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Evaluation of the Handline Fleet Fishing Season at the Palabuhanratu Nusantara Fishing Port, Indonesia

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ABSTRACT

Small-scale capture fisheries are the most dominant group in Indonesia and occupy >90% of the total fishermen and existing fishing fleets. Handline is one of the small-scale capture fisheries fleets that can generally be found in various fishing areas in Indonesia, one of which is around Palabuhanratu Bay, Sukabumi. This study evaluated the fishing season of small-scale handline fleets with a loading capacity of <5 GT. Data on catches and the number of fishing trips were monthly collected for 5 years from 2019 to 2023. Data were obtained from the Sukabumi Central Agency for Capture Fisheries Statistics, which were validated based on data from the handline fishing group's fishing logbook at the Palabuhanratu Nusantara Fishing Port. The fishing season evaluation was executed using the average monthly productivity value of the main catch of the handline fleet. A composition analysis showed that 15 fish species were successfully identified as the catch of the handline fleet. Overall, the ribbonfish (*Trichiurus lepturus*) is the main catch of this fleet with a composition of >55% in each fishing activity. The productivity value of the handline fleet's catch over the past 5 years shows a downward trend of 4.26% per year. The analysis of the fishing season based on the ribbonfish productivity shows that the peak fishing season was during the transition from the east season to the west season in September-November, with the highest peak catch in October. The lean season was in the west season in December-February, with the lowest point in February.

INTRODUCTION

Small-scale capture fisheries are Indonesia's most common group of fishermen and fishing fleets. The **Ministry of Maritime Affairs and Fisheries (2024)** stated that >90% of Indonesian fishermen are included in the group of small-scale fishermen with fishing vessel ownership <5GT. The dominance of small-scale fishermen in Indonesia is not in line with the completeness of comprehensive data collection. Data collection on catch results and fishing trips from small-scale fishermen are generally overlooked. Some

parties consider the low value of production per unit of fishing effort owned by small-scale fishermen **(Halim *et al.*, 2019; Sari *et al.*, 2021)**. However, if we consider the dominance of existing small-scale fishermen, of course, the value of the utilization of capture fisheries from this group is quite significant and must be taken into account **(Sari *et al.*, 2021; Herdiana *et al.*, 2024)**. The completeness of data collection from all capture fisheries, both large and small scale, is necessary to conduct fundamental analysis to determine the direction of sustainable capture fisheries management policies **(Sari *et al.*, 2021; Napitupulu *et al.*, 2022)**.

One of the fishing fleets included in the small-scale fishermen group is handline. Handline is a small-scale fishing fleet commonly found carrying out fishing activities in several regions in Indonesia, one of which is around the Palabuhanratu Nusantara Fishing Port, Sukabumi, Indonesia **(Baihaqi & Annida, 2025)**. Handline is one of the small-scale fishing fleets that is quite dominant at the Palabuhanratu Nusantara Fishing Port. Handline dominance is second after the boat seine fleet. The composition of active fishing in the Palabuhanratu Archipelago Fisheries Port shows 34% of the handline fleet **(CSA, 2023)**. In a deeper classification, the handline fleet at the Palabuhanratu Nusantara Fishing Port consists of small-scale fishermen (22.4%) with a boat size of <5 GT and powered by an outboard motor and medium-scale fishermen (11.6%) with a boat size of 5-10 GT and powered by a 23-37 HP engine **(Baihaqi & Annida, 2025)**.

Data from the Sukabumi **Central Fisheries Statistics Agency (2023)** shows that there has been a decline in the number of active handline fisheries at the Palabuhanratu Nusantara Fishing Port in the last 10 years. The decrease in the number of handline vessels is strongly suspected to be due to changes in the increasingly uncertain fishing season in recent years. This is reinforced by statements from handline fishermen who expressed their complaints in the form of changes in the weather in recent times, causing a shift in the increasingly uncertain fishing season. As a result, fishermen's incomes are also increasingly uncertain, which can lead to bankruptcy and the closure of fishing businesses from the handline fleet **(Central Fisheries Statistics Agency, 2023)**.

This study was conducted to evaluate the fishing season of small-scale handline fleets based on the average value of their main catch productivity over the past five years. The results can describe the conditions of the peak season to the lean season of fishing in the handline fleet at the Palabuhanratu Archipelago Fisheries Port, Sukabumi, Indonesia. Furthermore, the results of this evaluation can provide information for handline fishermen regarding the best times to conduct fishing operations.

