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Reef Fishes Community in the Candidate Sites for Lobster Restocking in Pangandaran and Trenggalek Waters, Indonesia

Gussasta Levi Arnenda[1]*, Mujiyanto Mujiyanto[1], Riswanto Riswanto[2], Danu Wijaya[3], Yayuk Sugianti[1], Amran Ronny Syam[1]

[1] Research Center for Biota System, National Innovation Research Agency, Jalan Raya Jakarta-Bogor Km. 48, Cibinong, Bogor, 16911 West Java, Indonesia
[2] Research Institute for Fisheries Enhancement, Agency for Marine and Fisheries Research and Human Resources, Ministry of Marine Affairs and Fisheries, Indonesia
[3] Research Institute for Freshwater Aquaculture and Fisheries Extension, Agency for Marine and Fisheries Research and Human Resources, Ministry of Marine Affairs and Fisheries, Indonesia
***Corresponding Author: gussastaarnenda@gmail.com**

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ABSTRACT

Lobster restocking has been introduced as a conservation strategy to enhance depleted wild stocks and support sustainable fisheries production. The survival rate of juvenile lobsters during restocking depends on ecological factors such as habitat quality and predation risk from reef fishes. This study analyzed the composition, distribution, and diversity of reef fish communities classified as lobster predators and non-predators in Pangandaran and Trenggalek Waters, Indonesia. Data were collected using the Stationary Visual Census method in May–June 2015. Although the dataset is ten years old, it serves as a valuable ecological baseline for assessing long-term reef fish community patterns at potential lobster restocking sites. The ratio between predator and non-predator reef fish in Pangandaran was 1:6, while in Trenggalek it was 1:9. Predatory fish diversity was higher in Pangandaran, dominated by nine species (57 individuals), whereas Trenggalek was recorded with eight species (19 individuals). Diversity and evenness indices ranged from moderate to high, with no dominant species detected. The most suitable sites for lobster restocking were identified as West and East Pananjung (Pangandaran) and Karang Gongso and North Damas (Trenggalek), which exhibited low predator abundance and high ecological stability.

INTRODUCTION

In recent years (2020–2025), Indonesia's coral reef ecosystems and lobster populations have faced escalating pressures from climate change, overexploitation, and habitat degradation **(Watt-Pringle *et al*., 2024; Ghafari, 2025)**. The loss of biodiversity and essential benthic habitats threatens the long-term sustainability of high-value fisheries, including spiny lobster (*Panulirus* spp.). While various conservation and restocking initiatives have been implemented, their overall effectiveness remains limited due to fragmented coordination and the lack of ecologically grounded monitoring systems **(Giyanto *et al*., 2023; Salayan *et al*., 2024)**.

The southern coast of Java, particularly the waters of Pangandaran and Trenggalek, represents a critical zone for lobster fisheries and seedling collection in Indonesia **(Nugraha *et al*., 2024)**. However, recent studies indicate a marked decline in lobster production driven by overfishing, juvenile harvest, and reef degradation **(Nurdin *et al*., 2023)**. With an estimated 6,782km² of potential lobster habitat across Indonesia, sustainable stock enhancement requires ecosystem-based approaches tailored to regional ecological and socioeconomic contexts **(Setyanto *et al*., 2019; Watt-Pringle *et al*., 2024)**.

Lobster restocking—defined as the release of wild-caught or hatchery-reared juveniles into natural habitats—is increasingly recognized as a viable strategy for rebuilding depleted populations. However, its success is highly dependent on habitat quality, structural complexity, and notably, predation risk from reef-associated fishes **(Goldstein *et al*., 2007; Cau *et al*., 2019)**. Effective site selection for restocking thus requires a thorough understanding of the composition and distribution of reef fish communities surrounding lobster habitats.

In this context, the terms "predator" and "non-predator" used in this study refer specifically to the trophic relationship between reef fishes and juvenile lobsters. Predator fishes are defined as species that are known to feed on crustaceans or juvenile lobsters based on established ecological literature—primarily mid-trophic carnivores such as groupers (Serranidae), snappers (Lutjanidae), and wrasses (Labridae) **(Meeren, 2000; Hixon, 2015; Brancart *et al*., 2024)**. Non-predator species, by contrast, are those that do not exhibit direct predatory behavior toward lobsters or whose trophic interactions with lobsters remain undocumented **(Mitchell *et al*., 2011; Hall, 2015)**.

