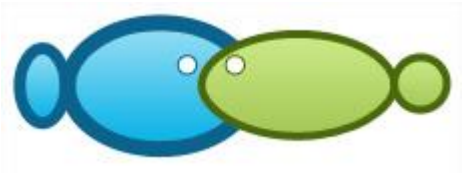

Productivity and feasibility of handline tuna business based at the Integrated Marine and Fisheries Center in Morotai Island

[1]Imran Taeran, [2]Zauzah Abdullatif, [3]Muhajir K. Marsaoli, [4]Zulhan A. Harahap

[1] Fishery Resource Utilization Department, Faculty of Fisheries and Marine Science, Khairun University, Ternate, Indonesia; [2] Agronomy Department, Faculty of Agriculture, Khairun University, Ternate, Indonesia; [3] Marine Science Graduate Study Department, Khairun University, Ternate, Indonesia; [4] Marine Science Department, Khairun University, Ternate, Indonesia. Corresponding author: Z. Abdullatif, zauzahlatif@gmail.com

Abstract. Tuna hand line is a fishing gear used by fishermen to catch tuna on Morotai Island, Indonesia. So far, there is little scientific information related to the performance of the tuna hand line business. This study aims to analyze the productivity and feasibility of the hand line tuna business based in Morotai Island's Integrated Marine and Fisheries Center (IMFC). The research was conducted on Morotai Island, North Maluku Province, Indonesia, from April to September 2022. Data on tuna production, number of units and trips for fishing in the 2015-2021 period were obtained through reports from the Department of Marine Affairs and Fisheries of Morotai Island Regency. Data related to business feasibility were obtained through interviews with hand line tuna fishermen. Analysis of production and productivity data was carried out by using descriptive statistics. Business feasibility analysis was carried out by calculating net present value (NPV), internal rate of return (IRR), benefit cost ratio (B/C ratio), and payback period (PP). The productivity of hand line tuna in the 2015-2021 period had an increasing trend, from 85 kg per trip in 2015 to 250 kg per trip in 2021. Productivity based on the number of tuna fishing units ranged from 1.82-3.42 tons per unit per day, yearly. Tuna hand line business required an investment of 3057 USD. The total cost of production was 9752 USD per year, the total revenue was 12,90 USD, so the net benefit achieved was 2538 USD. The investment criteria calculated were NPV>0, which was 9739 USD, an IRR > deposit interest rate is 77%, B/C ratio >1 is 4.19, R/C>1 is 1.25, and PP is 0.5 years.
Key Words: business feasibility, North Maluku, productivity, tuna fishing.

Introduction. Morotai Island Regency, which is located on the Pacific Rim, has a sea area of 79.6% of the regency total area of 2476 km^2, with a coastline length of 311.21 km, and consists of 33 islands. The regency's entire area is surrounded by the sea, namely: to the north it is bordered by the Pacific Ocean, to the west it is bordered by the Sulawesi Sea, to the south by Morotai Strait, and to the east by the Halmahera Sea (Ratnawati et al 2019). This geographic condition provides an opportunity for the marine fisheries sector to be the leading sector to be developed.

As an effort to develop the marine and fisheries sector, the government has built the Morotai Island's Integrated Marine and Fisheries Center (IMFC) in 2015. Its development was based on the Regulation of the Minister of Marine Affairs and Fisheries of the Republic of Indonesia Number 48/PERMEN-KP/2015 concerning General Guidelines for the Development of Integrated Marine and Fishery Centers on the Small Island and Border Area. The IMFC development was focused on four goals, namely: increasing added value, increasing competitiveness, modernization and corporatization of business, and strengthening the production and productivity of the main players and fishery business actors (KKP 2017). The area has been equipped with a Fish Landing Center (FLC), Processing Center, Export and Marketing Center, Logistics Center, and Integrated Service Center (KKP 2019), involving many business actors in the fishing industry development (Adam 2012).

