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Original research article

The Composition of Fish Catches in Purse Seiner Operating in the Indonesian Fisheries Management Area (WPP 713) Sulawesi Sea

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ABSTRACT

Purse seine is a widely used fishing gear in Indonesia for capturing small schooling pelagic species. The study aimed to analyze the catch composition of purse seine fishing performed using the KM Bintang Mas Maritime based at Nusantara Fisheries Port (NFP) Pekalongan and fishing in Indonesia Fisheries Management Area (IFMA 713) Sulawesi Sea. Data was collected through fishing trips observations and catch documentation from September 12, 2023 to February 16, 2024. The total catch was 155,000 kg which was composed of three dominant target species: *Decapterus macarellus* (32.25%), *D. punctatus* (29.03%), and *Sardinella lemuru* (22.59%) which make up 83.87% of the total catch. Bycatch made up 16.13% and included *Euthynnus affinis, Rastrelliger kanagurta, Selar crumenophthalmus, and Priacanthus macracanthus.* The high proportions of small pelagic fish in the catch is indicative of purse seine selectivity and show the target stocks in IFMA 713 are available. This data highlights the significance of regular evaluation and dynamic management strategies that can adapt to evolving conditions to maintain ecological balance and enduring resources.

Introduction

Indonesia's marine capture fisheries play a pivotal role in national food production and coastal employment. Along Central Java's north coast, Nusantara Fisheries Port (NFP) Pekalongan operates as a major base for purse seine fleets targeting small pelagic resources in Indonesia Fisheries Management Area (IFMA) 713, particularly across the Sulawesi Sea (Hidayat et al., 2023). IFMA 713 supports high yields of economically important species, including scads (*Decapterus spp.*), sardines (*Sardinella spp.*), and

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frigate tunas (*Auxis spp*.). Purse seine vessels operating in this region typically range from medium to large scale and are outfitted with light attraction systems designed to enhance catchability. Fishing expeditions frequently extend over several weeks, often lasting between 50 and 90 days (Hidayat et al., 2023). In similar fisheries, such as those operating in IFMA 714, both gear configuration and light intensity have been shown to influence not only catch volume but also species composition and the incidence of non-target capture (Nuraini et al., 2020). Understanding catch composition provides essential insights into gear performance and ecological outcomes. Shifts in species assemblages over time may signal community-level responses to exploitation pressure or habitat alteration. In IFMA 713, recent assessments have documented declining diversity and changing dominance patterns among small pelagic taxa, raising concerns about ecosystem stability and the cumulative impact of sustained fishing activity (Rahmawati et al., 2022).

Bycatch, defined as the incidental capture of non-target species, remains a structural issue in pelagic fisheries. Often discarded or retained with marginal economic value, these unintended catches can erode biodiversity and compromise stock resilience if left unmanaged (FAO, 2020). Reported bycatch rates in eastern Indonesia's purse seine fisheries suggest a significant proportion—up to 30%—of total landings consist of such species (Nuraini et al., 2020), underlining the need for systematic monitoring and mitigation. This study is based on an empirical study based on field data that is very important for translating policies into practical management. This study analyzes the composition of the purse seine fleet's catch operating in WPP 713. The results of this study can be used as recommendations in determining the selectivity of fishing gear, characterizing dominant species groups, measuring the diversity and frequency of bycatch, and evaluating the ecological implications of current fishing operations.

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Research methods

Time and place

The research was conducted from 12 September 2023 to 16 February 2024, and the field observations took place aboard Fishing Vessel (FV) Bintang Mas Maritime, a purse seine vessel operating out of Nusantara Fisheries Port (NFP) Pekalongan. Fishing activities were carried out in the southern waters of Indonesia Fisheries Management Area (IFMA) 713, situated roughly 230 to 250 nautical miles northeast of the port, within the Sulawesi Sea. Map location This research showed in Figure 1.

Data Collection Methods

Data were collected using a participatory-observational approach, in which the researcher directly joined the vessel and took part in fishing activities at sea. The data consisted of:

Primary data:

- Direct observation of fishing operations and post-catch handling.
- Informal interviews with the vessel's captain and crew members.
- Documentation of species and weights of fish landed after each fishing event.

Secondary data:

- Archival records and vessel/port documentation;
- Relevant literature and journal references on purse seine operations and small pelagic fish ecology.