Habitat characteristics for juvenile lobsters further influence restocking outcomes. Species such as *Panulirus homarus*, *P. ornatus*, and *P. versicolor* typically inhabit shallow reef zones with high structural complexity—e.g., crevices, boulder fields, seagrass beds, and mangrove roots—that offer both shelter and food resources **(Ihsan *et al*., 2019; Owu *et al*., 2020; Dining, 2025)**. Optimal conditions include depths of 10–30 meters, moderate currents, and temperatures ranging from 27–31°C, which support larval settlement and early benthic development **(Amin *et al*., 2022)**. Accordingly, predator density and habitat complexity must be assessed jointly to evaluate restocking feasibility.

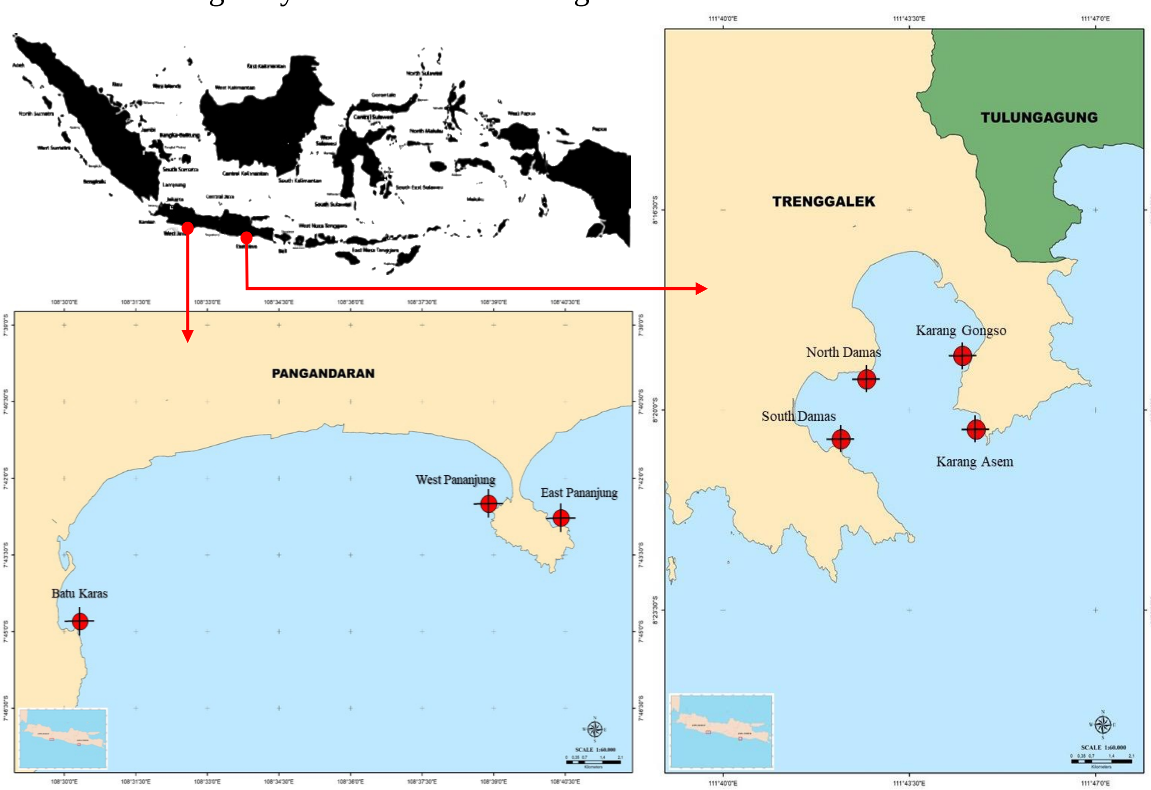
This study aims to assess the potential for lobster restocking by analyzing the composition of reef fish communities at candidate sites in Pangandaran and Trenggalek, Java. Field data were collected through stationary visual census (SVC) surveys conducted in May–June 2015. While the dataset is over a decade old, recent ecological assessments confirm that the reef conditions at these sites have remained relatively stable, allowing this dataset to serve as a reliable ecological baseline **(Koepper *et al*., 2022; Boudreau & Hanley, 2023)**. Understanding historical ecological patterns is essential for guiding adaptive management in dynamically changing marine systems.

