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The Assemblage of Carnivore Fish Composition (Lutjanidae, Lethrinidae, Haemulidae and Serranidae) of a Thousand Islands, Jakarta, Indonesia

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Abstract. The pivotal contribution of the Lutjanidae, Lethrinidae, and Serranidae families to coral reef ecosystems, coupled with their significance as targets for fishing activities, underscores the importance of understanding their presence and population dynamics in formulating effective coastal management policies. Employing the Underwater Visual Census (UVC) method, we conducted a carnivorous fish study at 14 station locations in the Thousand Islands. This group exhibited a diverse array of 17 species distributed across four families (Haemulidae, Lethrinidae, Lutjanidae, and Serranidae). Notably, *Cephalopolis micropion* emerged as the predominant carnivorous species, constituting 48.35% of the relative frequency. Site location KSBC.14 (Pari Island) displayed the highest diversity and abundance of carnivorous fish species, with 11 species and 1457 individuals per hectare (Ind./ha). KSBC.12 (Pramuka Island) also have highest abundance and additionally recorded the highest carnivorous fish biomass at 188.43 kg/ha. These findings provide valuable insights into the ecological dynamics of carnivorous fish populations, informing conservation and management strategies in coral reef ecosystems.

1 Introduction

The families Lutjanidae, Lethrinidae, Haemulidae, and Serranidae comprise carnivorous fish species that are commonly inhabiting coral reef lagoons and adjacent regions [1,2]. Within coral reef ecosystems, carnivorous reef fish assume pivotal roles and are recognized as predatory entities. The structuring of coral reef fish assemblages is substantially influenced by predators, including carnivorous reef fish [3]. These piscine taxa predominantly feed on crustaceans, fish, and mollusks, according to Kulbicki et al. (2005) [1]. The families Lutjanidae, Lethrinidae, and Serranidae notably contribute to the prevalence of carnivorous fish in coral reef lagoons, and they are frequently targeted by fishermen [2]. According to Tavera et al. (2012) [4] established relationships between the families Lutjanidae and Haemulidae with Sparidae and Lethrinidae, respectively. Furthermore, carnivorous reef fish

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actively participate in shaping the trophic structure of coral reef ecosystems. Alterations in the abundance or behavior of these carnivorous reef fish can wield substantial impacts on the trophic dynamics within coral reef ecosystems [3]

Numerous prior investigations have elucidated the pivotal ecological roles played by Lutjanidae, Lethrinidae, Haemulidae, and Serranidae within coral reef ecosystems. These fishes, identified as significant predators in coral reef environments, exhibit a diverse dietary repertoire encompassing crustaceans, fish, and mollusks [5–7]. Their ecological significance extends to regulating prey populations, thereby contributing to the equilibrium of the coral reef food web [8]. Certain species within Lutjanidae, Lethrinidae, and Haemulidae exhibit foraging behavior in proximate seagrass beds or sandy areas adjacent to reefs, fostering habitat connectivity and bolstering ecosystem resilience [9]. The biomass of these families, particularly in the Western Indian Ocean, emerges as a valuable metric for gauging coral reef fish abundance [10]. The ecological dynamics of these fishes are intricately influenced by historical, environmental, ecological, and anthropogenic factors [11].

Significantly, the population of carnivorous reef fishes has witnessed a noteworthy decline, with overfishing emerging as a conspicuous threat to both these fishes and the coral reef ecosystems they inhabit. Overfishing poses the risk of depleting key reef species and causing harm to coral habitats, resulting in the reduction of vital reef species across various locations [12]. The repercussions of overfishing extend to the biomass of coral reef ecosystems, particularly impacting large fish and scraping grazers, which serve as indicators of ecosystem health [13]. A comprehensive understanding of the composition of carnivorous reef fish communities assumes paramount importance, particularly in fostering the well-being of coral reefs for preservation and restoration efforts [14].

