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Production Analysis and Management of Tuna (*Thunnus spp.*) in Maluku Province, Indonesia

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ABSTRACT

This study discusses the management of tuna (*Thunnus spp.*) fisheries in the Indonesia Fisheries Management Area (IFMA) 714, with a focus on the waters of Maluku Province during the 2020–2024 period. The study aimed to analyze the management of yellowfin tuna (*Thunnus sp.*) fisheries in the waters of Maluku Province within IFMA714. A quantitative descriptive method was employed using secondary data obtained from the Statistics Data Portal of the Ministry of Marine Affairs and Fisheries (MMAF). The analyzed data included tuna production, the number of fishing vessels, and dominant fishing gear types. The results showed that tuna production fluctuated throughout the observation period, increasing in 2021, declining in 2022 and 2023, and then increasing significantly again in 2024. These fluctuations were influenced by oceanographic conditions, climate change, weather conditions, fishing intensity, operational costs, and market demand for tuna commodities. The number of fishing vessels also changed from year to year, reflecting the level of tuna resource utilization in the Maluku region. In addition, the dominant fishing gear shifted from trolling lines to handlines in 2024, indicating a transition toward more selective and environmentally friendly fishing practices. The findings suggest that sustainable tuna fisheries management through the control of fishing intensity, the use of environmentally friendly fishing gear, strengthened monitoring, and data-based management is essential to maintain tuna resource sustainability while supporting the long-term economic viability of fishing communities in Maluku Province.

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Introduction

The Banda Sea and Tolo Bay, which are included in the Indonesia Fisheries Management Area (IFMA) 714, represent important marine regions for Indonesia's fisheries and marine sector. This area possesses high fishery potential supported by favorable oceanographic conditions, particularly the upwelling phenomenon that transports nutrients from deeper waters to the surface, thereby enhancing phytoplankton productivity and supporting the growth of various fish species. In addition, the convergence of ocean currents creates important migration routes for economically valuable fish species such as tuna, skipjack tuna, and mackerel tuna. Maluku Province occupies a strategic position within IFMA 714 because most of its territory consists of marine waters and lies along the migration routes of large pelagic fish. These productive marine conditions make the fisheries sector a primary source of livelihood for coastal communities, ranging from fishing activities to seafood processing and distribution. Beyond providing food and employment opportunities, the fisheries sector also plays a significant role in increasing regional income and supporting the development of eastern Indonesia (Rubianti, 2023; Perangin-angin *et.al.*, 2018).

Thunnus spp., commonly known as tuna, is one of the leading fishery commodities that plays an important role in capture fisheries activities within IFMA 714, particularly in the Banda Sea. This species has high economic value and serves as one of Indonesia's major export commodities in international markets. The continuously increasing global demand for fresh, frozen, and processed tuna products such as loin and sashimi has stimulated the growth of fishing activities and has become a major source of income for fishers in eastern Indonesia.

Biologically, yellowfin tuna is classified as a large pelagic fish species with highly migratory behavior. The distribution patterns of Sea Surface Temperature (SST), ocean currents, and their interactions may generate upwelling and oceanic front phenomena, which are recognized as potential fishing grounds. The Banda Sea constitutes one of the most suitable habitats for yellowfin tuna due to the occurrence of upwelling, which enhances water fertility and the availability of natural food sources. High chlorophyll-a concentrations are associated with high levels of marine productivity and fertility (Haruna *et.al* 2018).

The management of *Thunnus spp.* fisheries in IFMA 714 must be conducted sustainably because intensive utilization may exert pressure on tuna stocks in the Banda Sea and surrounding waters. Effective fisheries management should maintain a balance among ecological, economic, and social aspects. Ecologically, tuna populations are influenced by habitat conditions, migration patterns, and exploitation rates. Economically, tuna fisheries constitute one of the primary sources of income for coastal communities in Maluku Province. However, fisheries management continues to face several challenges, including limited availability of accurate stock assessment data and increasing fishing pressure driven by high market demand. Furthermore, uncontrolled fishing practices, such as the use of less selective fishing gear and the capture of immature fish, may contribute to stock depletion and ecosystem disturbances if not properly managed (Efendi *et al.*, 2025).