Specifically, this study aims to analyze the composition and spatial distribution of reef fish communities at selected sites, classify reef fish species into predator and non-predator groups based on their feeding ecology, and identify locations with low predator abundance and favorable habitat conditions for potential restocking. By integrating taxonomy, trophic ecology, and spatial analysis, this study provides a science-based assessment of lobster restocking potential, contributing to evidence-based marine resource management in Indonesia.

MATERIALS AND METHODS

1. Study area

This study was conducted in May–June 2015 at three observation stations in Pangandaran, West Java (Batu Karas, West Pananjung, East Pananjung), and four stations in Trenggalek, East Java (North Damas, South Damas, Karang Gongso, and Karang Asem). Site selection was based on consultations with local stakeholders, historical lobster presence, and ecological conditions, particularly coral reef structure and substrate complexity. These locations represent key areas for lobster seedling fisheries and are considered ecologically suitable for restocking interventions.



(a) Pangandaran, West Java **(b) Trenggalek, East Java**

Fig. 1. Research stations in Pangandaran, East Java and Trenggalek, West Java

2. Habitat characteristics of lobsters and juveniles

Juvenile lobsters of the genus *Panulirus* typically inhabit shallow reef zones characterized by structurally complex substrates, including creviced rocks, coral rubble, seagrass beds, and mangrove roots. These environments provide both shelters from predators and access to benthic food sources. Optimal environmental conditions include depths of 10–30 meters, seawater temperatures of 27–31°C, salinity between 30–34 psu, and moderate current flows of 0.1– 0.2m/ s **(Owu *et al*., 2020; Amin *et al*., 2022)**. In the study areas, the substrate consists of mixed sand, coral fragments, and dead reef structures, with locations such as West Pananjung and Karang Gongso exhibiting higher structural complexity, offering increased shelter for juvenile lobsters.

3. Data collection

Reef fish data were collected using the *Stationary Visual Census* (SVC) method, a non-destructive survey technique suitable for shallow reef ecosystems **(Sherman *et al*., 2002)**. Certified divers conducted observations within a fixed-radius area at depths ranging from 5 to 20 meters, recording all visible fish within approximately 10-minute intervals. Fish species were identified to the lowest possible taxonomic level using the referencial guidance of **Allen and Adrim (2003)**, and categorized according to their ecological role.

Data analysis of species distribution was conducted through the evaluation of composition, abundance, species diversity, evenness, and dominance as ecological indicators to assess the feasibility of lobster restocking locations. The spatial distribution of reef fish species identified as potential lobster predators was further analyzed using Geographic Information Systems (GIS).

As stated by **Hillary *et al*. (2021)**, GIS is a valuable tool for integrating multiple ecological criteria across both spatial and temporal scales. In this study, GIS software (ArcGIS Desktop 10.8.2; ESRI Authorization Number: ESU238733964) was used to process and visualize the spatial patterns of different functional fish groups. Functional groupings were classified into three ecological categories: (a) major fish species, (b) target fish species, and (c) indicator species. These groups were used to characterize environmental conditions across observation stations in Pangandaran and Trenggalek waters. The data for each group were spatially mapped, transformed into raster formats, and interpolated using the inverse distance weighted (IDW) method and distance-based spatial analysis, following the approach described by **Radiarta and Erlania (2015)**. This allowed for the visualization of predator hotspots and identification of areas with low predation risk, which are essential for determining suitable sites for lobster restocking.