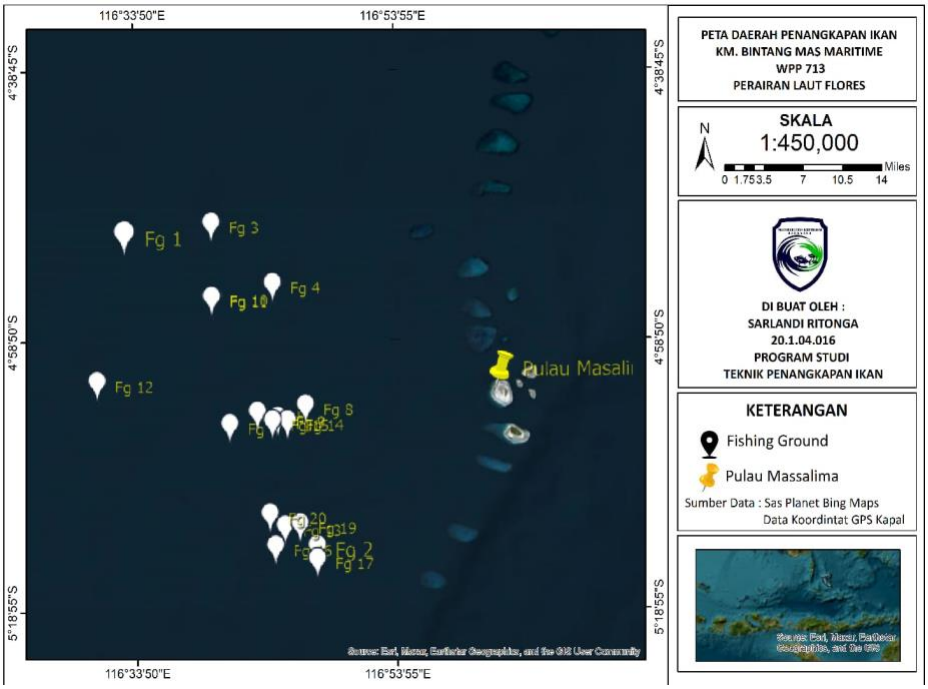


Figure1. Location Map

Data Analysis

Catch data were analyzed using descriptive quantitative methods. Each fish species was identified to the genus or species level and weighed in kilograms per haul. The composition of each species was calculated using the following formula:

$$Pi=(Ni/N)\times 100\%$$

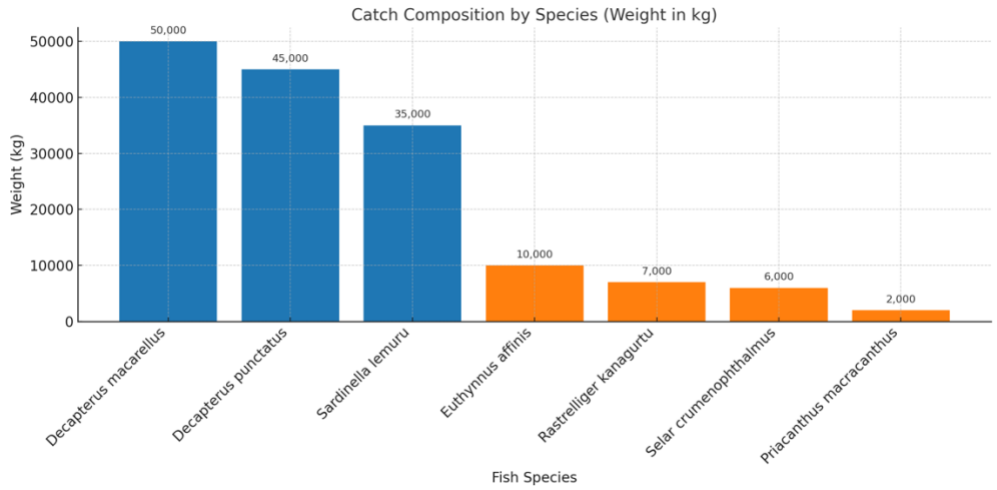
Where:
- Pi = Proportion (%) of the i-th species in the total catch
- Ni = Weight (kg) of the i-th species
- N = Total catch weight (kg)

The results were presented in tables and bar charts to facilitate visual interpretation of the proportion of dominant species versus bycatch. Further analysis distinguished between target species and non-target species (bycatch) following the definitions provided by Manalu (2003) and FAO (1995).

Result and Discussion

Catch Composition: Dominance of Target Species and Its Implications

Analysis of the catch from FV. Bintang Mas Maritime in Indonesia Fisheries Management Area (IFMA) 713 showed a clear dominance of small pelagic species. Three taxa—*Decapterus macarellus* (32.25%), *D. punctatus* (29.03%), and *Sardinella lemuru* (22.59%)—accounted for 83.87% of the total catch weight, which reached 155,000 kg. This composition reflects a high degree of gear selectivity, with purse seine operations effectively concentrating effort on key target species.



Note.: This bar chart illustrates the species-wise composition of total catch (in kilograms) obtained by FV. Bintang Mas Maritime during purse seine operations in IFMA 713. Blue bars represent target species (*D. macarellus, D. punctatus, S. lemuru*), while orange bars represent bycatch species (*E. affinis, R. kanagurta, S. crumenophthalmus, P. macracanthus*). The chart emphasizes the high selectivity toward small pelagic targets (83.87%) and the proportion of ecologically significant bycatch (16.13%).