The development of the Morotai fishing industry is generally focused on developing tuna fish resources (Sofiati & Alwi 2018; Sofiati & Deto 2019). The opportunity to develop tuna as a leading commodity in Morotai Island Regency is reasonable because the regency's high potential for tuna, and because tuna has a stable market price (Sofiati & Alwi 2019; Abdullah et al 2020). Morotai tuna businesses were carried out mostly in the form of small-scale businesses using motorboats and hand-line tuna fishing gears. The motorboats used had a capacity of 1.5-15 GT (Sofiati & Alwi 2019). The number of hand line tuna vessels continued to increase yearly due to several factors, including: relatively low costs, the good quality of the caught fish, being marketed as an export commodity, fishing activities do not depend on season, and fishing areas are relatively fixed around FADs and have a high productivity (Nurdin et al 2015).

The success of a fishing effort is highly depended on the productivity of the fishing gear used (Iskandar 2010). The productivity of fishing vessels represents the level of their ability to obtain fish catches in a period of time (Saputra et al 2011), providing fishermen with information about the ability of a fishing gear (Nurhayati et al 2018). Activity of using fishery resources can be measured by economic variables to assess the feasibility of the business and the level of community welfare, especially for tuna fishermen (Mustaruddin et al 2021). Information on available tuna resources, productivity of fishing gear, and business feasibility will facilitate the development of hand line tuna investments. This study aims to determine the productivity of hand line tuna fishing gear and analyze the feasibility of a hand line tuna business based at Morotai Island IMFC.

Material and Method. The research was conducted on Morotai Island, North Maluku Province (Figure 1), from April to September 2022.

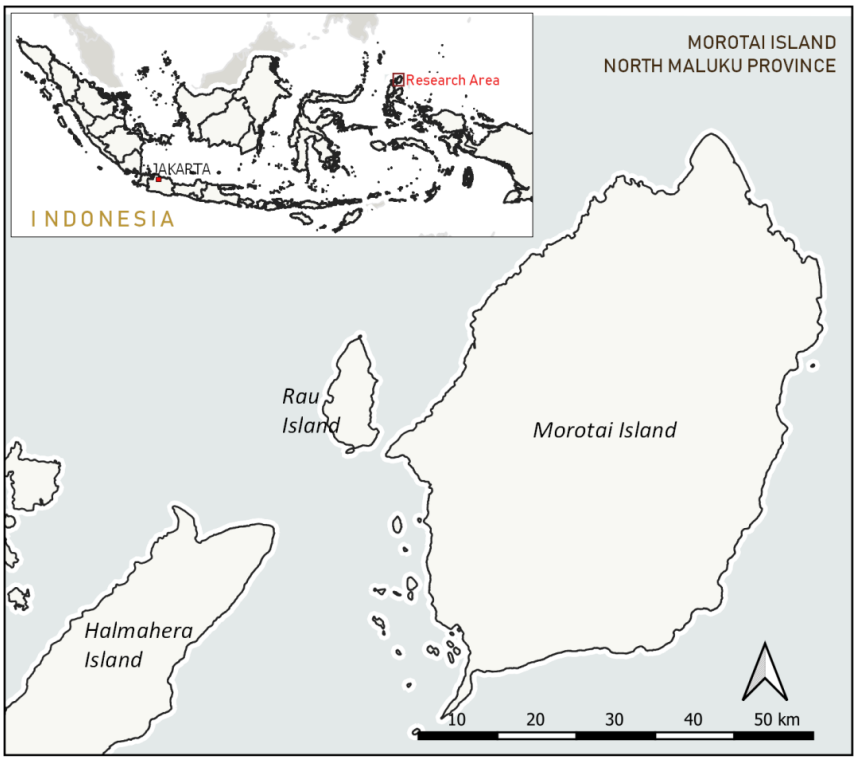

Figure 1. Research area in Morotai Island Regency, North Maluku, Indonesia.

The data collected in this study were primary and secondary data. Primary data were obtained from primary sources through direct interviews and questionnaires. Purposive sampling was performed. Purposive sampling is the determination of the sample with the consideration that the population is chosen intentionally based on certain objectives and

considerations. Respondents in this study were 100 hand line tuna fishermen based in IMFC Morotai. The types of data collected consisted of: boat dimensions (length, width, and depth), boat capacity (GT), type and engine power, investment costs, operational costs, maintenance costs, number of fishing trips, number of tuna catches, selling prices, and fishermen wages. Secondary data was collected through sources from relevant agencies, namely: the Department of Marine Affairs and Fisheries of the Morotai Island Regency, the Planning and Development Agency for Morotai Island, the Ministry of Marine Affairs and Fisheries of the Republic of Indonesia.

