Morphometric insights of least concern to vulnerable Elasmobranch in Tuban Waters, East Java: baseline data and fisheries implications

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Abstract. Indonesia is a mega biodiverse archipelagic nation with a high diversity of elasmobranch species (sharks and rays), yet it faces major challenges in their management. The northern coast of East Java, particularly Tuban Regency within Fisheries Management Area (FMA) 712, is a key landing site for these species. This study provides baseline morphometric data for elasmobranchs categorized as Least Concern (LC), Near Threatened (NT) and Vulnerable (VU) according to the IUCN Red List, and assesses their implications for sustainable fisheries management. Data were collected through daily observations of landings at Palang Fish Landing Base / Fish Landing Unit (PPI Palang) from May 2024 to April 2025. Shark landings consisted of 45.5% LC, 27.3% NT, and 27.3% VU species. Rays were composed of 38.5% LC, 30.8% NT, and 30.8% VU. Most individuals were below the known mature length (Lm), indicating that immature individuals were being harvested. These findings highlight the risk of silent collapse, where population declines progress unnoticed until a critical threshold is reached. Integrating biological considerations into fisheries management frameworks and fostering stronger collaboration between scientific and policy stakeholders is crucial to supporting the long-term sustainability of vulnerable species.

1 Introduction

Sharks and rays (elasmobranchs) have biological characteristics such as slow growth, long lifespan, late reproductive maturity, and low fecundity [1]. These characteristics make these species highly vulnerable to intensive fisheries exploitation [2]. Vulnerability is increasing due to global demand for meat, fins, and other by-products, so that most species are under pressure from over-exploitation [1].

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Globally, a recent IUCN Red List assessment indicates that elasmobranchs face unprecedented levels of conservation risk, with more than one-third of species classified as Vulnerable, Endangered, or Critically Endangered. Many populations continue to show long-term declining trends, reflecting cumulative pressures from overfishing, habitat degradation, and other anthropogenic pressures. This pattern highlights the increasing risks across shark and ray groups and underscores the urgency of strengthening science-based management and conservation strategies [3]. Indonesia is widely recognized as one of the world's largest contributors to elasmobranch landings, with a significant share derived from small-scale coastal fisheries [4]. However, basic biological information, particularly morphometric data, remains scarce in most Indonesian coastal areas, limiting the availability of comparable large-scale datasets needed to support effective fisheries management [5]. Standard morphometric measurements, including total length, fork length, precaudal length, and disc width, are key biological variables used to characterize elasmobranch population structure, assess size dynamics, and estimate growth and reproductive traits essential for effective stock assessment and management [6].

A number of studies conducted in Indonesia have provided initial insights into the size structure of elasmobranch catches as part of efforts to understand the dynamics of exploitation. However, the available information is still limited to specific locations and observation periods. In certain waters, catch reports show a relatively high proportion of small and juvenile individuals, indicating an interaction between fishing activity and juvenile age groups. This condition must be interpreted with caution due to the multispecies nature of tropical fisheries, where spatial and temporal variations in catch composition can lead to substantial differences in size structure. This issue is particularly important for elasmobranchs, as they are generally characterized by slow growth rates and low reproductive productivity. Such life history traits make elasmobranchs more vulnerable to fishing pressure than many teleost species [7,8].

Size structure of catches can be used as an early indicator to assess population status and exploitation intensity. Size-based approaches are known as relatively simple yet informative evaluation methods, especially in fisheries with limited data [9]. This approach is increasingly important in the context of data-limited fisheries, where simple biological indicators can provide early signals of stock changes [10]. Species morphometry plays a central role in revealing the biological characteristics of elasmobranchs, including growth patterns, size structure, and population variation between regions. This information forms the scientific basis for understanding population dynamics and designing more adaptive management strategies. However, the availability of morphometric data in Indonesia still largely depends on landing-based records and has not been systematically integrated. This data gap has the potential to hamper the development of evidence-based conservation strategies, particularly in the context of data-limited fisheries. Therefore, strengthening the local morphometric database is an important requirement for improving the quality of management decision-making [11]. Within this framework, morphometric studies not only provide an overview of the condition of shark and ray fisheries, but also serve as an important basis for monitoring changes in population structure over time. In line with these objectives, this study aims to present basic morphometric data on elasmobranch species with conservation statuses ranging from Least Concern to Vulnerable that are landed in the waters of Tuban, East Java. The findings of this study can serve as a baseline for establishing reference values for population size and structure. Overall, the results are expected to enhance our understanding of size structure variability and to contribute scientifically to the development of more adaptive and conservation-oriented fisheries management strategies in the northern coastal region of Java.