Figure 2. Catch Composition by Species Based on Weight

The marked dominance of a few species within the catch reflects both operational efficiency and ecological vulnerability. From a technical perspective, it indicates that the gear is functioning with high selectivity, concentrating effort on intended targets while limiting incidental take. This observation is consistent with Soepardi et al. (2023), who reported that hydraulic purse seines equipped with refined retrieval systems improve catch accuracy and reduce unintended capture. However, when a small subset of species consistently accounts for the majority of landings, as observed here, the risk of over-reliance on specific stocks becomes more pronounced. Such hyper-concentration may lead to structural imbalances within the population, especially in the absence of comprehensive stock assessments or adaptive management frameworks. Sustained pressure on narrowly defined species groups can impair recruitment and reduce resilience to environmental variability. As noted by Simanullang et al. (2023), fisheries exhibiting high species dominance require careful regulation of effort to prevent long-term depletion and ensure ecological stability.

These findings indicate that the proportion of target species in this study is higher than the national average range (typically around 75–80%). This could be attributed to: (1) the effectiveness of gear selectivity and operational technique used by KM Bintang Mas Maritime, or (2) the ecological characteristics of IFMA 713 that strongly support small pelagic fish aggregations.

In terms of sustainability, the dominance of Decapterus and Sardinella—species with rapid growth and short life cycles—is relatively manageable as long as spatial-temporal management and regular stock monitoring are maintained. However, these species are also known to be highly sensitive to overfishing pressure, as shown in the population ecology study by Fahrezy et al. (2024) in IFMA 712. Therefore, high dominance of target species should not merely be interpreted

as a sign of technical efficiency, but also as a management signal requiring adaptive strategies. This underscores the need for seasonal mapping of pelagic aggregations, establishment of dynamic catch quotas, and limitation of fishing operations in ecologically sensitive zones.

Table 1. Comparison with Previous Studies

Study Location	Dominant Target Species	Target Proportion (%)	Reference
IFMA 713 (This study)	*D. macarellus*, *D. punctatus*, *S. lemuru*	83.87%	This study
Java Sea – Batam	*D. punctatus*, *R. kanagurta*	76.5%	Rizieq et al., 2023
Java Sea – Pekalongan	*S. lemuru*, *D. russelli*	81.2%	Sutono et al., 2023
Java Sea – Tegal	*S. lemuru*, *A. thazard*	72.9%	Widiyastuti et al., 2023
Bone Waters – South Sulawesi	*D. macrosoma*, *R. kanagurta*	78.0%	Botu & Minggo, 2021

Bycatch and Ecological Evaluation

Despite the high dominance of target species in FV. Bintang Mas Maritime's purse seine operations, a total of 25,000 kg (16.13%) of the catch consisted of bycatch. These included four non-target species: *Euthynnus affinis* (kawakawa), *Rastrelliger kanagurtu* (Indian mackerel), *Selar crumenophthalmus* (bigeye scad), and *Priacanthus macracanthus* (red bigeye).

In many hauls, the net brought up more than just its intended target. While the catch profile remained heavily skewed—over 80% of the landed biomass came from just three pelagic species (*Decapterus macarellus, D. punctatus*, and *Sardinella lemuru*)—there were clear signs of ecological overlap. Incidental captures like *Euthynnus affinis* and *Priacanthus macracanthus* weren't rare. They point to something important: the gear may not be operating strictly in midwater, as intended.

Some sets revealed even more. The presence of benthic-associated species in several hauls suggests that purse seines, though nominally pelagic, sometimes dip into deeper strata. Why? It could be bathymetric complexity—undulating seafloor topography that unintentionally drags the net downward. Or it might stem from the gear setup itself—net weight, tow speed, lead line configuration—all influencing vertical reach. In areas like WPP 713, where schooling fish often shift vertically with light or thermocline gradients, this is more than a technicality. It's an ecological variable.

Bycatch isn't just a statistical nuisance. It's an ecological footprint. Non-target species—particularly those tied to demersal or reef habitats—often play stabilizing roles in trophic webs. Pulling them from structurally complex habitats, even sporadically, can trigger unintended consequences. We've seen this before. Tuda et al. (2019) documented similar vertical gear incursions in East African waters. In the Malacca Strait, Azmir et al. (2022) observed that 20–30% of purse seine landings included low-value or ecologically sensitive species—simply because nets followed deeper aggregations.

Then there's habitat integrity. Benthic incursions, especially over seagrass beds or coral rubble zones, risk more than species removal—they can physically disturb habitat structure. A

study by Hanifa et al. (2020) in coastal Kalimantan showed that purse seines descending beyond 30 meters occasionally damaged soft benthic habitats. That's not just a localized impact. These habitats serve as juvenile nurseries and foraging grounds. Lose them, and recruitment falters.