Data analysis was carried out using productivity analysis and business feasibility analysis. The calculated productivity is based on fishing trips and on fishing units. Fishing productivity is determined based on a ratio between production and the number of fishing trips (Saputra et al 2011; Gogasa et al 2020).

$$\text{Productivity (kg/trip)} = \frac{\sum \text{catch (kg)}}{\sum \text{trip}}$$

Productivity is based on the comparison between production and the number of fishing gear units, being calculated by the following equation (Setyorini et al 2009):

$$\text{Productivity (ton/unit)} = \frac{\sum \text{catch } (ton)}{\sum \text{fishing efforts (unit)}}$$

Business feasibility analysis was used to determine the feasibility of developing the handline tuna business in Morotai waters. This analysis was carried out for the development of tuna fish resources, which have abundant potential in Morotai sea (Sofiati & Alwi 2018). The results of the investment and business feasibility analyses were needed to strengthen the use of all fishing fleets, both non-motorized and motorized, which can be further developed in Morotai Island Regency (Zamroni et al 2019). A feasibility analysis was carried out on fleets of less than 5 GT, which were the dominant sizes used by handline tuna fishermen in Morotai Island. The study adopted the business feasibility analysis developed by Hanley & Spash (1993) that consists four components described below.

1. The Net Present Value (NPV) was used to determine the value of the present benefits obtained from an investment activity. If NPV>0, then the business is acceptable (feasible) and if NPV<0, then the business is not acceptable. The formula for calculating NPV is:

$$\text{NPV} = \sum_{t-1}^{n} \frac{\text{Bt} - \text{Ct}}{(1 - \text{i})^{n}}$$

Where: Bt - gross benefit (income) at year-t (USD); Ct - gross cost at e=year-t (USD); i - interest rate (%); t - investment period (i= 1, 2, 3, ..., n).

2. The Internal Rate of Return (IRR) was used to determine the extent to which tuna fishermen are able to return the capital invested from the business compared to the value of the cost of capital balance, namely the prevailing interest rate. A business investment will be declared feasible if the IRR value is greater than the return value. Mathematically, IRR is expressed by following equation:

$$\text{IRR} = i_1 + \left[\frac{\text{NPV}_1}{\text{NPV}_1 - \text{NPV}_2} \right] (i_2 - i_1)$$

Where: i_1 - interest rate producing positive NPV; i_2 - interest rate producing negative NPV; NPV_1 - NPV at discount rate i_1; NPV_2 - NPV at discount rate i_2.

3. The Benefit-Cost Ratio (B/C ratio) was used to compare the present value of benefits with the present cost value. Theoretically, the B/C ratio is a comparison between all benefit values to all sacrifices or costs, calculated using the formula:

$$\text{B/C Ratio} = \frac{\sum_{t-1}^{n} \frac{(B_t - C_t)}{(1+i)^t}}{\sum_{t-1}^{n} \frac{(C_t - B_t)}{(1+i)^t}}$$

Where: B - benefit; C - cost; 1 - discount rate; t - period. The criteria analysis is as follows: if *net* B/C ratio > 1, the investment is feasible since it produces benefits; if net B/C ratio = 1, the investment is at balance (no benefits or loss); if net B/C ratio < 1, the investment is not feasible (loss).

3. Revenue-cost ratio analysis was used to find out how far each cost spent in business activities can provide a number of revenue values as benefits. The formula used to calculate R/C is:

$$R/C = \frac{TR}{TC}$$

Where: if *R/C > 1*, business is profitable; if *R/C < 1*, business is loss; and if *R/C = 1*, business is in break event point.

5. The Payback Period (PP) is used to determine the length of the period required to return the capital invested in a business activity. A business is said to be feasible if the PP obtained is less than a specified period. The formula used is as follows:

$$PP = I/\pi$$

Where: PP - payback period; I - investment or budget needed for procurement of capital goods or fixed capital (USD); π - income (USD).

Results and Discussion

Integrated Fishery and Marine Center of Morotai Island. The development of IMFC is based on the principles of responsible, competitive, and sustainable management of marine and fisheries resources by involving all stakeholders (local governments, related ministries/institutions, BUMN/BUMD (national and local business organizations), private sector, cooperatives, local communities, and other relevant stakeholders. The implementation of IMFC development can integrate community-based marine and fishery business processes through optimizing the sustainable use of marine and fishery resources in small islands and/or border areas.