2 Method

2.1 Study Area

This research was conducted at the Palang Fish Landing Base / Fish Landing Unit (PPI), Tuban Regency, East Java, Indonesia (Fig. 1). This location serves as one of the primary landing centers along the northern coast of Java and is recognized as an important local landing site for elasmobranch species.

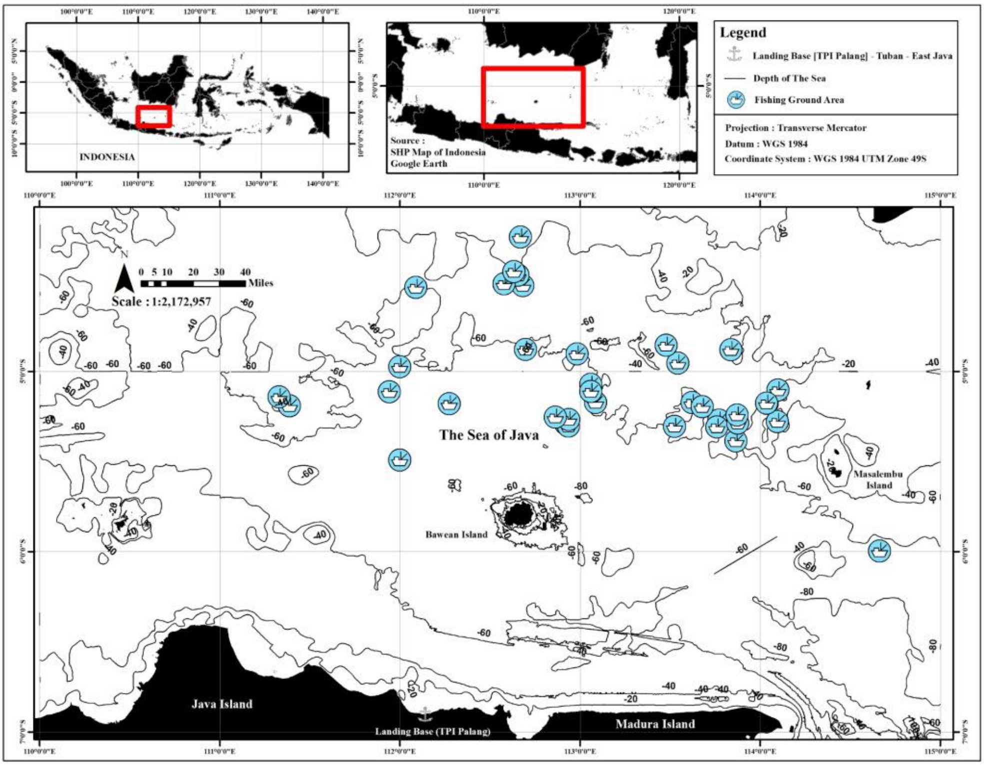

Fig. 1. Research location: Palang Fish Landing Base / Fish Landing Unit (PPI Palang), Tuban Regency, East Java, Indonesia.

2.2 Data collection

The data used in this study were morphometric data of elasmobranchs (sharks and rays) landed at the Palang Fish Landing Base / Fish Landing Unit (PPI), Tuban Regency, East Java. The morphometric data collected included total length (TL) for sharks and disc width (DW) for rays, recorded in centimeters (cm). In addition, species data, number of individuals, and conservation status according to the IUCN Red List were also documented for each specimen. Data collection was conducted directly in the field through observations during the landing of the catch. Each identified individual was measured using a measuring tape with an accuracy of 0.1 cm, then recorded by species. The recording process took place continuously from May 2024 to April 2025, providing a more comprehensive temporal picture of the variation in elasmobranch catches at the study site.

