Egyptian Journal of Aquatic Biology & Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN 1110 – 6131
Vol. 29(6): 1117 – 1128 (2025)
www.ejabf.journals.ekb.eg

Status of Small Pelagic Fish Resource Utilization in Buru District Waters, Maluku Province

Muhammad Ikbal Zakariah[1*], Muhammad Kasnir[2], Kasmawati[2], Muhammad Jamal[2]
[1] Doctor Candidate of Fisheries Science Program, University of Muslim Indonesia
[2] Department of Fisheries Science, University of Muslim Indonesia
[*]Corresponding Author: ikbalzakariah.umi@gmail.com

ARTICLE INFO

Article History:
Received: Aug. 25, 2025
Accepted: Nov. 2, 2025
Online: Nov. 25, 2025

Keywords:
Small pelagic fish,
Mini purse seine,
CPUE,
MSY,
Business feasibility,
Buru Regency

ABSTRACT

This study provides an integrated bioeconomic assessment of small pelagic fishery utilization in Buru District, Maluku Province, Eastern Indonesia. The analysis aims to evaluate the exploitation status and economic feasibility of fishing activities using mini purse seine gear. The Schaefer surplus production model was applied to estimate the catch per unit effort (CPUE) and maximum sustainable yield (MSY), while the financial evaluation included income, total costs, and the revenue-cost (R/C) ratio. Results showed that CPUE increased from 1.0996 ton/GT-day in 2019 to 1.4749 ton/GT-day in 2024, indicating improved gear efficiency. The estimated MSY and optimal effort (EMSY) were 7,116.34 ton/year and 109.96 trip/year, respectively, suggesting that current fishing efforts (1,440–2,304 trip/year) have exceeded sustainable levels. The business feasibility analysis yielded a net income of IDR 24.55 billion and an R/C ratio of 1.93, confirming economic viability but revealing ecological pressure due to overfishing. This research offers the first quantitative integration of MSY and economic feasibility indicators for small pelagic fisheries in Buru District, providing essential insights for adaptive and sustainable fisheries management aligned with SDG 14 (Life Below Water).

INTRODUCTION

Indonesia's Fisheries Management Areas (FMAs) 714 and 715 encompass ecologically rich marine regions such as the Banda and Seram seas, which support extensive small pelagic fisheries. These waters play a vital role in ensuring national fish supply and sustaining the livelihoods of coastal communities in Maluku Province. The region's strategic position and oceanographic variability make it one of the key fishing grounds for small pelagic species such as *Decapterus* sp., *Rastrelliger* spp., and *Selaroides* spp., which are mainly exploited using mini purse seine gear.

However, the rapid increase in fishing effort, coupled with limited stock assessment

Indexed in Scopus ELSEVIER DOAJ IUCAT

and weak regulation, has raised concerns about potential overfishing. Previous studies have reported declining catch rates and biological pressure in several Indonesian Waters due to uncontrolled expansion of small-scale fishing operations **(Maghfiroh & Zainuri, 2023; Widiyastuti *et al*., 2023)**. Similar patterns may occur in Buru District, where fishing activities continue to intensify, yet scientific assessments on stock utilization and sustainability remain scarce. Moreover, most existing studies in Eastern Indonesia focus on biological or production aspects, with limited integration of economic feasibility indicators that are essential for comprehensive fishery management.

Although several regional studies have addressed small pelagic fishery sustainability — for example, in the Tomini Bay **(Nurhayati *et al*., 2022)** and Banda Sea **(Puspita *et al*., 2023)**, there is still a lack of quantitative research that simultaneously assesses ecological and economic dimensions in Buru District. To date, no study has combined surplus production modeling with financial feasibility analysis for small pelagic fisheries in this area. Bridging this gap is crucial to provide a scientific foundation for adaptive fisheries policy in line with sustainable development goals.

Therefore, this study aims to (1) analyze the utilization status of small pelagic fish resources in Buru District using the Schaefer surplus production model to estimate CPUE and MSY, and (2) evaluate the economic feasibility of mini purse seine operations based on income, costs, and profitability indicators. The results are expected to support the formulation of evidence-based management strategies to balance ecological sustainability and economic welfare of local fishing communities.