The activities of the Morotai Island IMFC started in 2016. The objectives of the Morotai Island IMFC are: 1) increasing fish production, 2) improving the quality of fishery products through the industrialization of fishery in order to create added value, 3) bringing in foreign exchange through the export of fishery products, 4) increase economic growth in the fishery sector, and 5) increase job opportunities and business opportunities for fishermen and business actors in the fishery sector.

Some of the infrastructure owned by IMFC Morotai Island includes: integrated cold storage with a capacity of 200 tons, refrigerated transport cars, and a 10 tons ice factory. IMFC Morotai Island has exported tuna loins to several countries that contribute to improving national welfare and foreign exchange. In 2018, there were 74 tons of tuna loin exports with a value of 626153.96 USD. In 2019, tuna loin exports from IMFC Morotai increased to 251 tons with a value of 2259000 USD. In addition to tuna loin, IMFC Morotai Island also produces tuna and baby tuna in an average of 10 tons per month, with a value of 12036.74 USD and an average of 2.7 tons per month of ice worth 4371.24 USD.

Handline tuna fishing units. Most tuna fishermen in Morotai Island area use handline fishing gear because it is very simple. The main parts of the handline fishing gear consist of the main line, base line, fishing line, swivel, and weights. The specifications consist of: the main rope made of nylon number 150 with a length of 300 m, the base rope made of nylon number 80, with a length of 10 m, fishing swivel number 1, tuna hook no. 4, the main weight made of tin and additional weights using stones measuring 300-500 kg, bait in the form of fish or squid. Handline tuna boats are made of fiberglass; have a length ranging from 7 to 10.8 m, 1-1.2 m width, and 0.5-0.8 m height. The dominant propulsion engines used are 15 and 40 HP, each boat using 1-2 engines.

Fishing operations are carried out for one day (daily trip), starting at 06:00 and finishing at 15:00 local time. The fishing grounds are in Morotai territorial sea, especially those that have been installed with FADs. The operation is carried out by hooking the bait on the fishing line. The bait is tied to additional ballast (stone), which is lowered and dropped to a predetermined depth. The average catch per trip per unit ranges from 2-5 fish per trip with an average fish weight of 30-40 kg per fish.

Handline tuna production and productivity. Tuna production in Morotai Island district for the 2015-2021 period increased yearly. Total production of 309 tons in 2015 increased to 2612 tons in 2021. Tuna production experienced a drastic increase in 2018, due to an increase in the number of boats and additional fishing trips since the operation of the IMFC (Table 1).

Table 1

Tuna production of Morotai Island Regency in 2015-2021

Year	*Production (ton)*	*Boat (unit)*	*Trip*
2015	309	121	3635
2016	325	189	1757
2017	496	277	2041
2018	1863	544	6978
2019	1985	737	7089
2020	2223	784	9665
2021	2612	802	10448

The level of fishing productivity will provide a picture of the fishing effort carried out in an area. Catch productivity can be measured simply by comparing the production volume of the catch with the amount of effort made.

In this research, productivity is defined as productivity based on fishing gear units and productivity based on fishing trip units. The productivity of handline tuna catching in Morotai in the period 2015-2021 has an increasing trend, both productivity according to fishing trip units and productivity according to the number of fleet units. The average fishing productivity according to fishing trips in 2015 was 85 kg per trip, increasing to 250 kg per trip in 2021, and the average fishing productivity according to the number of fleet units each year fluctuated between 1.72 to 3.42 tons per unit (Figure 2).

The average value for this productivity is higher than the average CPUE of handline in Bitung waters, namely 1516 kg per trip (Darondo et al 2020). Productivity experienced a significant increase in 2018, indicating the positive impact of the operation of the IMFC on Morotai Island. The operation of the IMFC was followed by the assistance regarding the fishing fleet, resulting in an increase in the number of fishing trips. Nurdin et al (2015) stated that the fluctuations in catch could be influenced by the number of fleets and the number of fishing trips each year. A greater number of trips will be positively correlated with the catch (Alhuda et al 2016; Damayanti 2020). The facilities available at the IMFC such as fish landing centers, ice factories, cool storage, and marketing can be convenient and provide motivation for fishermen and business actors in carrying out tuna fishing activities. In addition, the formation of cooperatives facilitated the marketing of the catch. Fleet unit assistance and FAD assistance by the local and central government had a very positive effect on increasing tuna catch production.