2.3 Data analysis

Data analysis was conducted descriptively and exploratively using R version 4.5.1 with the *ggplot2*, *dplyr* and *ggpubr* packages. Data analysis encompassed the composition of shark and ray catches, the proportional representation of species based on their IUCN Red List conservation status, and the comparative distribution of size classes among species. Size distributions were derived from total length (TL) for sharks and disc width (DW) for rays, while length at maturity (Lm) was obtained from secondary data sourced from (https://www.fishbase.org/home) and IUCN Red List (https://www.iucnredlist.org/en). The results of this analysis provide a morphometric overview as well as important information to support ecological and conservation studies of elasmobranchs.

3 Results

3.1 Composition of ray and shark catches

There are 11 identified shark species, with the dominant *Carcharhinus tjutjot* (212 individuals, VU) and *Chiloscyllium punctatum* (203, NT). Other relatively abundant species are *Hemipristis elongata* (86, VU), *Chiloscyllium plagiosum* (57, NT), and *Hemigaleus microstoma* (53, VU). Overall, the majority of shark catches were from VU category species (Fig. 2). A total of 12 ray species were identified. The catch was dominated by *Neotrygon orientalis* (146 individuals, LC) and *Pateobatis uarnacoides* (139 individuals, VU). In general, the VU category dominates in terms of the number of species, however many LC individuals were also found at the study site (Fig. 3).

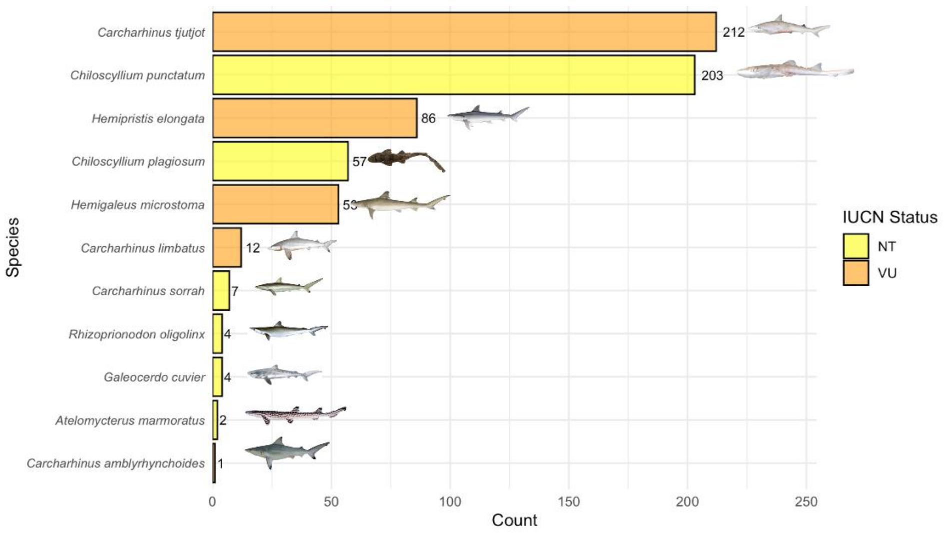

Fig. 2. Species composition of shark catches based on number of individuals.