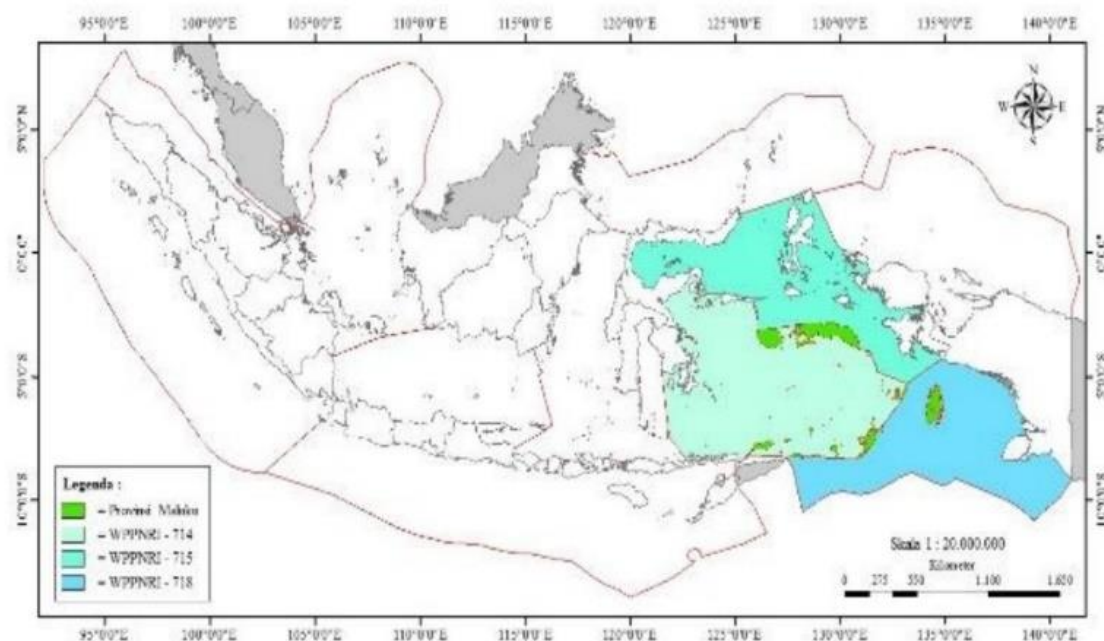
Comprehensive information is essential for effective tuna fisheries management, including trends in tuna production, changes in the number of fishing vessels, and the dominant fishing gear used by fishers. It is also necessary

to identify the factors influencing fluctuations in tuna production to maintain tuna resource sustainability while supporting the welfare of fishing communities in Maluku Province. Therefore, this study aims to analyze the management of tuna (*Thunnus spp.*) fisheries in the waters of Maluku Province, with a part of IFMA 714.

Research Methods

Time and Place

The research was conducted from May 2025 in the Maluku Province, which is a part of Indonesia Fisheries Management Area (IFMA) 714 (Figure 1).



Source: Angkotasari *et al.*, (2025)

Figure 1. The Map of Indonesia Fisheries Management Area

Equipment and Materials

The equipment and materials used in this study consisted of data-processing tools and secondary data related to tuna fisheries management in IFMA 714. The equipment included a laptop or computer for data processing, Microsoft Excel software for statistical data analysis, Microsoft Word for scientific manuscript preparation, and internet access for obtaining data from the official portal of the Ministry of Marine Affairs and Fisheries (MMAF, 2025). In addition, a

map of Fisheries Management Area 714 was utilized to illustrate the study location in the waters of Maluku Province. The research materials consisted of secondary data obtained from the official publications of the Ministry of Marine Affairs and Fisheries (MMAF), including tuna (*Thunnus spp.*) production data, the number of fishing vessels, and information on dominant fishing gear types during the period 2020–2024. In addition, supporting information was collected from scientific journals, articles, and other relevant literature

related to tuna fisheries management, oceanographic conditions, and the sustainability of fisheries resources within IFMA 714.