Table 1. The geographical position of sampling sites

Region	Research stations		Coordinates		Reef condition coverage
			East Longitude	Southern Latitude	
Pangandaran, West Java	1.	Batu Karas	7.748917	108.504750	low*)
	2.	Pananjung Barat	7.707722	108.648944	low*)
	3.	Pananjung Timur	7.712639	108.672500	low*)
Trenggalek, East Java	4.	Damas Utara	8.323695	111.709694	low**)
	5.	Karang Gongso	8.320917	111.741389	low**)
	6.	Karang Asem	8.337389	111.746667	low**)
	7.	Damas Selatan	8.342472	111.702694	low**)

Note: *), **) Preliminary survey results (2015).

4. Classification of predator and non-predator fish

Fish species were classified into predator and non-predator groups based on their feeding ecology and trophic behavior. Predator species were defined as those with documented feeding habits involving crustaceans or juvenile lobsters, including groupers (Serranidae), snappers (Lutjanidae), and wrasses (Labridae) **(Meeren, 2000; Hixon, 2015; Brancart *et al*., 2024)**. Non-predators included herbivorous, detritivorous, and planktivorous species that show no known direct predation on lobsters **(Mitchell *et al*., 2011)**. A classification table of predator species and their dietary traits was compiled from verified literature sources to ensure accurate grouping.

5. Data analysis

Species diversity (H') was calculated using the Shannon-Wiener index, while evenness (E) and dominance (D) were derived using Pielou’s evenness index and Sanders’ dominance formula, respectively **(Sanders *et al*., 1995)**. Spatial analysis was conducted using ArcGIS 10.8.2 with inverse distance weighting (IDW) interpolation to map predator fish distribution and identify spatial trends. These spatial patterns served as key indicators of habitat suitability for juvenile lobster restocking.

Additional habitat characteristics such as coral cover, substrate type, and availability of shelter were recorded during field observations and supported by secondary data sources, including recent coral reef monitoring reports **(Sri Turni & Arip, 2016; Mujiyanto *et al*., 2024)**.

6. Data validity and limitations

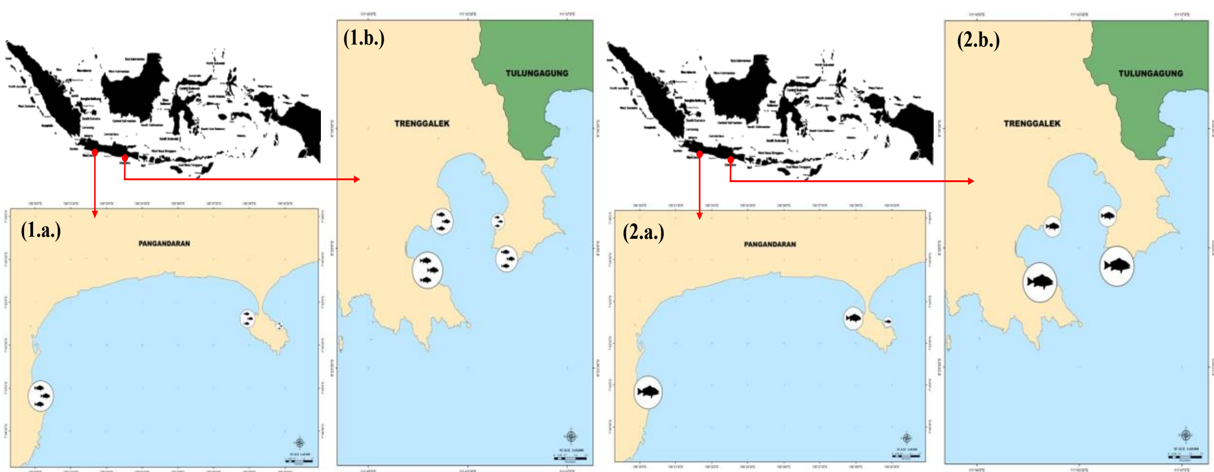
Although the primary data were collected in 2015, recent ecological assessments have confirmed that the reef conditions in Pangandaran and Trenggalek have remained relatively stable, with minimal anthropogenic or environmental changes affecting the reef fish community structure **(Koepper *et al*., 2022; Boudreau & Hanley, 2023)**. Therefore, the dataset remains a valid ecological baseline for evaluating long-term trends and informing adaptive restocking strategies. Nevertheless, this study acknowledges that the absence of more recent field surveys constitutes a key limitation. Follow-up monitoring is recommended prior to restocking implementation to validate site conditions under current environmental scenarios.