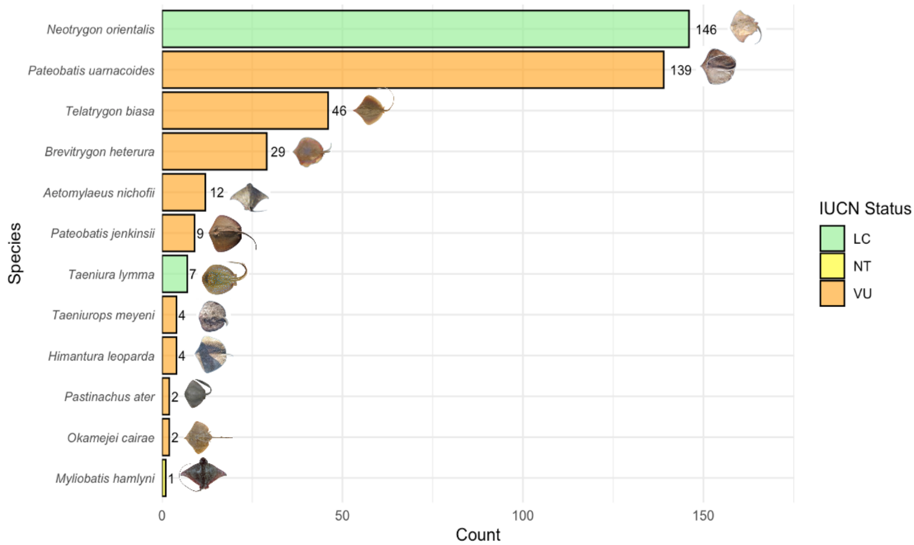

Fig. 3. Species composition of ray's catches based on number of individuals.

3.2 Proportion of elasmobranch conservation status

The composition of conservation status based on the IUCN Red List shows clear differences in the proportion of sharks and rays landed at the Palang Fish Landing Base (PPI Palang), Tuban Regency, East Java, Indonesia. In the shark group, species with the Vulnerable (VU) category dominate with a proportion of 57.9%, while the Near Threatened (NT) category is recorded at 42.1%, and no species are in the Least Concern (LC) category. In the Rays group The Vulnerable (VU) category also dominates with a higher percentage, namely 61.6%, followed by Least Concern (LC) at 38.2%, while the Near Threatened (NT) category is only represented in very small numbers (0.1%) (Fig. 4). The dominance of the Vulnerable category in both sharks and rays indicates that these species tend to be caught more frequently.

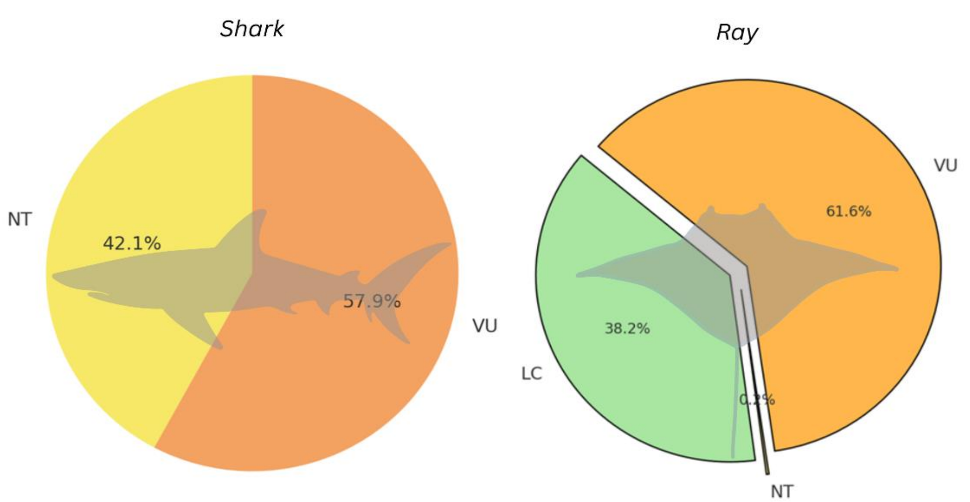

Fig. 4. Proportion of elasmobranch conservation status (NT: *Near Threatened*, LC: *Least Concern*, VU: *Vulnerable*).