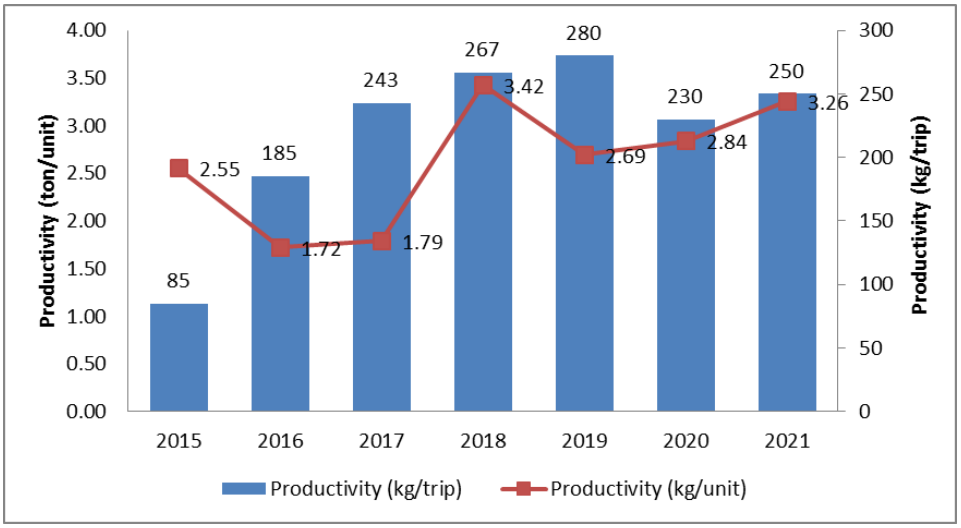

Figure 2. Productivity graph of tuna hand line.

The increase in handline tuna productivity was also thought to be related to the availability of tuna resources in the waters. Wiyono (2010) stated that high productivity can reflect the abundance of fish in a sea water body. Imron et al (2020) stated that if the productivity value increases, it indicates that the condition of the resource is good. Morotai Island Sea is part of the Pacific Ocean, thought to be a good tuna fishing area, because it is one of the entry gates for the Indonesian Through Flow (Haikal et al 2012). The assumption that the waters of Morotai Island is a good fishing area for tuna is strengthened by oceanographic conditions, such as sea surface temperature, chlorophyll-a concentration, and the size of the fish captured. BAPPEDA office of North Maluku Province (2022) reported that the Morotai area sea surface temperature varied between 28.9-31.2°C, the distribution of chlorophyll-a ranged from 0.023-1.4 mg L^{-1}, and the average size of tuna caught was 30 kg. Paillin et al (2020) stated that a water with a sea surface temperature between 29-30°C is good as a fishing area. Widodo (1999) stated that if the chlorophyll-a concentration is greater than 0.2 mg m^{-3} in water, then it is categorized as a potential fishing ground. The size of yellowfin tuna that is said to be suitable for catching is 20 kg, because at this size the fish has spawned once (FAO 2016).

The feasibility of a handline tuna business. The investment costs for the hand line tuna fishing business are used to procure boats, propulsion engines, fishing gear and accessories. Tuna handline business requires an investment of 3057 USD. The largest investment proportion is in propulsion engines, reaching 56% and in boats, with 41%, while fishing gear and equipment have only 3% of the investment (Table 2).

Table 2

Investment budget for a tuna handline business in Morotai Island Regency

Investment item	*Cost (USD)*	*Proportion (%)*
Boat	1267	41
Engine	1710	56
Fishing gear	79	3
Total	3057	100

Operational costs are total costs used for a tuna fishing business activity, consisting of variable costs and fixed costs. The amount of variable costs was 9197 USD. The biggest variable costs were fuel, reaching 56% and crew wages, with 32%. Other operational costs include supplies, ice, and bait in very low quantities, with a proportion of only 3-5%. Fixed costs only consist of depreciation costs and maintenance costs amounting to 554.78 USD, with the largest value being depreciation with a proportion of 73%, while

the maintenance value was 27%. The total operational cost for one year is 9752 USD, while the total revenue is 12290 USD, so the net benefit is 2538 USD (Table 3).