RESULTS

1. Species composition of reef fish communities

Visual surveys identified a total of 65 reef fish species from 38 genera and 17 families in Pangandaran, and 83 species from 29 families in Trenggalek. In Pangandaran, three families were classified as predators and 14 as non-predators, resulting in a predator-to-non-predator ratio of 1:6. In Trenggalek, 10 predator families and 18 non-predator families were recorded, yielding a ratio of 1:9. The lower predator ratio in Trenggalek suggests reduced ecological predation pressure on juvenile lobsters in comparison to Pangandaran.

The most dominant predator species in Pangandaran was *Naso annulatus*, while *Scolopsis affinis* dominated in Trenggalek. Most predator species were from Serranidae (groupers), Lutjanidae (snappers), and Nemipteridae, all of which have documented feeding behaviors involving crustaceans and juvenile lobsters. A detailed list of predator species and their distribution across sites is presented in Table (2), and visualized in Fig. (2).



(1) number of reef fishes species (2) Presence of reef fishes

Fig. 2. Fish predators' distribution based on species number (1) and fish presence (2)

Table 2. Predatory reef fish species found in coastal waters of Pangandaran and Trenggalek

	Family	Species	Locations	
			Pangandaran	Trenggalek
1.	Armadillidae	*Pericephalus* sp.	-	+
2.	Blastidae	*Balistoides conspiculum*	-	+
		Balistoides viridescens	+	-
		Melichthys niger	+	-
		Naso annulatus	+	-
		Naso thynnoides	+	-
		Sufflamen bursa	+	-
		Suflamen chrysopterus	+	-
3.	Bothidae	*Asterorhombus intermedius*	-	+
		Samariscus triocellatus	-	+
4.	Cottidae	*Myoxocephalus octodecemspinosus*	-	+
		Myoxocephalus scorpius	-	+
5.	Lutjanidae	*Lutjanus fulvus*	+	-
		Lutjanus kasmira	+	+
		Lutjanus quinquelineatus	-	+
		Lutjanus vitta	+	-
6.	Nemipteridae	*Scolopsis affinis*	-	+
		Scolopsis taeniopterus	-	+
7.	Ocypodidae	*Uca (Minuca) pugnax*	-	+
8.	Serranidae	*Cephalopholis boenack*	+	-
		Cephalopholis cyanostigma	+	-
		Epinephelus fasciatus	+	-
		Epinephelus quoyanus	+	-
		Plectranthias nanus	-	+
9.	Strongylocentrotidae	*Strongylocentrotus franciscanus*	-	+
10.	Uranoscopidae	*Uranoscopus sulphureus*	-	+
11.	Uropterygiinae	*Uropterygius fasciolatus*	-	+

2. Abundance and ecological indices

Non-predatory species dominated both regions in terms of abundance. In Pangandaran, *Thalassoma lunare* (Labridae) was the most abundant non-predator at 2.00 ind/m³, while *Naso annulatus* was the most abundant predator (1.20 ind/m³). In Trenggalek, *Dascyllus auripinnis* (Pomacentridae) recorded the highest abundance among non-predators at 9.60 ind/m³, followed by *Scolopsis affinis* (Nemipteridae) as the dominant predator at 1.28 ind/m³.

Species diversity (H') ranged from 2.57 to 3.37 in Pangandaran and from 2.79 to 3.47 in Trenggalek, indicating moderate to high diversity levels. Evenness (E) values exceeded 0.80 across all stations, suggesting a well-balanced distribution of individuals among species. Dominance index (D) values remained low (<0.15), reflecting the absence of any dominant species and a stable community structure.