MATERIALS AND METHODS

Location and time of research

This study was conducted in the coastal waters of Buru District, Maluku Province, Eastern Indonesia, which is geographically located between 3°15′–3°50′ S and 126°15′–127°10′ E (Fig. 1). The region is part of Fisheries Management Areas (FMA) 714 (Banda Sea) and 715 (Seram Sea), both of which are known for high small pelagic fish productivity. Data collection and analysis were carried out from March 2024 to January 2025. The research location and distribution of fishing grounds are illustrated in Fig. (1) using a georeferenced map produced in ArcGIS 10.8, based on administrative boundaries from the **Buru District Marine and Fisheries Service (2024)**.

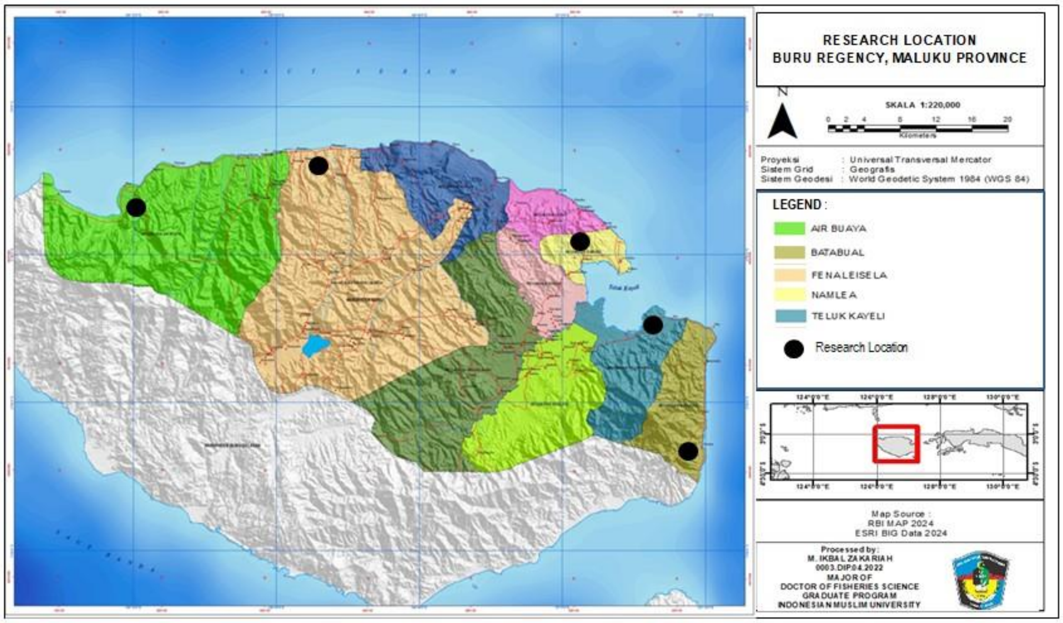

Fig. 1. Research location map

Data types and sources

This study applied a quantitative descriptive approach integrating primary and secondary data. Primary data were obtained through structured interviews with 12 active mini purse seine units distributed across five sub-districts (Air Buaya, Fena Leisela, Namlea, Teluk Kayeli, and Batabual). Respondents included vessel owners, skippers, and crew members.

Secondary data included annual catch and effort statistics from 2019–2024, sourced from the Buru District Fisheries Office and the Maluku Province Marine and Fisheries Service. Additional secondary datasets such as chlorophyll-a concentration and sea surface temperature (SST) were acquired from satellite repositories (MODIS Aqua and Copernicus portal) to support interpretation of productivity variation.

Population and sample

The total population consisted of 12 mini purse seine vessels operating in Buru waters. Since the population was relatively small (<30), a total sampling method was applied to include all vessels. From each vessel, three key respondents (owner, captain, and crew) were selected purposively to provide information on fishing operations, costs, and income structures.