MATERIALS AND METHODS

The study focused on a small-scale handline fishing fleet with a size of <5 GT docked at the Palabuhanratu Nusantara Fishing Port, Sukabumi, Indonesia. Data on catches and the number of monthly fishing trips were collected from 2019-2023 from the Sukabumi Central Fisheries Statistics Agency, validated from the handline fishing

group's capture fisheries logbook data. Catch data in units (Kg) were analyzed to determine the composition structure of the handline fleet's catch. The analysis of the catch composition was calculated using a formula referring to **Krebs (2014)**.

$$Catch\ composition_i = \frac{B_i}{B}\ x\ 100\% \quad \text{.....(1)}$$

The catch composition value is presented in percentage units, where B_i is the number of catches of species-i, and B is the total number of main catches. Both have weight units (Kg).

For the next step, the catch production data and the number of fishing trips were analyzed to determine the average catch productivity of the handline fleet and to see the variations on an annual and monthly basis. The catch productivity was analyzed based on the estimated catch value per unit of fishing effort, with a function referring to **Gulland (1983)**.

$$CPUE_i = \frac{Catch_i}{Effort_i} \quad \text{.....(2)}$$

Where, $CPUE_i$: number of catches per unit effort at time-i (Kg/trip); $Catch_i$: number of catches at time-i (Kg); and $Effort_i$: the number of fishing attempts in this case is the number of fishing trips during the period.

Fishing season evaluation was analyzed using the fishing season index calculation approach based on the average productivity of catches with monthly variations from 2019-2023. The average monthly productivity value was then calculated based on the moving average value, referring to **Imron *et al.* (2022)**. At least six stages are required to conduct a fishing season index analysis using this approach:

1. Arrange a data series of $CPUE_i$ from January 2019 until December 2023.

   $$n_i = CPUE_i \quad \text{.....(3)}$$

   Where, n_i is the monthly series value of catch per unit effort in sequence-I and i is the monthly data series sequence: 1, 2, 3, …., 60.

2. Arrange moving average CPUE for every 12 months (MA)

   $$MA_i = \frac{1}{12}\left(\sum_{i=i-6}^{i+5} CPUE\right) \quad \text{.....(4)}$$

   Where, MA_i: moving average 12 month sequence-I; CPUEi: CPUE sequence-I; and i: 6, 7,..., n-5.

3. Arrange moving average centered CPUE (MAC)

   $$MAC_i = \frac{1}{2}\left(\sum_{i=i}^{i=1} MA_i\right) \quad \text{.....(5)}$$

   Where, MAC_i: moving average centered CPUE sequence-I; MA_i: moving average 12 month sequence-i; and i: 7, 8, ..., n-5.

4. Arrange month average ratio (MAR)

$$MAR_i = \frac{CPUE_i}{MAC_i} \quad \text{.....(6)}$$

Where, MAR_i: month average ratio-I; $CPUE_i$: CPUE sequence-I; and i: 6, 7, ..., n-5.

5. Arrange the average value in a matrix of size ixj for each month of each year. Then, calculate the monthly ratio average value and the overall average total value.
   a. The average ratio for sequence month-i ($ARSM_i$)

$$ARSM_i = \frac{1}{n}\left(\sum_{j=1}^{n} ARSM_{ij}\right) \quad \text{.....(7)}$$

Where, $ARSM_i$: average ratio for sequence month-I; $ARSM_{ij}$: average ratio for sequence month i x j; i: 1, 2, ..., 12; j: 1, 2, 3, ..., n.

   b. Total of month average ratio (TMAR)

$$TMAR = \sum_{i=1}^{12} ARSM_i \quad \text{.....(8)}$$

Where, TMAR: total month average ratio; $ARMS_i$: average ratio for sequence month-i; i: 1, 2, ..., 12.

   c. Calculate the correction factor

Ideally, the TMAR value is 1200. However, there are often slight differences due to several factors which cause the TMAR value not to be exactly 1200. Therefore, the TMAR value needs to be corrected into a correction factor (CF) value with the formula:

$$CF = \frac{1200}{TMAR} \quad \text{.....(9)}$$

6. Calculate the fishing season index

After the correction factor (CF) value and average monthly ratio value ($ARSM_i$) are obtained, then fishing season index value is calculated using the formula:

$$FSI_i = ARSM_i \; x \; CF \quad \text{.....(10)}$$

Where, FSI_i: fishing seasonal index sequence-i; $ARSM_i$: average ratio for month sequence-i; i : 1, 2, ..., 12. The FSI value can be used to recommend suitable fishing times for certain caught commodities in a fishing fleet. Referring to **Baihaqi and Annida (2024b)**, an FSI value >100% indicates the peak fishing season. FSI values between 50-100% indicate a normal fishing season. An FSI value <50% suggests a lean season that is not recommended for fishing activities.