3.3 Morphometric size distribution: Total Length (TL) in sharks and Disc Width (DW) in rays

The TL distribution graph shows the size variation among the shark species landed. Some species, such as *Galeocerdo cuvier* and *Hemipristis elongata*, has individuals with sizes approaching or exceeding Lm, although their numbers are relatively limited. As for species such as *Chiloscyllium punctatum*, *Hemigaleus microstoma*, and *Rhizoprionodon oligolinx* dominated by individuals with a size below Lm (Fig. 5). The distribution of Disc Width (DW) in ray species also shows a similar pattern. Several large species such as *Pateobatis uarnacoides*, *Himantura leoparda* and *Taeniurops meyeni* shows some individuals that have passed the mature gonadal size. However, the majority of species such as *Neotrygon orientalis*, *Telatrygon biasa*, and *Brevitrygon heterura* caught in sizes below Lm (Fig.6). This condition confirms the high level of exploitation of juvenile groups in the ray in the research area.

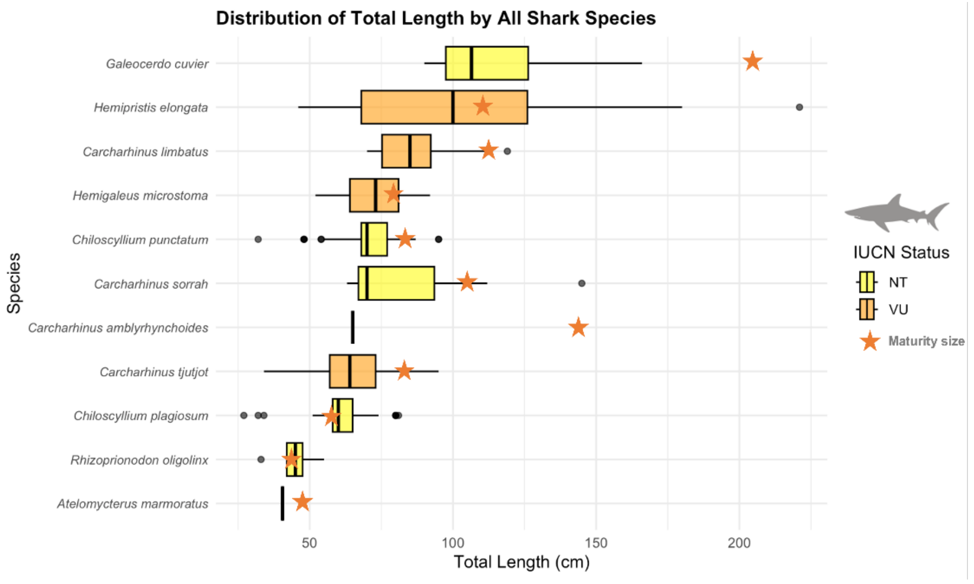

Fig. 5. Total length distribution of shark species.

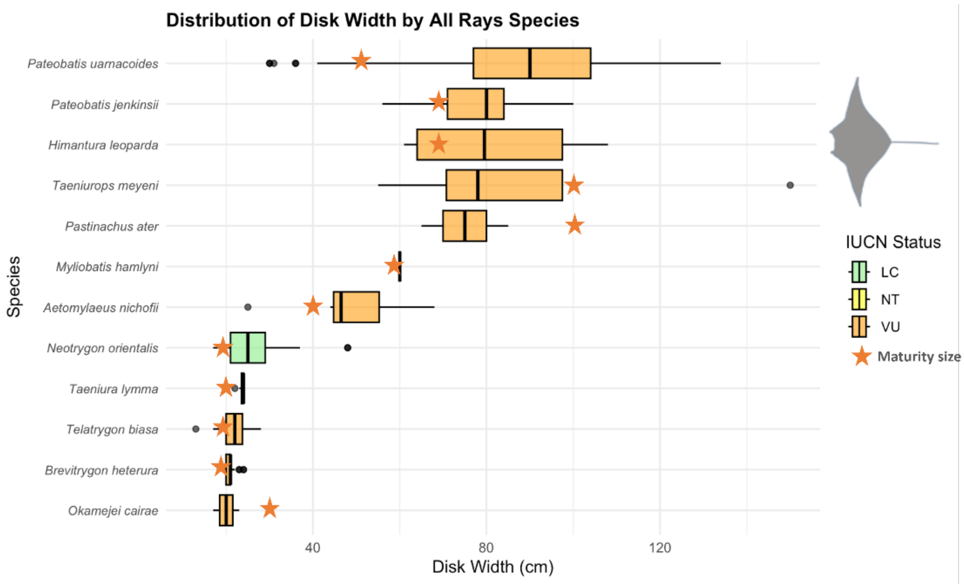

Fig. 6. Disk width distribution of ray species.