Data collection techniques

The method used in this study is the survey method. The survey method aims to collect data from a number of variables in a community group through direct interviews and based on a list of questions that have been prepared in advance **(Ghaffar, 2006)**. The data collected are primary data and secondary data. Primary data were collected through structured interviews with fishermen (ship captains and crew) and ship owners, as well as direct observations in the field (observations). Secondary data were illustrated through statistical data on mini purse seine capture fisheries production in 2019-2024 from related agencies (the Maluku Province Marine and Fisheries Service and the Buru Regency Fisheries Service) and literature studies (journals, research reports).

Secondary data collection was conducted through literature studies, the internet, journals and data from the Buru Regency Fisheries Service and the Maluku Province Marine and Fisheries Service. Secondary oceanographic data were obtained from a satellite data provider portal that provides chlorophyll-a and sea surface temperature (SST) information with medium spatial and temporal resolution. Data were downloaded in raster format for the period December 2023 to November 2024.

Data analysis

Analysis of the status of utilization of small pelagic fish resources.

The level of utilization effort is carried out based on the surplus production model. Catch per unit effort (CPUE) is a method used to determine the results of the amount of marine fisheries production averaged over an annual period **(Gulland, 1983)**. Catch per unit effort (CPUE) analysis is used to determine the abundance and level of utilization based on the division between the total catch (Catch) and the fishing effort (Effort) with the equation according to **Sparre and Venema (1999)** as follows:

$$CPUE = \frac{C}{E}$$

Information :
Catch (C) = Total catch (kg)
Effort (E) = Total fishing effort (units)
CPUE = Catch per effort (kg/unit)

The CPUE value of the total catch (C) can be used to estimate MSY stock (*Maximum Sustainable Yield*) simply by using regression analysis between CPUE and the number of attempts which will later form the equation: y = a – bx, where:

$$b = \frac{n \; xy - xy}{n \; x^2 - (x)^2}$$

After a and b are obtained, they are then entered into the Schaefer formula, so that the sustainable potential of fish resources/maximum sustainable yield (MSY) and f MSY are obtained as follows:

The Schaefer model **(Sparre & Venema, 1999)** used in this study is the maximum sustainable production (MSY) obtained by substituting the optimum effort value. The Schaefer model is a parabolic equation that has a maximum value of Y (i), MSY, at a stage of effort:

$$MSY = \; -a \; 2b$$

The catch results at the optimal effort stage where a MSY condition will be achieved can be calculated using the formula:

$$MSY = -a^2 x\, 4b$$

Description: MSY =*Maximum Sustainable Yield*

Feasibility analysis of mini purse seine business

Feasibility analysis measurements include total cost analysis, total revenue analysis, profit analysis, R/C ratio, and payback period. According to **Soekartawi (2002)**, the calculation of total cost of fishermen's expenditure uses the following formula:

TC = FC + VC

Where,
TC : Expenditure cost (IDR)
FC : Fixed costs (IDR)
VC : Variable Cost (IDR)

Business income (TR) is the multiplication of the selling price (P) of the catch with the production of the catch obtained (Q). The formula used is:

TR = P x Q

Where, TR = Total revenue (IDR); P = Selling price (Kg); Q = Catch results

Profit represents the net return generated from total revenue after deducting all production costs incurred during a single fishing operation. In principle, the purpose of any fishing business is to achieve economic gain and ensure operational sustainability. The profit can be calculated using the following equation **(Karningsih *et al*., 2014)**.

π = TR – TC

Where, **π** = Profit (IDR); TR = Total income (IDR); TC = Total cost (Expenses (IDR)

The revenue-cost (R/C) ratio is an indicator used to evaluate the financial performance of fishing operations by comparing total revenue from fish production with the total operational costs incurred over a specific period. According to **Soekartawi (1995)**, the R/C ratio can be calculated using the following formula:

R/C ratio = TR/TC

Where, R/C ratio = Business feasibility; TR = Total income (IDR); TC = Total cost (IDR).

The resulting R/C ratio provides an indication of the economic feasibility of the fishing business. If the R/C ratio value is greater than 1, the fishing operation is considered profitable and financially viable. An R/C ratio equal to 1 indicates a break-even point where total revenue equals total cost, while a value less than 1 signifies that the operation is not economically feasible because costs exceed revenues. This indicator is widely used in fisheries economic analyses to assess the sustainability and profitability of small-scale fishing enterprises **(Soekartawi, 1995; Rahmawati & Arifin, 2023)**.