Thousand Islands consists of a series of 105 small (under 10 ha) and very low-lying (under 3 meters above sea level) islands [15], about 80 km from the north coast of the city [16]. Administratively included in the Jakarta area and directly adjacent to Banten Province. The status and designation of seawater areas are mostly included in the conservation area of the Thousand Islands National Park [17], some areas are national shipping lanes and others are managed by the local government as marine protection areas with general use. Some islands are unpopulated islands and other populated islands with a total population of around 22,700 people, the island chain is densely populated 65% of the people live on the four main islands Panggang, Pramuka, Kelapa and Harapan [16]. Several islands has private ownership are managed as resorts and exclusive residences. Large areas of reef flat and coral reefs are utilized for aquaculture and seaweed farming. The development of the Thousand Islands coral reefs is influenced by various environmental factors and anthropogenic pressures have caused dramatic changes in coral reef ecosystems [18]. The intensified land use and developmental activities, in conjunction with the dense coastal population residing along the Jakarta and northern Java coastlines, engender environmental repercussions such as pollution, sedimentation, and heightened nutrient levels in aquatic environments culminating in eutrophication, with discernible implications for the well-being of coral reefs.

Monitoring results during 2004-2005 showed an increasing trend of moderate conditions, with an average live coral cover of 32.95 (2004) and 33.2% (2005) [19]. Another report showed that the Thousand Islands coral reefs were severely affected by coral bleaching in the year and the impact on mortality. Increased nutrients from various human activities from the mainland of Jakarta and surrounding areas through 6 major river estuaries increased the growth of coral competitor algae and increased disease infections in corals. Pollution, especially from marine debris and oil spills, has an impact on ecosystems along the coast of the small islands of Thousand Islands, including coral reef ecosystems. Another impact is from tourism activities that have continued to increase since the beginning of 2000, which do not consider the limited carrying capacity of small islands. Anthropogenic pressure in the Thousand Islands has also resulted in changes in coral reef fish composition, especially carnivorous fish, so it is very important to know the composition of coral reef fish in the Thousand Islands,

2 Materials and Methods

2.1 Sites Location

The research location of carnivorous fish (Lutjanidae, Lethrinidae, Haemulidae, Serranidae) was conducted at 14 station locations in the Thousand Islands, DKI Jakarta. The following are the details of the research locations of reef fish in Thousand Islands, Jakarta presented in Table 1.

Table 1. Sites Location

No	Location	Sites	Longitude	Latitude
1	Peteloran Barat Island	KSBC.01	-5º27’47.52 (N)	106º32’47.76 (E)
2	Penjaliran Barat Island	KSBC.02	-5º27’46.80 (N)	106º33’06.84 (E)
3	Sebaru Besar Island	KSBC.03	-5º30’21.96 (N)	106º32’31.20 (E)
4	Melinjo Island	KSBC.04	-5º34’11.28 (N)	106º32’34.08 (E)
5	Genteng Besar Island	KSBC.05	-5º36’49.32 (N)	106º33’02.16 (E)
6	Bira Besar Island	KSBC.06	-5º36’54.36 (N)	106º34’40.44 (E)
7	Kayuangin Genteng Island	KSBC.07	-5º37’08.04 (N)	106º33’47.52 (E)
8	Belanda Island	KSBC.08	-5º36’11.88 (N)	106º36’19.80 (E)
9	Pamegaran Island (east)	KSBC.09	-5º38’09.24 (N)	106º36’15.48 (E)
10	Pamegaran Island (south)	KSBC.10	-5º38’20.04 (N)	106º35’27.24 (E)
11	Karya Island	KSBC.11	-5º38’20.04 (N)	106º35’27.24 (E)
12	Pramuka Island	KSBC.12	-5º43’55.20 (N)	106º36’12.60 (E)
13	Payung Island	KSBC.13	-5º49’03.72 (N)	106º35’45.60 (E)
14	Pari Island	KSBC.14	-5º51’04.68 (N)	106º35’45.72 (E)