Data Analysis

A quantitative descriptive approach was employed using secondary data obtained from the official publications of the Ministry of Marine Affairs and Fisheries (MMAF). The dataset covered the period from 2020 to 2024 and included tuna (*Thunnus spp.*) production, production value, the number of fishing vessels, and dominant fishing gear types in Maluku Province. The collected data were analyzed descriptively to identify trends and fluctuations in tuna production and resource utilization during the study period. The results were presented in tables and descriptive narratives to facilitate the interpretation of changes in production and fishing activities across years. Comparative analyses among years

were also conducted to identify patterns of production fluctuations and trends in tuna resource utilization within the study area. The findings are expected to provide a comprehensive overview of tuna fisheries conditions and to serve as a basis for developing sustainable fisheries management strategies in IFMA 714.

Results and Discussion

Tuna Production in Maluku Province

The production of tuna (*Thunnus spp.*) in Maluku Province during the period 2020–2024 showed a fluctuating trend. Production increased from 2020 to 2021, declined in 2022, reached its lowest level in 2023, and increased significantly again in 2024. These fluctuations indicate that tuna production in the region is influenced by fishing pressure and environmental conditions. Therefore, sustainable fisheries management is required to maintain stock stability and ensure the long-term sustainability of tuna resources (Haruna *et al.*, 2018).

Table 1. Tuna Production in Maluku Province (2020–2024)

Year	Tuna Production (tons)
2020	106,571,53
2021	139,963,21
2022	125,737,07
2023	59,767,10
2024	140,030,52

Source: MMAF Statistical Data Portal (MMAF, 2025).

In 2020, tuna (*Thunnus spp.*) production in Maluku Province reached 106,571.53 tons, indicating that tuna fisheries within IFMA 714 were operating under relatively favorable conditions. The high production level was supported by the availability of tuna resources, suitable oceanographic conditions, and active fishing operations utilizing various fishing gears, including troll lines, handlines, and longlines. Environmental factors such as sea surface temperature, ocean currents, and food

availability likely contributed to the distribution and abundance of tuna in the fishing grounds, thereby enhancing catch rates. In addition, stable market demand and favorable economic conditions encouraged fishing activities throughout the year. These findings suggest that both ecological and economic factors played important roles in supporting tuna production in 2020 and highlight the importance of sustainable fisheries management to maintain stock stability

and ensure the long-term utilization of tuna resources (Tangke *et al.*, 2019).

In 2021, tuna (*Thunnus spp.*) production in Maluku Province increased significantly to 139,963.21 tons, indicating a higher level of tuna resource utilization compared to the previous year. The increase in production was likely influenced by the greater intensity of fishing activities, supported by the increasing number of fishing vessels and the effective use of fishing gears such as handlines, longlines, and purse seines. Favorable oceanographic conditions, including sea surface temperature, ocean currents, and the availability of natural prey, may have enhanced the distribution and abundance of tuna in the fishing grounds, thereby increasing catch rates. In addition, strong market demand and favorable economic conditions encouraged fishers to intensify their fishing activities throughout the year. These findings suggest that technical, ecological, and economic factors collectively contributed to the increase in tuna production in 2021 and emphasize the importance of sustainable fisheries management to ensure the long-term utilization of tuna resources (Dalegi *et al.*, 2020).

In 2022, tuna (*Thunnus spp.*) production in Maluku Province declined to 125,737.07 tons compared to 139,963.21 tons in 2021, indicating fluctuations in tuna resource utilization within IFMA 714. The decrease in production was likely influenced by changes in oceanographic conditions, including sea surface temperature, ocean currents, and the availability of natural prey, which affected the distribution and abundance of tuna in fishing grounds. In addition, unfavorable weather conditions and seasonal variations may have reduced the number of effective fishing days and limited fishing activities. Rising operational costs, particularly fuel prices, also affected fishing efficiency by restricting the frequency and range of

fishing operations. These conditions resulted in lower catch volumes and highlight the importance of adaptive and sustainable fisheries management to maintain the long-term productivity of tuna resources in Maluku Province (Angkotasan *et al.*, 2025).