RESULTS

Utilization of small pelagic fish resources

Based on data in Table (1), the production, fishing effort, and CPUE of mini purse seine fisheries in Buru Regency from 2019 to 2024 exhibited a consistent upward trend in both total catch and fishing intensity. The production of small pelagic fish increased from 1,900.10 tons in 2019 to 3,398.07 tons in 2024, while fishing effort rose from 1,728 GT-days to 2,304 GT-days over the same period. Correspondingly, the CPUE improved from 1.0996 to 1.4749 ton/GT-day, indicating a rise in fishing efficiency.

This positive trend suggests optimization of fishing gear operation and more effective utilization of fishing grounds, implying that small pelagic fish stocks remain relatively productive. However, the observed increase in CPUE may also reflect improvements in fishing technology and efficiency rather than an actual rise in stock abundance.

The utilization status of small pelagic fish resources in Buru Regency was therefore evaluated using two key bioeconomic indicators: Catch per unit effort (CPUE) and the estimated maximum sustainable yield (MSY).

Table 1. Production, effort and CPUE of mini purse seine in Buru Regency (2019-2023)

Year	Production (tons)	Effort (trip/year)	CPUE (ton/trip)	Catch cumulative (tons)
2019	1,900	1728	1.0996	1,900
2020	1,425	1440	0.9896	3,325
2021	2,407	1872	1.2860	5,733
2022	2,569	2016	1.2742	8,301
2023	3,096	2160	1.4332	11,397
2024	3,398	2304	1.4749	14,795

In the cumulative catch vs CPUE graph of mini purse seine fishing gear in Buru Regency, the linear regression equation is y = 0.00004 + 994.28 with an R^2 value of 0.8433 (Fig. 2). The R^2 value indicates the extent to which catch or effort can affect CPUE. If the R^2 value approaches 0, it means that they do not affect each other, and if the R^2 value approaches 1, it means that they affect each other. Based on this value, the R^2 value = 0.8433 means that the cumulative catch affects CPUE. If the number of catches = 1, then the CPUE is equal to the value of a or 994.28.

Each additional 1 catch amount will affect the CPUE value by the value of b. Thus, in Buru Regency it was found that, if there is an additional 1 catch amount, it will increase the CPUE value by 0.00004.

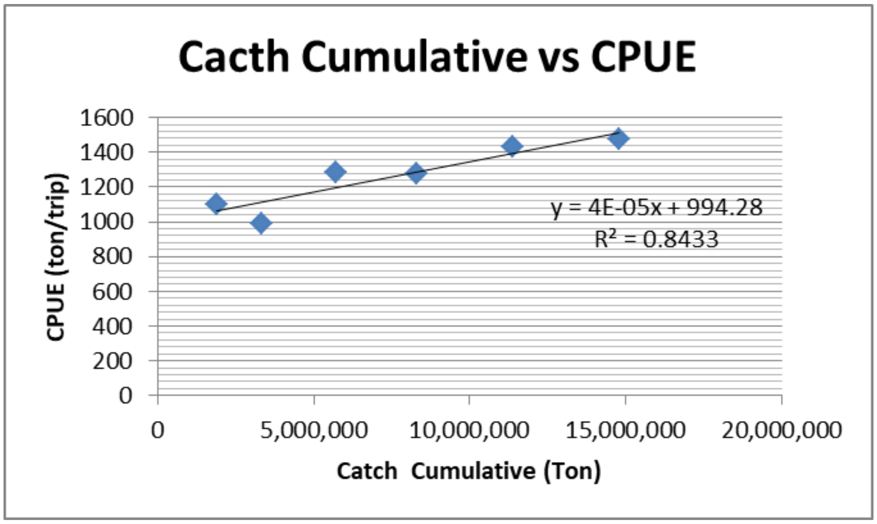

Fig. 2. Relationship between cumulative catch and CPUE of mini purse seine fisheries in Buru Regency

On the graph of fishing effort vs CPUE, a linear regression equation is obtained y = 0.0006x + 0.1294 with an R^2 value of 0.953 (Fig. 3). The R^2 value is close to 1 so that fishing effort affects CPUE. If fishing effort = 1 then CPUE is 0.1294. Every additional 1 fishing effort will increase CPUE by 0.0006.