Table 3

Operational cost, total cost, total income, and net benefit of a tuna handline business

Components	*Value per year (USD)*	Proportion (%)
Variable (non-fixed) cost		
Fuel (gasoline)	5,190	56
Supplies	466	5
Ice	243	3
Bait	380	4
Crew wages	2918	32
Total	9197	100
Fixed costs		
Depreciation	402.73	73
Maintenance	152.04	27
Total	554.78	100
Total costs	9752	-
Total income	12290	-
Net benefit	2538	-

The handline tuna fishery business requires economic sustainability in order to meet the needs of the actors involved in it. Table 4 shows that all the parameters analyzed meet the criteria for feasibility. The NPV value of 9739 USD is higher than 0, indicating that the investment provides a reasonable net benefit, even after considering the prevailing interest rates. IRR was 77%, greater than the benchmark interest rate (10%). The B/C ratio was 4.19, higher than 1, meaning that all handline fleets used by fishermen in the area are eligible to continue their business throughout the year. The R/C of 1.25 is higher than 1, indicating that the tuna handline business is feasible to continue. PP was 0.5 years, meaning that the business is feasible, and the return on capital being lower than the estimated life of the project in a period of 10 years.

Table 4

Tuna handline business feasibility

Feasibility parameters	*Standard*	*Values*	*Category*
NPV	>0	9739 USD	Feasible
IRR	>10%	77%	Feasible
B/C ratio	>1	4.19	Feasible
R/C	>1	1.3	Feasible
PP	-	0.5	Feasible

Note: NPV - net present value; IRR - internal rate of return; B/C ratio - benefit/cost ratio; R/C - revenue-cost ratio; PP - payback period.

Business feasibility is very important to determine the financial performance of a business. Information about business feasibility becomes a reference for capital owners in making decisions of investments in their business. The handline tuna fishery business has a decent NPV value, reaching 9739 USD. This NPV value represents the net profit that can be received over the life of the tuna handline business. The IRR (77%) value is also considered feasible that shows investing money in a handline tuna business can yield a decent profit ratio that can easily cover the interest on credit loans (10% per year). Batista et al (2015) and Prabowo et al (2012) state that in addition to being profitable, the value of investment returns must be large enough to cover all fishing expenses, especially credit/loan interest, which is usually high. The survey results show that all handline tuna fishermen in Morotai rely on loans either from banks or moneylenders for boat purchases and fishing operational costs. The value of the B/C ratio indicates that the

revenue is always greater than all the financing spent to support handline tuna operations. Thus, the business can always generate profits in its operation. The R/C value indicates that each business unit is feasible to be developed. Because NPV, IRR, B/C ratio, and PP have good values, in terms of investment, the handline tuna business can be developed in Morotai Island Regency.

Conclusions. The productivity of handline tuna fishing gear in the 2015-2021 period fluctuated, but had an upward trend from 85 kg per trip in 2015 to 250 kg per trip in 2021. When the productivity value was based on the number of tuna fishing units, there were fluctuations in productivity in the period 2015-2021 generated by each fleet. The highest productivity occurred in 2018, with a tuna catch productivity value of 3.42 tons per unit per year. Tuna hand line business requires an investment of 3057 USD. The largest investment proportion is in the engine propulsion, up to 56%, and in the boat, with a value of 41%. The total cost of production is 9752 USD/year, the total revenue is 12290 USD so the net benefit achieved is 2538 USD. The investment criteria are: NPV>0 (9739 USD, IRR > deposit interest rate (77%), B/C ratio>1 (4.19), R/C>1 (1.25), and PP is 0.5 years. In terms of investment, the handline tuna business may be developed in Morotai.

Acknowledgements. We would like to thank the Center for Research and Community Service of Khairun University that has provided funding for this research through Higher Competitive Research Scheme (PKUPT) fund.

Conflict of Interest. The authors declare that there is no conflict of interest.

References

Abdullah R. M., Taeran T., Akbar N., 2020 [Evaluation of tuna fisheries management based on an ecosystem approach in Morotai Island District]. Jurnal Enggano 5(2):143-151. [In Indonesian].