In 2023, tuna (*Thunnus spp.*) production in Maluku Province declined sharply to 59,767.10 tons, representing the lowest production level during the 2020–2024 period. This substantial decrease indicates that tuna fisheries within IFMA 714 experienced considerable pressure associated with resource availability, environmental conditions, and fishing operations. The decline in production was likely influenced by intensive fishing pressure in previous years, which may have reduced tuna stock abundance. In addition, climate variability, unfavorable weather conditions, and changes in oceanographic factors, including sea surface temperature and ocean currents, may have affected the distribution and availability of tuna in fishing grounds. Increasing operational costs, particularly fuel prices, also limited fishing activities and reduced fishing efficiency. These conditions resulted in lower catch volumes and emphasize the importance of implementing sustainable and adaptive fisheries management to maintain the long-term productivity and conservation of tuna resources in Maluku Province (Nurhayati *et al.*, 2018).

Increasing operational costs, particularly fuel prices, were also considered important factors contributing to the decline in tuna (*Thunnus spp.*) production in 2023. Higher expenditures for fuel, logistics, ice supply, and vessel maintenance reduced the operational capacity of fishing fleets and limited the frequency of fishing trips. In addition, market instability and fluctuating tuna prices reduced the economic incentives for fishers to intensify fishing activities. The decline in the number of active

fishing vessels and limited supporting facilities, such as cold storage systems and fishing port infrastructure, further affected the efficiency of tuna fisheries in Maluku Province. These conditions highlight the importance of strengthening sustainable fisheries management through controlling fishing intensity, improving fisheries infrastructure, and promoting environmentally friendly fishing practices to ensure the long-term productivity and sustainability of tuna resources within IFMA 714 (Tuyu *et al.*, 2023).

In 2024, tuna (*Thunnus spp.*) production in Maluku Province increased significantly to 140,030.52 tons, representing the highest production level during the 2020–2024 period and indicating a recovery of tuna fisheries within IFMA 714 following the decline recorded in 2023. The increase in production was likely associated with improved oceanographic conditions, including sea surface temperature, ocean currents, and the availability of natural prey, which enhanced the distribution and abundance of tuna in fishing grounds. In addition, the recovery of fishing activities, supported by the increasing number of active fishing vessels and more intensive fishing operations, contributed to higher catch volumes. These conditions indicate that both environmental and operational factors played important roles in supporting the recovery of tuna production in 2024 and emphasize the importance of sustainable fisheries management to maintain the long-term productivity and conservation of tuna resources in Maluku Province (Tangke *et al.*, 2016).

The increase in tuna (*Thunnus spp.*) production in 2024 was also supported by improvements in fishing operations and favorable economic conditions. The use of more efficient fishing gears expanded fishing areas, and fishers' experience in identifying productive fishing grounds contributed to

higher catch volumes. In addition, government support through the provision of fishing facilities, fuel subsidies, and improvements in fisheries infrastructure, including fishing ports and cold storage systems, enhanced the efficiency and quality of tuna handling and distribution. Strong domestic and international market demand, accompanied by relatively stable tuna prices, also encouraged fishers to intensify their fishing activities. These findings indicate that tuna resources within IFMA 714 remain productive and possess considerable recovery potential. However, the increase in production should be accompanied by sustainable fisheries management to prevent overexploitation and ensure the long-term sustainability of tuna resources in Maluku Province (Dwi *et al.*, 2025).

The development of tuna (*Thunnus spp.*) production in Maluku Province during the 2020–2024 period exhibited a fluctuating pattern, indicating dynamic changes in tuna fisheries within IFMA 714. Production increased from 2020 to 2021, declined in 2022, reached its lowest level in 2023, and recovered significantly in 2024. These fluctuations were influenced by a combination of ecological, technical, and economic factors, including oceanographic conditions, weather variability, fishing intensity, operational costs, market demand, and the availability of fishing vessels and fishing gear. The recovery observed in 2024 suggests that tuna resources in Maluku waters remain productive and possess the potential to support fisheries activities. However, the observed fluctuations highlight the importance of implementing adaptive and sustainable fisheries management based on scientific data to ensure the optimal utilization and long-term sustainability of tuna resources in Maluku Province (Nur *et al.*, 2024).