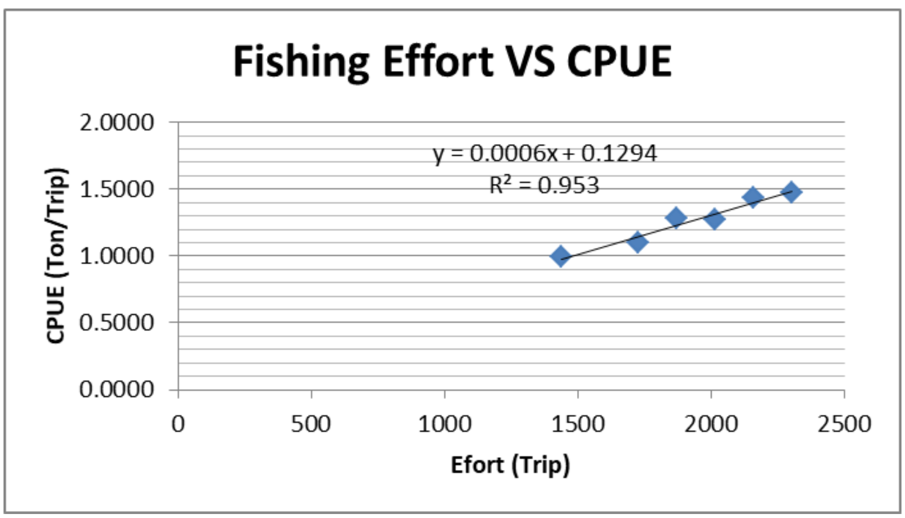

Fig. 3. Relationship between fishing effort and CPUE of mini purse seine fisheries in Buru Regency

Maximum sustainable yield (MSY)

Based on the results of the surplus production analysis using the Schaefer model, the catch maximum sustainable yield (CMSY) value was obtained at 7.116.34 ton/year and the optimum effort (EMSY) was 109.96 trip/year (Fig. 4). These values reflect the maximum level of catch and fishing effort that can still be carried out sustainably without reducing the stock of small pelagic fish in the waters of Buru Regency. However, when compared to actual data over the past six years (2019–2024), the annual effort used far exceeds the EMSY value, with an effort range of 1.440 to 2.304 trip/year.

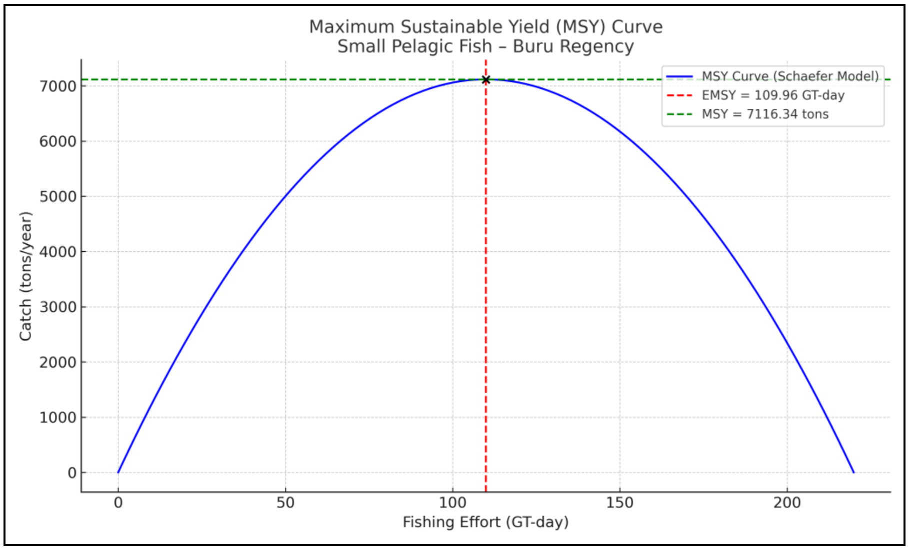

Fig. 4. Maximum sustainable yield (MSY) curve of small pelagic fisheries estimated using the Schaefer surplus production model in Buru Regency

These results indicate that small pelagic fishing activities in Buru Regency have reached an overfished condition. Although fish production increased from 1.425 tons in 2020 to 3.398 tons in 2024, this rise was accompanied by a substantial escalation in fishing effort. The CPUE values showed only a modest increase, suggesting that the higher production was primarily driven by intensified fishing activities rather than an actual improvement in stock abundance.