Table 3. Ecological index of reef fish based on visual census data

Ecological Index	Research Stations	
	Pangandaran, West Java	Trenggalek, East Java
Diversity index (H’)	2.57 to 3.37	2.79 to 3.47
Uniformity index (E)	0.81 to 0.87	0.93 to 0.97
Dominance index (D)	0.05 to 0.13	0.03 to 0.07

3. Habitat complexity and physical structure

Field observations and secondary data revealed that most study sites had low to moderate coral cover (20–45%), with mixed substrates including sand, rubble, and coral rock. Structurally complex habitats were concentrated in West and East Pananjung (Pangandaran), as well as Karang Gongso and North Damas (Trenggalek), where the presence of crevices, boulders, and dead coral formations provided effective shelter for juvenile lobsters.

In contrast, Karang Asem and South Damas in Trenggalek featured more open, sandy substrates with sparse coral heads, leading to greater exposure of juvenile lobsters to predators. These differences in habitat structure directly affect the suitability of sites for restocking efforts.

4. Functional Group Distribution

Reef fish species were classified into three functional ecological groups: major species, target species, and indicator species. In Pangandaran, major fish accounted for 43.43% of total species, target species 21.21%, and indicator species 35.36%. A similar pattern was observed in Trenggalek, although the proportion of predator species was significantly lower.

Functional group conversion revealed that predator species comprised 23.37% of the total reef fish community in Pangandaran, and 9.94% in Trenggalek. This further supports the conclusion that ecological predation pressure on juvenile lobsters is considerably lower in Trenggalek waters.

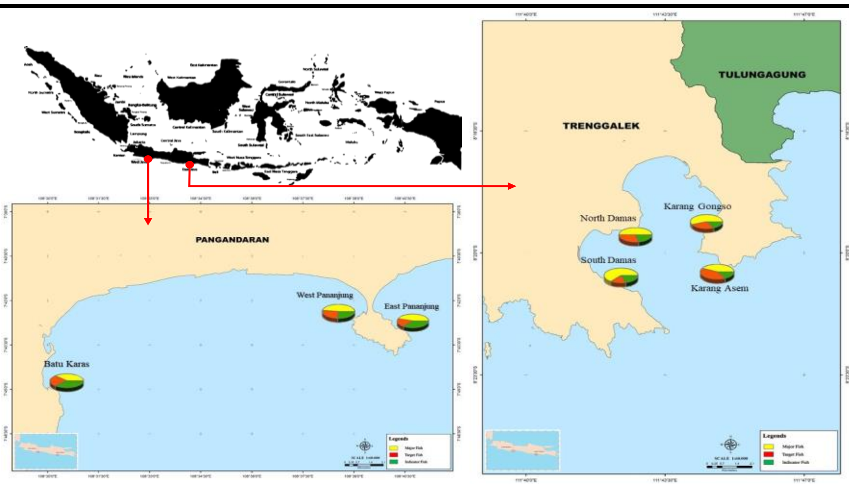


Fig. 3. Fish species distribution number of each group at candidate lobster restocking sites

5. Spatial analysis and identification of priority restocking sites

Spatial analysis was performed using ArcGIS 10.8.2 with inverse distance weighted (IDW) interpolation and proximity analysis. Reef fish data from each observation point were converted into raster format, allowing for the visualization of predator density and habitat suitability across study sites.

The results showed that West and East Pananjung (Pangandaran), and Karang Gongso and North Damas (Trenggalek) exhibited both low predator abundance and high structural habitat complexity—making them the most favorable sites for lobster restocking. In contrast, areas such as South Damas and Karang Asem presented high predator densities and lacked suitable shelter, making them less optimal for restocking initiatives.

DISCUSSION

The outcomes of this study demonstrate distinct reef fish community compositions in Pangandaran and Trenggalek, particularly in terms of predator and non-predator fish groups, which are essential for assessing the ecological feasibility of lobster restocking. With a predator-to-non-predator ratio of 1:9, Trenggalek presents significantly lower ecological predation pressure compared to Pangandaran (1:6), making it a more favorable site for the restocking of juvenile lobsters.