4 Discussion

The study results show that the proportion of elasmobranchs in the Vulnerable (VU) category is quite high, both in the shark (57.9%) and ray (61.6%) groups. This finding is in line with global conditions, where most elasmobranch species, especially in Southeast Asia and Indonesia, are recorded as threatened or experiencing population decline, with an estimated 59% of species being threatened and 72.5% showing a declining trend [12]. In the shark group, the species that dominate the catch include: *Carcharhinus tjutjot, Hemipristis elongata* and *Hemigaleus microstoma.*

The observed length frequency distributions indicate a fishing pattern that disproportionately captures immature individuals. Several shark species, including *Chiloscyllium punctatum* and *Rhizoprionodon oligolinx*, are frequently recorded below their sexually mature length (Lm). A similar trend is seen in rays such as *Neotrygon orientalis*, *Telatrygon ordinary* and *Brevitrygon heterura*. The predominance of subadult individuals in the catch suggests that some resources are exploited before reproduction [13]. Exploitation pressure on vulnerable elasmobranch species generates not only ecological concerns but also important socio-economic implications. In the study area, shark and ray landings are actively traded in local markets and partly integrated into domestic supply chains, suggesting that market demand plays a meaningful role in shaping exploitation intensity. The strong dependence of coastal communities on these commodities illustrates that elasmobranch fisheries operate within a closely linked socio-ecological system, where ecological sustainability and economic well-being are inseparable [14]. Contemporary fisheries governance increasingly recognizes that biological indicators must be interpreted alongside socio-economic realities. In elasmobranch fisheries, effective management requires balancing conservation objectives with the livelihood needs of fishing communities. The implementation of minimum landing sizes represents a practical tool to reduce juvenile exploitation while preserving the reproductive structure of stocks. Beyond ecological benefits, protecting immature cohorts can contribute to long-term socio-economic stability by improving stock productivity, enhancing catch quality, and reducing vulnerability to boom-and-bust cycles associated with overexploitation. Integrating conservation targets with livelihood-sensitive approaches is therefore essential to minimize trade-offs and support more equitable transitions in small-scale fisheries [15]. In addition to scientific approaches based on catch size-structure assessments, governance strategies that emphasize Community-Based Fisheries Management (CBFM) provide an important complementary pathway. CBFM functions not only as a monitoring mechanism but also as a platform for local empowerment, strengthening the role of fishers through active participation in rule-making, surveillance, and catch reporting. Such engagement fosters a sense of stewardship, increases social legitimacy, and reduces implementation costs because regulations emerge from deliberative processes perceived as fair by the community. This perspective is particularly relevant to the study area, where conservation approaches that rely solely on restrictive measures—without offering viable economic alternatives—may generate resistance and social tension. More integrative strategies that combine conservation initiatives with the strengthening of local economic opportunities are therefore more likely to produce durable outcomes. By reinforcing both ecological sustainability and socio-economic resilience, these approaches can promote fisheries governance that is adaptive, inclusive, and socially equitable, while supporting long-term resource stewardship in coastal communities.

5 Conclusion

The findings indicate that elasmobranch catches in the Tuban waters are dominated by species classified as Vulnerable (VU), with the majority of individuals measuring below their length at maturity (Lm). This pattern suggests fishing pressure that disproportionately affects smaller or younger size classes. The morphometric data collected provide important baseline information on size variation and population structure of elasmobranchs in the northern coastal waters of Java. These insights can inform future biological research and offer a scientific foundation for developing more adaptive and conservation-oriented fisheries management strategies that support both resource sustainability and the socio-economic resilience of coastal communities.

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