Adam L., 2012 [Sustainable fisheries development policy (Case study of Wakatobi District, Southeast Sulawesi Province and Morotai Island District, North Maluku Province)]. Jurnal Perikanan dan Kelautan 2(2):115-126. [In Indonesian].

Alhuda S., Anna Z., Rustikawati I., 2016 [Analysis of productivity and business performance of purse seine fishermen at the Lempasing Beach Fishing Port, Bandar Lampung]. Jurnal Perikanan Kelautan 8(1):30-40. [In Indonesian].

Batista M. I., Horta e Costa B., Gonçalves L., Henriques M., Erzini K., Caselle J. E., Gonçalves E. J., Cabral H. N., 2015 Assessment of catches, landings and fishing effort as useful tools for MPA management. Journal of Fisheries Research 172(1):197-208.

Damayanti H. O., 2020 [Productivity of purse seine fishing nets]. Jurnal Litbang: Media Informasi Penelitian, Pengambangan dan IPTEK 16(1):29-46. [In Indonesian].

Darondo F. A., Halim S., Wudianto, 2020 [The abundance of yellowfin resources (*Thunnus albacares* Bonaterre 1788) in Bitung Waters]. Jurnal Sains dan Teknologi 3(1):49-64. [In Indonesian].

Gogasa A. A., Taeran I., Kadir I. A., 2020 [Productivity and characteristics of fish caught by gill nets operated around FADs]. Hemyscyllium 1(1):83-92. [In Indonesian].

Haikal V. M., Taofiqurohman A., Riyantini I., 2012 [Analysis of water masses in North Maluku waters]. Jurnal Perikanan dan Kelautan 3 (1):1-9. [In Indonesian].

Hanley N. D., Spash C., 1993 Cost benefit analysis and the environment. Edward Elgar, 278 p.

Imron M., Wijayanti S. O., Wiyono E. S., 2020 [Dominant commodity and purse seine productivity based in Ujungbatu Fish Auction Site, Jepara Regency]. Marine Fisheries 11(1):49-60. [In Indonesian].

Iskandar D., 2010 [Inventory of purse trawling units used by fishermen in Mayangan Village, Subang Regency]. Dept. Pemanfaatan Sumberdaya Perikanan, IPB, Bogor, Indonesia, pp. 45-46. [In Indonesian].