2.2 Assemblages Carnivore Fish Data Collection

The research of carnivore reef fish biodiversity is conducted through the application of the Underwater Visual Census (UVC) method, originally developed by English in 1994. This globally utilized method extends beyond coral reef fish research and monitoring, demonstrating efficacy in surveilling a diverse range of marine organisms. The versatility of UVC renders it instrumental in coral reef health monitoring programs, thereby facilitating informed management and conservation decisions [20]. The preference for employing the Underwater Visual Census method in reef fish biodiversity monitoring is attributed to its cost-effectiveness, non-destructive nature, and environmental compatibility. This method emerges as particularly ideal for monitoring coral reef ecosystems in designated areas such as Marine Protected Areas (MPAs), Conservation Areas, and sites associated with Underwater Eco-tourism. The widespread application of UVC is instrumental in supporting decision-making processes within management and conservation programs [21–24].

The application of the Underwater Visual Census (UVC) method utilizing Belt Transect adhered to the prescribed protocols of the Reef Health Monitoring Program [25]. For coral reef fish biodiversity monitoring, the Belt Transect employed possessed a length of 70 meters and a lateral observation width of 5 meters (2.5 meters on the left side and 2.5 meters on the right side), resulting in a total monitoring area of 350 m^2. Following the procedures of the Reef Health Monitoring Program, the recorded reef fish groups were categorized into Carnivorous. The Carnivorous fish group comprised four recorded fish tribes, including Haemulidae (Sweetlips), Lethrinidae (Emperors), Lutjanidae (Snapper), and Serranidae (Groupers). The inclusion of carnivorous fish groups in the Reef Health Monitoring (RHM) protocol is motivated by their ecological role in preserving ecosystem equilibrium through the regulation of fish groups occupying lower trophic levels [26]. Additionally, these carnivorous fish are of particular interest to fishermen due to their status as target species, contributing significantly to food security [27,28].

2.3 Data Analysis

Following the fundamental guidelines of the Reef Health Monitoring Program [25,29]. The acquired reef fish data will undergo comprehensive analysis encompassing assessments of species diversity, density/abundance, estimation of fish weight derived from length (length-weight relationship), and the determination of reef fish biomass. These analyses, integral to the field of Ecology, constitute foundational methods for measuring populations and communities of reef fish within a coral reef ecosystem [24]. Several ecological indices were also used in data analysis including Shannon's diversity index (H), Evenness uniformity index (J) and Simpson's Dominance Index (D).

3 Result and Discussion

3.1 Carnivore Fishes Species in Thousand Island

Table 2. Carnivore Reef Fish in Thousand Island

No	Species	Family	IUCN	CITES	Relative Frequency (%)
1	*Plectorhinchus chaetodonoides*	Haemulidae	NE	NE	2.03
2	*Plectorhinchus vittatus*	Haemulidae	LC	NE	1.01
3	*Lethrinus erythropterus*	Lethrinidae	LC	NE	2.53
4	*Lethrinus harak*	Lethrinidae	LC	NE	2.28
5	*Lethrinus ornatus*	Lethrinidae	LC	NE	2.28
6	*Lutjanus biguttatus*	Lutjanidae	LC	NE	2.03
7	*Lutjanus bohar*	Lutjanidae	LC	NE	0.25
8	*Lutjanus carponotatus*	Lutjanidae	LC	NE	2.03
9	*Lutjanus decussatus*	Lutjanidae	LC	NE	10.63
10	*Lutjanus fulviflamma*	Lutjanidae	LC	NE	7.85
11	*Cephalopholis cyanostigma*	Serranidae	LC	NE	4.30
12	*Cephalopholis boenak*	Serranidae	LC	NE	6.58
13	*Cephalopholis microprion*	Serranidae	LC	NE	48.35
14	*Diploprion bifasciatum*	Serranidae	LC	NE	0.25
15	*Epinephelus fasciatus*	Serranidae	LC	NE	5.82
16	*Epinephelus merra*	Serranidae	LC	NE	0.51
17	*Epinephelus ongus*	Serranidae	LC	NE	1.27