Non-predatory species dominated both regions in terms of abundance. In Pangandaran, *Thalassoma lunare* (Labridae) was the most abundant non-predator at 2.00 ind/m^3, while *Naso annulatus* was the most abundant predator (1.20 ind/m^3). In Trenggalek, *Dascyllus auripinnis* (Pomacentridae) recorded the highest abundance among non-predators at 9.60 ind/m^3, followed by *Scolopsis affinis* (Nemipteridae) as the dominant predator at 1.28 ind/m^3. Species diversity (H’) ranged from 2.57 to 3.37 in Pangandaran and from 2.79 to 3.47 in Trenggalek, indicating moderate to high diversity levels. Evenness (E) values exceeded 0.80 across all stations, suggesting a well-balanced distribution of individuals among species. Dominance index (D) values remained low (<0.15), reflecting the absence of any dominant species and a stable community structure.

Diversity and community structure comparisons from other regions reinforce these findings. In Trenggalek, the reef fish community is characterized by high species diversity (H' = 2.79–3.47) and evenness (E > 0.80), indicating a balanced community structure. The low dominance index (D < 0.15) suggests minimal species monopolization, supporting ecological stability **(Wibowo & Adrim, 2013)**. Comparable diversity indices have also been reported in the waters of Ulee Kareung, where species diversity (H') ranges from 2.80 to 3.16 and evenness values span 0.79 to 0.88, further supporting the presence of a well-balanced and stable reef fish community **(Putra *et al*., 2022)**. In Kendari, the diversity index ranges from 1.36 to 3.23, with low dominance, also indicating a stable structure with 111 species across 24 families **(Adrim *et al.*, 2012)**. Paraja Bay exhibits high evenness (0.93–0.98) and low dominance, showing strong species uniformity and stability **(Mujiyanto *et al*., 2021)**.

Lobster restocking is a strategy to rehabilitate depleted stocks due to overexploitation and habitat degradation. As shown in previous studies **(Nurfiarini *et al*., 2016)**, site selection based on ecological indicators such as predator density is crucial. Lower predator abundance is associated with higher survival rates of restocked juveniles. The presence of predatory fish, such as the queen triggerfish, has been shown to significantly reduce the survival of other reef invertebrates like *Diadema antillarum*, indicating that similar risks exist for juvenile lobsters **(Hereu *et al*., 2005; Leitão *et al*., 2008)**.

The relationship between predator abundance and juvenile survival is a critical aspect of marine ecology, particularly in the context of habitat restoration. Structural habitat enhancements, such as increased complexity, can provide refuges that reduce predation and increase survival **(Edeline *et al*., 2025)**. For example, juvenile red snapper abundance increased in habitats with greater complexity and predator exclusion **(Erisman *et al*., 2020)**, and similar results have been observed in sea urchins in algal habitats **(Kelly *et al.*, 2024)**.

Restoration efforts that enhance habitat complexity can lead to increased prey diversity and abundance by reducing predation pressure **(Chang & Todd, 2023)**. Habitat modifications should consider predator-prey dynamics to ensure effective outcomes **(Lennox *et al*., 2025)**. However, responses may vary; in some systems, complexity stabilizes interactions, while in others it may reduce energy transfer **(Mazzarisi & Smerlak, 2024)**. Predators may even enhance prey growth by lowering intra-species competition, necessitating context-specific management **(Mazzarisi & Smerlak, 2024)**.

Rearing conditions during early development significantly influence juvenile behavior and survival. Access to shelters increases activity and reduces aggression, while exposure to predator cues results in smaller carapace size and behavioral changes, suggesting that preconditioning juveniles in structured habitats may enhance post-release survival **(Polverino *et al.*, 2025)**. The importance of habitat structure is also highlighted by studies showing that substrates such as seagrass and mud flats improve lobster settlement and survival **(Romero-Torres *et al*., 2017; Dinning & Rochette, 2019)**. Furthermore, reef rugosity and benthic condition significantly influence fish biomass, trophic levels, and assemblage patterns, particularly in families like Epinephelidae and Chaetodontidae **(Samoilys *et al*., 2025)**.

Habitat complexity and ecological stability across Indonesian reefs also show strong correlation. For instance, Sekotong Bay's seagrass and mangrove systems enhance resilience by offering feeding and breeding niches **(Joyosemito & Nasir, 2021; Fitrianti, 2025)**. On Sangiang Island, habitat complexity strongly correlates with fish abundance **(Hidayatullah *et al*., 2020)**. Lombok's diverse reef fish communities promote tourism and economic value while sustaining ecological health **(Irawan & Hariadi, 2019)**. Sempu Strait also illustrates the importance of monitoring, showing that diversity and evenness can be maintained despite anthropogenic pressure **(Bintoro *et al*., 2023)**.

