenden *et al*., 2018) which reported higher diversity index values ($H' > 3$) and evenness index values ($J > 1$), indicating a stable community. The decline in target reef fish populations in Oransbari Bay can be attributed to coral destruction and overexploitation. Coral fish populations are declining due to localized small-scale fisheries.



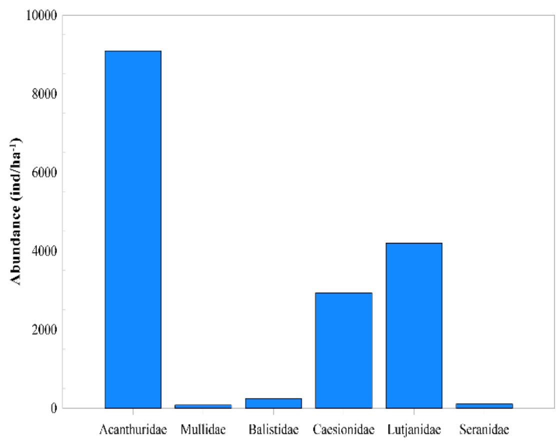


Figure 3. Abundance values of target reef fish species per station and family (ind/ha^{-1} ± SE) in Oransbari Bay waters.

Table 4. Comparison of richness index, diversity index, and evenness index of target reef fishes in Oransbari Bay.

No.	Station	1	2	3
	Species number (S)	7	11	8
	N = Σ ni (fish)	236	749	264
	Index			
1.	*Margalef (R1)*	1.098	1.511	1.255
2.	*Menhinick (R2)*	0.456	0.402	0.492
3.	*Simpson (λ)*	0.518	0.798	0.71
4.	*Shannon (H)*	1.145	1.812	1.508
5.	*Evenness (J)*	0.449	0.556	0.565
6.	*Dominance (D)*	0.481	0.202	0.29

While the abundance of targeted species can vary within different areas, the high fishing pressure near fishing villages exacerbates this decline (Sini *et al*., 2019). Furthermore, the diversity of target reef fish species indicates coral diversity within the ecosystem. Consequently, issues related to reef fisheries must be integrated with managing coral reef ecosystems.

The highest diversity value was observed at station 2, likely attributed to the higher coral cover than the other two stations. Coral cover influences the diversity of reef fishes by offering shelter and food resources. Research indicates a positive correlation between coral cover and reef fish abundance and diversity (Coker *et al*., 2014).

However, the degree of dependence of reef fishes on live corals varies, ranging from species highly reliant on corals for food or habitat to those that are not dependent on corals (Pratchett *et al*., 2011). It is challenging to isolate the relative importance of live corals versus the physical structure provided by high coral cover and diversity. Therefore, the impacts of coral loss on reef fish assemblages are expected to vary depending on absolute levels of coral cover, compositional changes, and alterations in structural complexity, particularly following disturbances.

CONCLUSION

The average live coral cover in Oransbari Bay was determined to be 20.2% ± 2.37%, while the abundance of target species reef fishes ranged from 3146.7 to 9986.7 individuals per hectare. Notably, the Acanthuridae family emerged as the most abundant and diverse group among reef fish target species, being present across all surveyed locations. Our study revealed that the abundance and diversity of reef fish target species were significantly influenced by coral cover and fishing activities. This observation aligns with the absence of several key target species, such as fish from the Scaridae, Siganidae, and Haemulidae family groups, underscoring the intricate interplay between coral health, fishing pressure, and reef fish dynamics in Oransbari Bay.

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