RESULTS

The handline fishing fleet docked at the Palabuhanratu Nusantara Fishing Port, Sukabumi, Indonesia, has been successfully identified as having 15 catch species. Furthermore, the composition of the handline fleet's catch analyzed annually and monthly shows that the species of fish caught that has the highest portion and is the main catch is the ribbonfish (*Trichiurus lepturus*). This species is known to always dominate (>55% of the total catch) in every handline fleet fishing operation (Fig. 1).

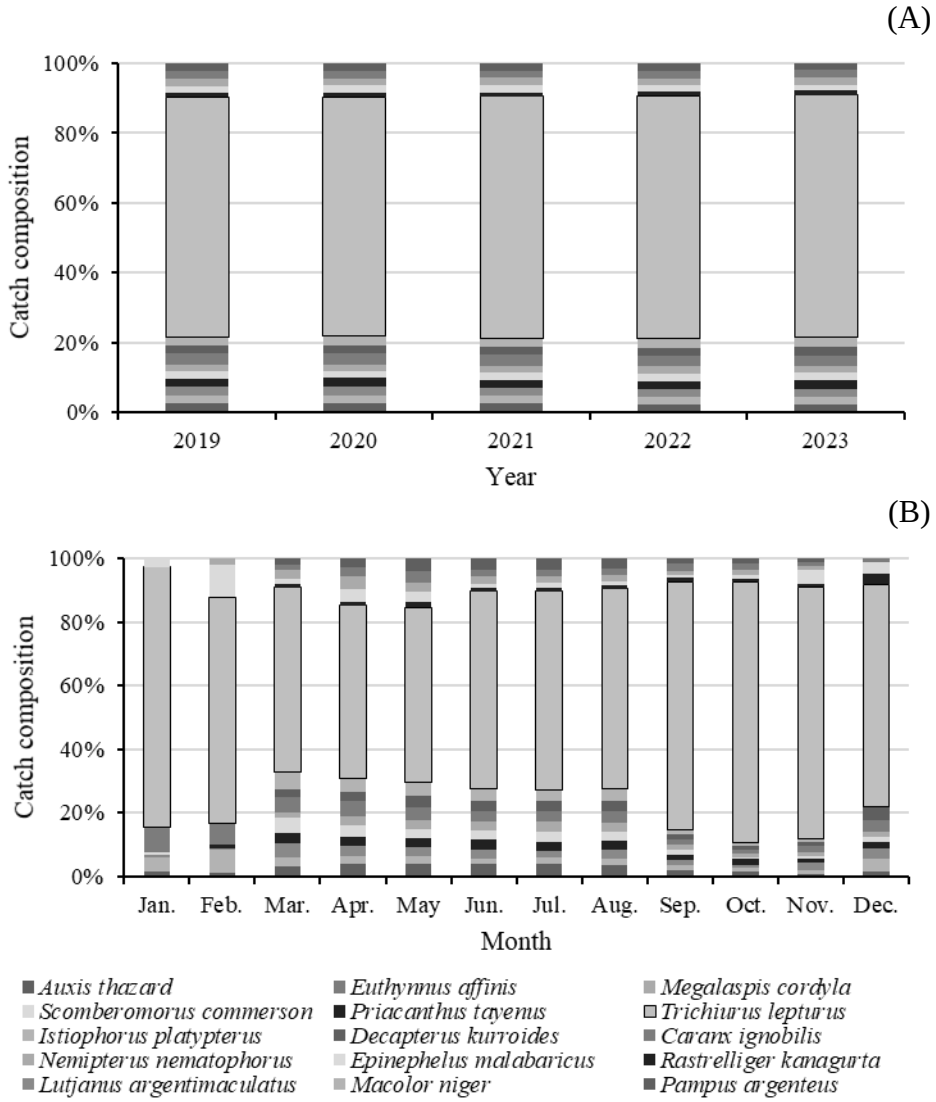

Fig. 1. Catch composition of handline fleet based on **(A)** annual and **(B)** monthly calculations

The average productivity value of the total catch of the handline fleet based on annual calculations shows a downward trend of 4.26% per year. The decrease in average productivity also occurs specifically for the ribbonfish, the main catch. This species' catch productivity also decreases yearly with a trend of 4.01% per year. Based on the monthly

average, the catch productivity value reached its highest point in October with 100.6 ± 18.8kg/ trip for the total catch and 82.6 ± 15.4kg/ trip for the ribbonfish species. The lowest catch productivity value was in February, with 24.4 ± 8.9kg/ trip for the total catch and 17.3 ± 6.3 for the ribbonfish species (Fig. 2).