From an ecological perspective, this pattern reflects a transition toward unsustainable exploitation, where excessive effort may gradually reduce fish biomass, disrupt population dynamics, and ultimately threaten the long-term productivity of the fishery. The observed stagnation or slight decline in CPUE is consistent with the typical symptoms of overfishing, as continuous and intensive fishing pressure reduces natural stock abundance **(Widiyastuti *et al*., 2023; Tuapetel & Rahman, 2025)**.

Therefore, these findings provide an essential scientific basis for developing adaptive and sustainable management strategies—such as regulating fishing effort, implementing seasonal closures, and enhancing catch monitoring—to maintain the sustainability of small pelagic fish resources in Buru Regency.

Feasibility of fishing business

Business feasibility analysis is an important aspect in evaluating the sustainability of fisheries activities not only from an ecological perspective but also from an economic perspective. Based on the simulation of the average price of small pelagic fish of Rp15.000/kg, the total income in 2024 is calculated from the total production 2024 amounting to 3.398.07 tons or 3.398.070 kg, then the income (Revenue) is IDR 50.971.050.000. Operational costs consist of fixed costs (ship depreciation) and variable costs (fuel, crew wages, logistics, ice, diesel, and maintenance of the equipment). Based on the survey and literature, the estimated total cost in 2024 is IDR 26.422.350.000 and the net profit is IDR 24.548.700.000. The R/C ratio value obtained is 1.93 which means that the R/C ratio> 1 indicates that the mini purse seine fishing business in Buru Regency is economically feasible.

DISCUSSION

The utilization of small pelagic fish resources in the waters of Buru Regency plays a critical role in supporting the local economy and ensuring food security. The analysis of utilization status in this study is based on two key bioeconomic indicators: catch per unit effort (CPUE) and maximum sustainable yield (MSY). The integration of primary field data with secondary statistics and relevant literature provides a comprehensive overview of the current state of the fishery and its implications for long-term sustainability.

The observed increase in CPUE over the period 2019–2024 may reflect optimization of fishing gear operation and more efficient exploitation of fishing grounds. At first glance, this pattern suggests that small pelagic fish stocks remain productive. However, such an increase can also result from improved gear performance or fishing technology rather than a real enhancement in stock abundance. This finding is consistent with previous studies showing that mini purse seine fisheries across Indonesia, including in Tomini Bay, have expanded rapidly due to their operational efficiency and relatively low investment costs **(Anggawangsa *et al*., 2014; Nurhayati *et al*., 2022)**.

Although fish production has grown substantially, this expansion has been driven by a sharp rise in fishing effort rather than natural stock recovery. An increase in total production without a proportional increase in CPUE is an early signal of stock depletion. The trend of stable or slightly increasing CPUE despite greater effort indicates a gradual decline in resource abundance **(Widiyastuti *et al*., 2023)**. Ecologically, such a condition marks the onset of unsustainable exploitation, potentially reducing fish biomass, altering population structure, and threatening long-term fisheries productivity in the region.

According to **Widodo and Suadi (2008**), overfishing occurs when the level of fishing effort exceeds that required to achieve MSY. Therefore, maintaining fishing effort below or near the EMSY threshold is essential to ensure optimal yield while preserving stock resilience. In the case of Buru Regency, actual effort levels far exceed EMSY (109.96 trip/year), suggesting the need for immediate management interventions. If unregulated, continuous effort expansion could trigger biological overexploitation and economic inefficiency in the near future.