In the context of the visual census of coral reef fish within the Thousand Islands, Jakarta, the carnivorous fish group exhibited a diversity of 17 species distributed across four distinct fish families (Haemulidae, Lethrinidae, Lutjanidae, and Serranidae) (Table 2). The Haemulidae family, representing a singular genus, Plectorhinchus, manifested as comprising two distinct Haemulidae fish species. Within the Lethrinidae family, the genus Lethrinus was identified, encompassing three distinct fish species. The Lutjanidae family, represented by the Lutjanus genus, comprised five species of Lutjanidae fish. The Serranidae family displayed three genera, including Cephalopolis with three fish species, the Diploprion genus hosting a single Serranidae fish species, and the Epinephelus genus consisting of three Serranidae fish species. Notably, *Cephalopolis micropion* emerged as the carnivorous fish species with the highest relatively frequency of 48.35%. The majority of carnivorous fish identified within the Thousand Islands fall within the Least Concern (LE) classification according to the International Union for Conservation of Nature (IUCN). A solitary species, *Plectorhinchus chaetodonoides,* remains Not Evaluated (NE) within the IUCN framework.

Our results found that *Cephalopolis micropion* was the most common fish found in the Thousand Islands. *Cephalopholis microprion*, commonly referred to as Freckled hind, is a carnivorous fish species commonly found in shallow waters, usually occupying muddy reefs, mid-lagoon and backreef zones, where most of the coral reef conditions in the Thousand Islands have very suitable conditions for *Cephalopholis microprion.* Previous studies shown *Cephalopholis microprion* is an important species for fisheries in some areas [30]. Understanding the composition and abundance of *Cephalopholis microprion* and other reef fish species is important for the protection and restoration of coral reefs [31]. In addition to the snapper family Lutjanidae, *Lutjanus decussatus* is a species of marine ray-finned fish belonging to the family Lutjanidae that is often found in the Thousand Islands. Lutjanus decussatus, also known as the checkered snapper. The presence of *Lutjanus decussatus* in the Thousand Islands is also supported by several previous studies that *Lutjanus decussatus* constitutes a Lutjanid species with a broad distribution across the western Pacific and eastern Indian Ocean [32]. Although *Lutjanus decussatus* is prevalent in the Thousand Islands, observations from local fishermen suggest a diminishing population, evidenced by declining catch rates. The decline in the population of this fish species may be attributable to multifaceted factors, encompassing overfishing, habitat degradation, or inadequacies in management strategies [33]

3.2 Carnivore Fishes Species in Thousand Island

Within the Thousand Island, site location for KSBC.12 (Pramuka Island) and KSBC.14 (Pari Island) exhibit the utmost diversity in carnivorous fish species, encompassing 11 species. Conversely, station KSBC.10 (South Pamegaran Island) demonstrates the least number of carnivorous fish species, with total species of 3 species. Analysis of abundance reveals that site location KSBC.14 (Pari Island) presents the highest carnivorous fish abundance, quantified at 1457 (Ind./ha) (Figure 15). In contrast, stations KSBC.03 (Sebaru Besar Island) and KSBC.10 (South Pamegaran Island) record the lowest carnivorous fish abundance, each the total abundance 429 Ind./ha. Moreover, site location KSBC.12 (Pramuka Island) showcases the highest carnivorous fish biomass, amounting to 188.43 kilograms per hectare (kg/ha). Conversely, the lowest carnivorous fish biomass is observed at site location KSBC.02 (Penjaliran Barat Island) of 58.56 kg/ha.