All of this circles back to gear behavior—and its ecological shadow. Monitoring the vertical dimension of purse seine operation is no longer optional. It's central to any bycatch mitigation strategy worth its name. Acoustic profiling, real-time depth sensors, gear modification trials—these tools exist. What's needed now is commitment to apply them, and the policy frameworks to mandate their use in multispecies zones like WPP 713.

Ecosystem-based fisheries management (EAFM) isn't a slogan. It's a mandate to see the full picture. And bycatch, often overlooked, is part of that picture—blurry at the edges, but urgent all the same. The national average for bycatch proportions in purse seine fisheries ranges between 12%–20%, placing the findings of this study near the upper limit. This suggests that while still within acceptable bounds, targeted intervention is warranted to reduce non-target catch.

Table 2. Comparison with Similar Studies

Study Location	Bycatch Proportion (%)	Dominant Bycatch Species	Reference
IFMA 713 (This study)	16.13%	*E. affinis*, *R. kanagurtu*, *P. macracanthus*	This study
Batam Fishing Port	18.2%	*R. kanagurtu*, *Caranx* sp.	Rizieq et al., 2023
Java Sea – Pekalongan	12.7%	*A. thazard*, *Selaroides* spp.	Sutono et al., 2023
Sibolga Fishing Port	20.1%	*Auxis rochei*, *Selar* spp.	Asva et al., 2023

Bycatch reduction remains a complex and evolving challenge, shaped not only by gear design but also by species behavior and decisions made during fishing operations. Ongoing advancements in selective fishing technologies, however, offer practical pathways for improvement. Modifying fishing gear continues to deliver measurable benefits. Even minimal adjustments—such as mesh size or escape panel placement—can significantly alter catch composition. In recent years, innovations like embedded LED lighting have shown promise. Satyawan et al. (2023) demonstrated that specific light spectra can reduce incidental capture of non-target species while maintaining yield of the intended catch. These systems leverage differences in visual sensitivity among taxa, enhancing selectivity through targeted sensory cues.

Temporal factors also influence gear performance. In mixed-species pelagic zones such as WPP 713, diel shifts in fish assemblages have been shown to affect catch profiles. Haris et al. (2023) found that net deployment timing—often varied by only a few hours—can determine whether a set produces predominantly target species or becomes dominated by bycatch. Such findings highlight the need for fine-scale temporal adjustments in fishing strategies.

Spatial variation in bycatch incidence further complicates management. Non-target species tend to aggregate in identifiable zones that shift over time. By tracking these distributions,

fisheries can implement more responsive spatial measures, including rotating closures or exclusion zones tied to observed patterns. Trials in parts of the Coral Triangle suggest that adaptive spatial management not only reduces ecological impact but can also support catch stability. Applying similar frameworks in WPP 713 could yield comparable benefits, given the area's ecological sensitivity and commercial relevance.

Much of what is classified as bycatch retains economic or nutritional value but is often discarded due to logistical, infrastructural, or market limitations. This results in unnecessary biomass loss and constrains the efficiency of fishing operations.

Species such as Rastrelliger kanagurta and Euthynnus affinis, though not primary targets, are both marketable and suitable for processing into products like surimi, fishmeal, or feed ingredients. In coastal and island regions where economic diversification is limited, these underutilized resources could reinforce food security and contribute to local livelihoods—provided that reliable cold storage and basic processing infrastructure are in place.

In contrast, taxa like Priacanthus macracanthus are more frequently discarded, often due to weak market demand or limited capacity for sorting and preservation onboard. While these practices may streamline deck operations, they contribute to underreporting and distort stock assessments by removing biomass that goes unaccounted for in monitoring systems.

Industrial and semi-industrial purse seine fleets already possess the physical capacity for improved retention—segregation systems, temperature control, and access to mobile processing platforms are within operational reach. What remains lacking is cohesive policy support and incentive structures that encourage full utilization. When discard becomes the more convenient option, efficiency and accountability are undermined.

Effective bycatch management must go beyond limiting removals. It should also prioritize how catches—targeted or otherwise—are handled, recorded, and integrated into value chains. Minimizing waste is not just an ethical imperative; it is a practical step toward long-term sustainability.

Conclusion

The purse seine catch in IFMA 713 was dominated by three small pelagic species—*Decapterus macarellus, D. punctatus*, and *Sardinella lemuru*—which accounted for over 80% of total biomass, reflecting the gear's selective efficiency toward aggregated target species. Although bycatch represented only around 16%, several non-target species play ecologically significant roles that warrant attention. The dominance of small pelagics suggests that stocks in this area remain productive, yet sustained fishing pressure must be closely monitored. Catch composition of this nature serves as a critical indicator for evaluating fishery performance and informing ecosystem-based management policies.

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