The mini purse seine fishery in Buru Regency demonstrates high economic feasibility, with an R/C ratio of 1.93, indicating substantial profitability. However, this economic success must be interpreted cautiously, as it often becomes the primary driver of effort escalation. Similar findings were reported by **Rahmawati and Arifin (2023)** and **Pical and Rahman (2025)**, who noted that strong profitability in small-scale purse seine operations can accelerate resource depletion when management controls are weak. In the present study, the positive financial performance coincides with excessive fishing effort, underscoring the classic trade-off between short-term economic gain and long-term ecological stability.

Comparable studies across Eastern Indonesia have revealed parallel patterns. In the Banda Sea, **Puspita *et al*. (2023)** observed that pelagic fishery productivity remains high but faces increasing ecological stress from intensified operations. Meanwhile, **Setiawan and Fahrudin (2021)** emphasized that socio-economic dependency on small pelagic fisheries often limits the willingness of local fishers to reduce effort, making community-based management and incentive mechanisms crucial. These findings reinforce the need to couple economic feasibility analyses with ecological performance indicators, ensuring that profitability does not compromise sustainability.

From a policy perspective, adaptive and science-based management is urgently required to prevent further degradation of small pelagic stocks in Buru Waters. Strategies such as effort limitation, seasonal closures, and monitoring of CPUE trends can help maintain stock productivity **(Dahuri & Purbayanto, 2021)**. Furthermore, integrating local fishers into co-management frameworks can enhance compliance and foster stewardship over marine resources. As demonstrated by **Tawari *et al*. (2025)**, the sustainable traditional fishing practices using *Tali Kor* gear in Watubela Waters embody ecological sensitivity and selective harvesting principles that maintain resource balance. Such community-based ecological wisdom provides an exemplary model for harmonizing traditional knowledge with modern fisheries management in Maluku Waters. Sustainable management of small pelagic fisheries should not only aim to maintain biological stocks but also to secure the socio-economic resilience of coastal communities that depend on them.

In summary, the current utilization pattern in Buru Regency illustrates the dual reality of small pelagic fisheries in Indonesia—economically profitable yet ecologically vulnerable. Balancing these dimensions requires integrated policy interventions that combine bioeconomic assessments with participatory governance to align local livelihoods with the broader objectives of sustainable marine resource management and SDG 14 (Life Below Water).

CONCLUSION

This study reveals that small pelagic fisheries in Buru Regency have exceeded sustainable exploitation levels. Despite increased production from 1.900 tons (2019) to 3.398 tons (2024), fishing effort rose sharply, surpassing the estimated optimal level (EMSY = 109.96 trip/year). The calculated MSY of 7.116.34 ton/year and the declining CPUE trend indicate an overfished condition. Economically, the fishery remains profitable (R/C ratio = 1.93), generating a net income of IDR 24.55 billion, yet this profitability is achieved under ecologically unsustainable conditions. To maintain long-term productivity, adaptive management is essential through effort limitation, seasonal closures, and participatory co-management involving local communities. Balancing ecological sustainability and economic viability is critical to ensure the resilience of small pelagic fisheries and to support the achievement of Sustainable Development Goal 14 (Life Below Water) in Buru Regency.

REFERENCES

Anggawangsa, R. F.; Suwarso, S. and Wudianto, W. (2014). Catch rate and catch composition of mini purse seine in Bualemo, Banggai District. *Indonesian Fisheries Research Journal*, 20(1), 23–28.

Aprilia, R.; Susiana, S. and Muzammil, W. (2021). Tingkat pemanfaatan ikan kembung (*Rastrelliger kanagurta*) di perairan Mapur yang didaratkan di Desa Kelong, Kabupaten Bintan. *Jurnal Kelautan: Indonesian Journal of Marine Science and Technology*, 14(2), 111–119.

Asia, H. (2024). *Buku referensi potensi sumber daya perikanan di WPP 714, 715, 716* (1st ed.). PT Media Penerbit Indonesia.

Dahuri, R. and Purbayanto, A. (2021). Sustainable fisheries management framework for Indonesian archipelagic waters. *Marine and Fishery Sciences*, 12(4), 251–266.

Dollu, E. A.; Tell, Y. Y. and Bolang, F. B. (2021). Analisis kelayakan usaha perikanan tangkap mini purse seine (pukat cincin) di perairan Kokar, Kabupaten Alor, Nusa Tenggara Timur. *Akuatika Indonesia*, 6(1), 1–10.