Number of Fishing Vessels and Dominant Fishing Gear Types

The number of fishing vessels and the dominant fishing gear types used in Maluku Province during the 2020–2024 period reflected the dynamic nature of tuna fishing activities within Fisheries Management Area of the Republic of Indonesia (IFMA) 714. The number of

operating vessels changed from year to year, as did the types of fishing gear predominantly used by fishers. These changes indicate the influence of economic factors, fish resource conditions, advancements in fishing technology, and fishers' adaptation to changing marine environmental conditions (Rahmat & Thamrin, 2016).

Table 2. Number of Fishing Vessels and Dominant Fishing Gear Types

Year	Number of Fishing Vessels	Dominant Fishing Gear Type
2020	87,516	Troll Line
2021	88,841	Troll Line
2022	64,591	Troll Line
2023	64,005	Troll Line
2024	71,201	Handline

Source: Portal Data Statistik KKP (MMAF, 2025).

In 2020, the number of fishing vessels reached 87,516 units, with troll lines being the dominant fishing gear. The large number of vessels operating during that year indicates that tuna fishing activities were conducted actively and intensively. This condition was supported by the abundant availability of tuna resources in the waters of Maluku. Fisheries Management Area of the Republic of Indonesia (IFMA) 714 is recognized as one of the most productive areas for harvesting large pelagic species, particularly tuna, making capture fisheries an important source of livelihood for many fishing communities. The dominance of troll lines can be attributed to their effectiveness in catching tuna while requiring relatively lower operational costs compared to more modern fishing gears. Troll lines are commonly used by both traditional and medium-scale fishers in Maluku because they are simple to operate and do not require sophisticated technology. In addition, this fishing gear is highly adaptable to various marine conditions and can be operated by small- to medium-sized vessels. The extensive use of troll lines also indicates that tuna fisheries in

Maluku are still largely characterized by small-scale fisheries employing relatively simple fishing technologies. These conditions provide economic advantages for fishers because the investment costs associated with fishing gear are relatively low, making them more affordable for coastal communities (Nurhayati *et al.*, 2018).

In 2021, the number of fishing vessels increased to 88,841 units, while troll lines remained the dominant fishing gear used in Maluku Province. The increase in the number of vessels indicates a higher intensity of tuna fishing activities, which was likely driven by favorable tuna production and strong market demand in both domestic and international markets. The continued dominance of troll lines suggests that this fishing gear remained suitable for the characteristics of tuna resources and fishing conditions in Maluku waters. However, the increasing number of fishing vessels and fishing intensity may impose greater pressure on tuna resources if not accompanied by effective management measures. Therefore, continuous monitoring and sustainable fisheries management are necessary to

maintain resource availability and ensure the long-term sustainability of tuna (*Thunnus spp.*) fisheries within IFMA 714 (Rahmat & Ilhamdi, 2015b).

In 2022, the number of fishing vessels declined significantly to 64,591 units, while troll lines remained the dominant fishing gear used in Maluku Province. The reduction in the number of vessels indicates a decrease in fishing intensity, which was likely influenced by rising operational costs, unfavorable weather conditions, and changes in oceanographic factors affecting the distribution and availability of tuna resources. These conditions may have limited fishing activities and reduced the number of effective fishing days. Despite the decline in fishing vessels, the continued dominance of troll lines suggests that most fishers still relied on traditional fishing methods due to their economic efficiency and suitability for local fishing conditions. These findings highlight the importance of adaptive fisheries management to maintain fishing efficiency and ensure the sustainable utilization of tuna (*Thunnus spp.*) resources within IFMA 714 (Haruna et al., 2018).