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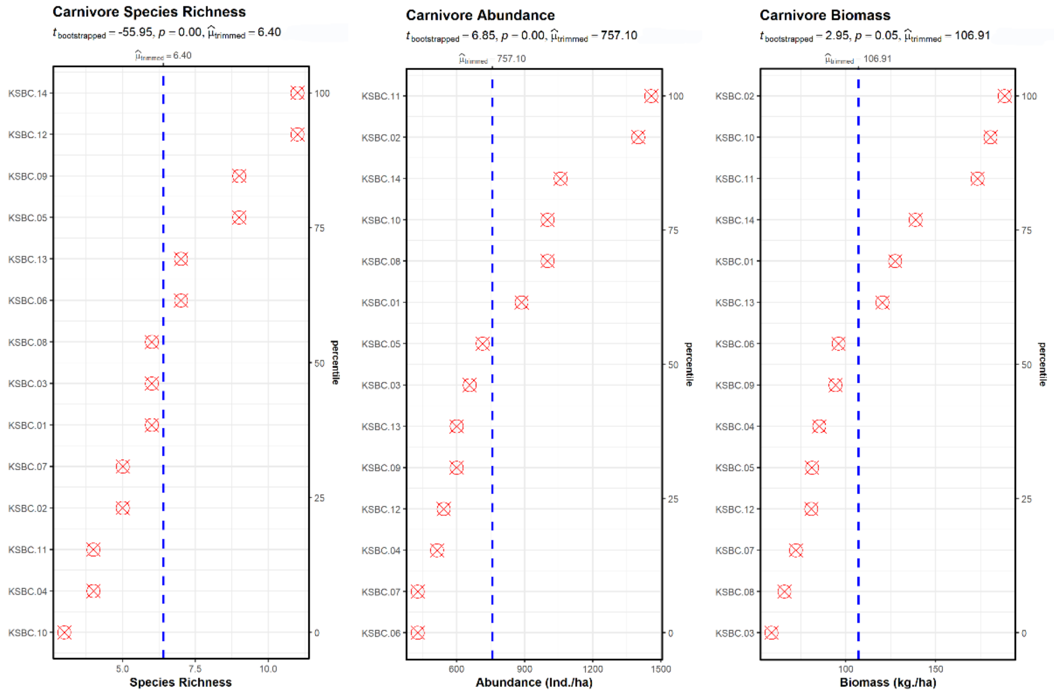

Fig. 1. Species Richness, Abundance and Biomass Carnivore Fish in each Site Location Thousand Island, Jakarta

Our findings indicate that Pari Island and Pramuka Island exhibit a heightened composition of carnivorous fish in comparison to other islands within the Thousand Islands. This observation aligns with previous research, which demonstrated the highest fish diversity, as measured by the Shannon biodiversity index, at Pari North within the midshore zone [34], The substantial composition observed is substantiated by the good state of the coral reefs in that particular location [34]. Our findings demonstrate that, despite their proximity to Jakarta, Pari Island and Pramuka Island exhibit superior diversity, abundance, and biomass composition compared to islands situated farther from Jakarta. The comparatively favorable reef condition at Pari Island, particularly in contrast to sites situated to the north, may be regarded as an indicator suggesting that water masses originating from Jakarta have a limited impact on the offshore reefs of the Thousand Islands location [34].

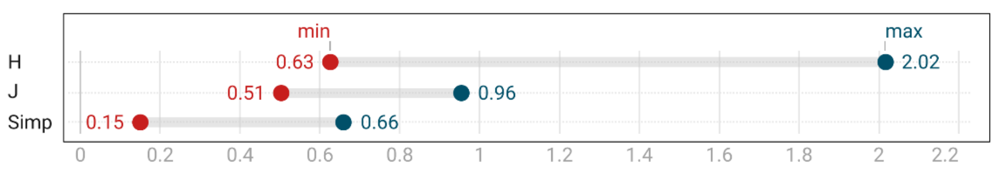

Fig. 2. Several Ecological Indices of Carnivore Reef Fishes in Thaousand Island, Jakarta

The findings indicate that the Shannon diversity index (H) within the Thousand Islands varied from 0.63 to 2.02, with an average H value of 1.36. The Evenness Index (J) of the Thousand Islands spans from 0.51 to 0.96, averaging at 0.74. Simultaneously, the dominance index (Simp) across the Thousand Islands ranges from 0.15 to 0.66, with a mean Simp value of 0.37.

3 Conclusion

The study outcomes reveal that the preeminent carnivorous fish composition within the Serranidae family predominantly features the species *Cephalopolis micropion*, frequently and extensively distributed across the Thousand Islands of Jakarta. Among these islands, Pramuka Island and Pari Island exhibit a notably heightened carnivorous fish composition, encompassing diversity, abundance, and biomass, surpassing that of other island locales.

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