Kabupaten Buru, Dinas Perikanan. (2020). *Proposal bantuan sarana perikanan tangkap*. Dinas Perikanan Kabupaten Buru.

Karningsih, F.; Rosyid, A. and Wibowo, B. A. (2014). Analisis teknis dan finansial usaha perikanan tangkap cantrang dan payang di Pelabuhan Perikanan Pantai Asemdoyong Kabupaten Pemalang. *Journal of Fisheries Resources Utilization Management and Technology*, 3, 158–167.

Maghfiroh, V. and Zainuri, M. (2023). Analisa tingkat pemanfaatan ikan tongkol (*Euthynnus affinis*) di perairan Pasongsongan dan sekitarnya, Kabupaten Sumenep, Madura. *Juvenil: Jurnal Ilmiah Kelautan dan Perikanan*, 4(3), 158–166.

Nurhayati, A.; Baskoro, M. S. and Zulkarnain, M. (2022). Bioeconomic analysis of small pelagic fisheries in Tomini Bay using the Schaefer model. *Indonesian Fisheries Research Journal*, 28(2), 71–82.

Pical, V. J. and Rahman, R. (2025). Alternative livelihoods of traditional fishermen as the impact of climate change in Ambon City. *Egyptian Journal of Aquatic Biology and Fisheries*, *29*(1), 243-256.

Puspita, R.; Yuniarti, R. and Satria, F. (2023). Assessment of small pelagic fishery sustainability in the Banda Sea, Indonesia. *Ocean & Coastal Management*, 241, 106766.

Rahmawati, E. and Arifin, Z. (2023). Economic performance and profitability of small-scale purse seine fisheries in Indonesia. *Fisheries Research*, 263, 106589.

Setiawan, A. and Fahrudin, A. (2021). Socioeconomic aspects and management strategies for small pelagic fisheries in Eastern Indonesia. *Marine Policy*, 133, 104736. https://doi.org/10.1016/j.marpol.2021.104736

Siregar, S. (2017). *Metode penelitian kuantitatif: Dilengkapi dengan perbandingan perhitungan manual & SPSS*. Kencana.

Suryawati, S. H. and Kuswoyo, A. (2022). Overfishing analysis of small pelagic fisheries in the Java Sea using production models. *Jurnal Ilmu Kelautan Tropis*, 14(3), 145–157.

Tawari, R. H. S.; Rahman.; Borut, R. R; Haruna. and Siahainenia, S. R. (2025). Sustainable traditional fishing: Ecological principles in the use of *Tali Kor* fishing gear in Watubela Waters, Maluku-Indonesia. *Egyptian Journal of Aquatic Biology and Fisheries*, 29(2), 149-158.

Teh, L. C. L.; Cashion, T. and Sumaila, U. R. (2020). Measuring the sustainability of small-scale fisheries: A global perspective. *Marine Policy*, 122, 104264. https://doi.org/10.1016/j.marpol.2020.104264

Tuapetel, F. and Rahman. (2025). Utilization of fish resources and conservation efforts in Ambon Bay, Indonesia. *Egyptian Journal of Aquatic Biology and Fisheries, 29*(1), 1425 – 1435.

Widiyastuti, H.; Kuswoyo, A. and Tirtadanu, T. (2020). Perikanan jaring bobo di Ambon. *Prosiding Seminar Nasional Perikanan dan Kelautan VIII Tahun 2019*, 1–8.

Widiyastuti, H.; Noegroho, T. and Pangaribuan, N. (2023). Characteristics of small pelagic mini purse seine fisheries in Rembang, Central Java. *Marine Fisheries: Journal of Marine Fisheries Technology and Management*, 14(1), 53–64.

Widodo, J. and Suadi, S. (2008). *Pengelolaan sumberdaya perikanan laut*. Gadjah Mada University Press, Yogyakarta.

Zainuddin, M.; Kurnia, M. and Sudirman, S. (2020). Seasonal variability of small pelagic fish distribution in relation to oceanographic factors in the Sulawesi Sea. *Regional Studies in Marine Science*, 37, 101334.