In 2023, the number of fishing vessels declined slightly to 64,005 units, while troll lines remained the dominant fishing gear used in Maluku Province. The continued decrease in fishing vessels indicates that tuna fisheries within IFMA714 experienced considerable pressure, which was likely associated with declining tuna catches, unfavorable weather conditions, and changes in oceanographic factors affecting tuna distribution. Increasing operational costs and limited financial capacity among fishers may have further reduced fishing activities and the number of active vessels. Despite these challenges, the continued dominance of troll lines indicates that fishers still relied on traditional and economically efficient fishing methods. These conditions

emphasize the importance of strengthening adaptive and sustainable fisheries management to maintain the productivity and long-term sustainability of tuna (*Thunnus spp.*) resources in Maluku Province (Rahmat & Ilhamdi, 2015).

In 2024, the number of fishing vessels increased to 71,201 units, indicating a recovery in tuna fishing activities within IFMA 714 following the decline observed during the previous two years. This increase was likely supported by improved economic conditions, stronger market demand for tuna, favorable environmental conditions, and government support through the provision of fishing facilities and fisheries infrastructure. A notable change during this period was the shift in the dominant fishing gear from troll lines to handlines, reflecting the adoption of more selective and environmentally friendly fishing practices. The increasing use of handlines may contribute to reducing bycatch and improving fish quality, thereby enhancing the economic value of tuna catches. These findings suggest that the transition toward handline fisheries represents a positive development in promoting sustainable tuna (*Thunnus spp.*) fisheries management and ensuring the long-term sustainability of tuna resources in Maluku Province (Rahmat & Thamrin, 2016).

The development of fishing vessel numbers and dominant fishing gear types during the 2020–2024 period demonstrates that tuna fishing activities in Maluku Province were strongly influenced by fish resource conditions, environmental factors, the economic capacity of fishers, and fisheries management policies. Fluctuations in the number of fishing vessels reflected changes in the intensity of tuna resource utilization over time, whereas shifts in the dominant fishing gear indicated fishers' adaptation to evolving fisheries conditions. Therefore, more effective

management of fishing fleets and fishing gear use is required to ensure the optimal utilization of tuna resources while maintaining the long-term sustainability of fish stocks in the waters of Maluku (Rahmat & Thamrin, 2016).

Future tuna fisheries management presents considerable opportunities for innovation through the development of aquaculture, considering that tuna has traditionally been exploited as a capture fishery resource. Research on tuna aquaculture technologies has recently been initiated by the Ministry of Marine Affairs and Fisheries of the Republic of Indonesia. This initiative represents a strategic approach to maintaining the conservation and long-term sustainability of fish stocks in marine ecosystems. Marine aquaculture of tuna has the potential to complement capture fisheries, which have long served as the primary source of tuna production. However, several hydro-oceanographic parameters must be carefully considered in the development of marine aquaculture systems. These include current velocity, bathymetry, substrate characteristics, the degree of protection provided by coastal and marine environments, water temperature, and dissolved oxygen (DO) concentrations, all of which play critical roles in determining the suitability and success of tuna aquaculture operations (Adibrata *et al.*, 2023).

Conclusion

The management of Tuna (*Thunnus spp.*) fisheries in the waters of Maluku Province within the Fisheries Management Area of the Republic of Indonesia (IFMA) 714 during the 2020–2024 period showed dynamic conditions influenced by ecological, technical, and economic factors. Tuna production fluctuated, increasing from 106,571.53 tons in 2020 to 139,963.21 tons in 2021, declining to 125,737.07 tons in 2022 and reaching its lowest level of 59,767.10 tons in 2023, before increasing significantly to

140,030.52 tons in 2024. These fluctuations were influenced by oceanographic conditions, climate change, fishing intensity, operational costs, and market demand. The number of fishing vessels also changed throughout the study period, increasing from 87,516 units in 2020 to 88,841 units in 2021, decreasing to 64,591 units in 2022 and 64,005 units in 2023, and increasing again to 71,201 units in 2024. In addition, the dominant fishing gear shifted from troll lines to handlines in 2024, indicating a transition toward more selective and environmentally friendly fishing practices. Therefore, sustainable tuna fisheries management through controlling fishing intensity, promoting environmentally friendly fishing gear, strengthening monitoring systems, and implementing data-based management is essential to maintain tuna resource sustainability and support the long-term welfare of fishing communities in Maluku Province.

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