Significant gaps remain in Indonesia's MPA management plans, where destructive fishing and climate change are frequently identified as primary threats, yet local stressors such as sedimentation, eutrophication, and anchoring are often underrepresented in zoning and action frameworks. Only a few MPAs, including Kaimana and Laut Sawu, have fully integrated stressor management across all planning stages **(Capriati *et al.*, 2025)**.

Significant gaps remain in Indonesia's MPA management plans. While destructive fishing and climate change are commonly identified threats, specific local stressors such as sedimentation, eutrophication, or anchoring are often underrepresented in zoning and action sections. Only a few MPAs, such as Kaimana and Laut Sawu, fully integrate stressor management across planning stages **(Capriati *et al*., 2025)**.

Predator species composition also contributes to understanding ecological risks. In Pangandaran, the most dominant predator species was *Naso annulatus*, while *Scolopsis affinis* dominated in Trenggalek. Most predatory fish identified belong to the Serranidae (groupers), Lutjanidae (snappers), and Nemipteridae families—all known to feed on crustaceans, including juvenile lobsters. A detailed inventory of these species is provided in Table (2) and visualized in Fig. (2). Their distribution reinforces the conclusion that Trenggalek hosts a lower density and diversity of potential lobster predators compared to Pangandaran.

Spatial analysis using ArcGIS IDW interpolation further supports this conclusion. The mapping of predator densities and habitat complexity revealed that areas such as West and East Pananjung (Pangandaran) and Karang Gongso and North Damas (Trenggalek) exhibited both low predator abundance and high structural habitat complexity. These conditions make them the most favorable sites for lobster restocking. Conversely, South Damas and Karang Asem were characterized by high predator density and open, sandy substrates with limited shelter, increasing juvenile exposure to predation and reducing restocking viability.

Furthermore, functional ecological group classification revealed that predator species comprised 23.37% of the total reef fish community in Pangandaran, and only 9.94% in Trenggalek, highlighting the reduced predation pressure in Trenggalek.

Therefore, integrated assessments are needed, combining ecological (predator density, benthic structure) and social factors (community support, enforcement) **(Nurfiarini *et al*., 2016)**. Post-restocking monitoring of predator-prey interactions is also essential, including non-consumptive effects such as altered behavior **(Mitchell & Harborne, 2020)**. Habitat enhancement, artificial refuges, and coral restoration are viable adaptive strategies **(Williams *et al*., 2022; Lennox *et al*., 2025)**.

Practical recommendations include: Habitat pre-assessment before restocking to evaluate both predator presence and structural features; the use of shelters or complex substrates in hatcheries to condition behavioral resilience; timing and site selection based on predator mapping and updated field surveys; post-release monitoring of juvenile behavior and survival in relation to predator activity; and long-term community-based management including habitat restoration and regulation enforcement **(Polverino, 2025)**.

Overall, Trenggalek—with its lower predator ratio, high diversity, and ecological balance—emerges as a strong candidate for integrated restocking initiatives. Pangandaran, though ecologically more complex, offers opportunities for targeted habitat enhancement and monitoring strategies. Both locations underscore the importance of integrating biological, structural, and social dimensions into marine conservation and restocking programs.

CONCLUSION

This study concludes that Trenggalek presents a more ecologically suitable environment for juvenile lobster restocking compared to Pangandaran, due to its lower predator density, higher species diversity, balanced community structure, and greater habitat complexity. Spatial and ecological analyses identified specific zones—such as Karang Gongso and North Damas—as optimal release sites, highlighting the importance of predator mapping and structural habitat assessment. Successful restocking efforts require an integrated approach, including ecological evaluation, habitat enhancement, behavioral preconditioning, and targeted management of local stressors. These findings support the use of site-specific, data-driven strategies to improve restocking outcomes and to promote sustainable marine resource management.

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