Mustaruddin, Murdiyanto B., Wiyono E. S., Laitupa J. P., 2021 [The prospect of developing a tuna hand line business in D.I. Yogyakarta: Overview of resources and investment]. Jurnal Ilmu Pertanian Indonesia 26(4):612-619. [In Indonesian].
Nurdin E., Sondita M. F. A., Yusfiandayani R., Baskoro M., 2015 [Productivity and fishing season for yellowfin (*Thunnus albacares* Bonnaterre, 1788) in small-scale fisheries in Palabuhanratu, West Java]. Jurnal Penelitian Perikan Indonesia 21(3):147-154. [In Indonesian].
Nurhayati M., Wisudo S. H., Purwangka F., 2018 [Productivity and season pattern of catching yellowfin tuna (*Thunnus albacares*) in Fishery Management Area 573]. Jurnal Akuatika Indonesia 3(2):127-135. [In Indonesian].
Paillin J. B., Matrutty D. D. D. P., Siahainenia S. R., Tawari R. H. S., Haruna, Talahatu P., 2020 [Potential fishing grounds for yellowfin tuna *Thunnus albacares*, Bonnaterre, 1788 (Teleostei:Scombridae) in the Seram Sea]. Jurnal Kelautan Tropis 23(2):207-216. [In Indonesian].
Prabowo, Wiyono E. S., Haluan J., Iskandar B. H., 2012 [Gillnet fishing business sensitivity in Tegal City, Central Java Province]. Buletin PSP 20(2):131-142. [In Indonesian].
Prabowo, Wiyono E.S., Haluan J., Iskandar B. H., 2013. [Performance of Small Scale Fisheries Financing in Tegal City, Central Java]. Marine Fisheries 4 (1):1-9. [In Indonesian].
Ratnawati E., Asaf R., Tarunamulia, 2019 [Socio-economic characteristics of coastal fishing communities in Morotai Island Regency]. Prosiding Simposium Nasional Kelautan dan Perikanan VI, Universitas Hasanuddin, Makassar, Indonesia, pp. 68-72. [In Indonesian].
Saputra S. W., Solichin A., Wijayanto D., Kurohman F., 2011 [Productivity and feasibility of the tuna longliner business in Cilacap Regency, Central Java]. Jurnal Saintek Perikanan 6(2):84-91. [In Indonesian].
Setyorini, Suherman A., Triarso I., 2009 [Comparative analysis of productivity of fishing business with bottom set longline in Juana, Pati Regency]. Jurnal Saintek Perikanan 5(1):7-14. [In Indonesian].
Sofiati T., Alwi D., 2018 [Tuna fisheries management strategy in Morotai Island Regency]. Jurnal Ilmu Kelautan Kepulauan 1(2):22-29. [In Indonesian].
Sofiati T., Alwi D., 2019 [Analysis of the financial feasibility of the tuna fishing business in the tuna center village, Morotai Island Regency]. Jurnal Ilmu Kelautan Kepulauan 2(1):77-83. [In Indonesian].
Sofiati T., Deto N. S., 2019 [Profile processing of frozen tuna loin at PT Ocean Treasure, Morotai Island Regency]. Jurnal Bluetien Fisheries 1(2):12-22. [In Indonesian].
Widodo J., 1999 [Application of remote sensing technology for fisheries in Indonesia]. Prosiding Seminar Validasi Data Inderaja untuk Bidang Perikanan, Jakarta. [In Indonesian].
Wiyono E. S., 2010 [Composition, diversity and productivity of basic fish resources in Cirebon coastal waters, West Java]. Indonesian Journal of Marine Sciences 15(4):214-220. [In Indonesian].
Zamroni A., Suryawati S. H., Ramadhan A., Koeshendrajana S., 2019 [The development of the fishing industry in Morotai Island Regency: A scientific concept for an economic integration model]. Jurnal Perikanan dan Kelautan 9(1):15-34. [In Indonesian].
*** Badan Perencanaan Pembangunan Daerah (BAPPEDA Malut), 2022 [Identification of fisheries development opportunities in Morotai Island District, North Maluku Province]. [In Indonesian].
*** FAO (Food and Agriculture Organization of the United Nations), 2016 Biological characteristics of tuna. Available at: http://www.fao.org/fishery/top ic/16082/en
*** KKP (Kementerian Kelautan dan Perikanan), 2017 [Grand design of the Integrated Marine and Fisheries Center]. Biro Perencanaan KKP Republik Indonesia, Jakarta. [In Indonesian].

*** KKP (Kementerian Kelautan dan Perikanan), 2019 [Report on the development of the Morotai Integrated Marine and Fisheries Center (SKPT) for 2019]. 56 p. [In Indonesian].
*** Regulation of the Minister of Maritime Affairs and Fisheries of the Republic of Indonesia No.48/PERMEN-KP/2015 concerning General Guidelines for the Development of Integrated Marine and Fisheries Centers in Small Islands and Border Areas.

Received: 20 September 2022. Accepted: 01 December 2022. Published online: 30 March 2023.
Authors:
Imran Taeran, Fishery Resource Utilization Department, Faculty of Fisheries and Marine Science, Khairun University, Jl. Jusuf Abdulrahman, 97719 Ternate, North Maluku, Indonesia, e-mail: imran_taeran@ymail.com
Zauzah Abdullatif, Agronomy Department, Faculty of Agriculture, Khairun University, Jl. Jusuf Abdulrahman, 97719 Ternate, North Maluku, Indonesia, e-mail: zauzahlatif@gmail.com
Muhajir Kader Marsaoli, Marine Science Graduate Study Department, Khairun University, Jl. Jusuf Abdulrahman, 97719 Ternate, North Maluku, Indonesia, e-mail: ajimarsal68@gmail.com
Zulhan Arifin Harahap, Marine Science Department, Khairun University, Jl. Jusuf Abdulrahman, 97719 Ternate, North Maluku, Indonesia, e-mail: zulhan@unkhair.ac.id

How to cite this article:
Taeran I., Abdullatif Z., Marsaoli M. K., Harahap Z. A., 2023 Productivity and feasibility of handline tuna business based at the Integrated Marine and Fisheries Center in Morotai Island. AACL Bioflux 16(2):899-908.