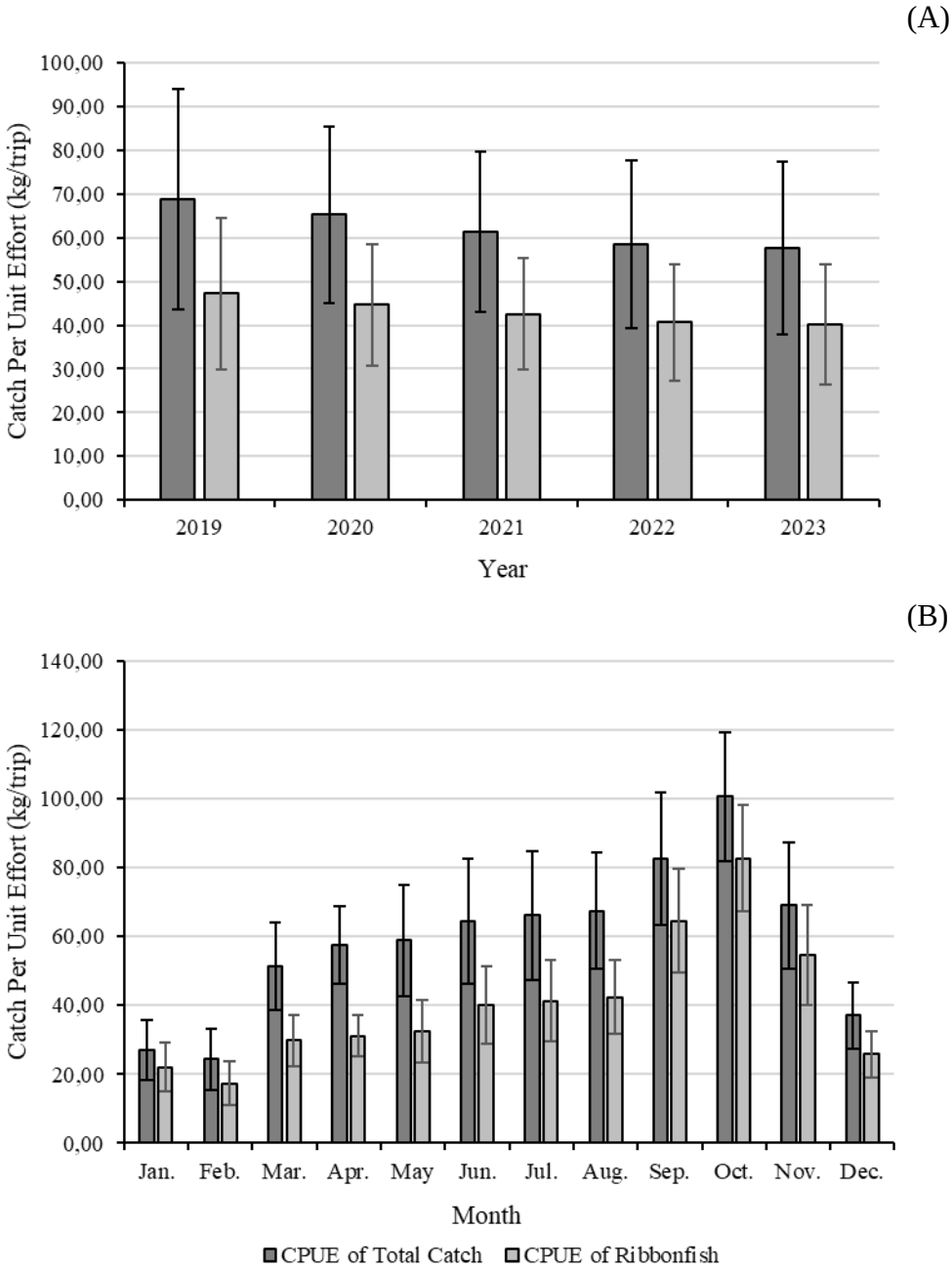

Fig. 2. Productivity of handline fleet catches based on **(A)** annual and **(B)** monthly calculations

Evaluation of the handline fishing fleet's fishing season based on the moving average value of the productivity of the main catch (*Trichiurus lepturus*) shows that the peak season conditions are during the transition from the east season to the west season,

from September to November. The lean season with the lowest value is in the west season, from December to February (Fig. 3).

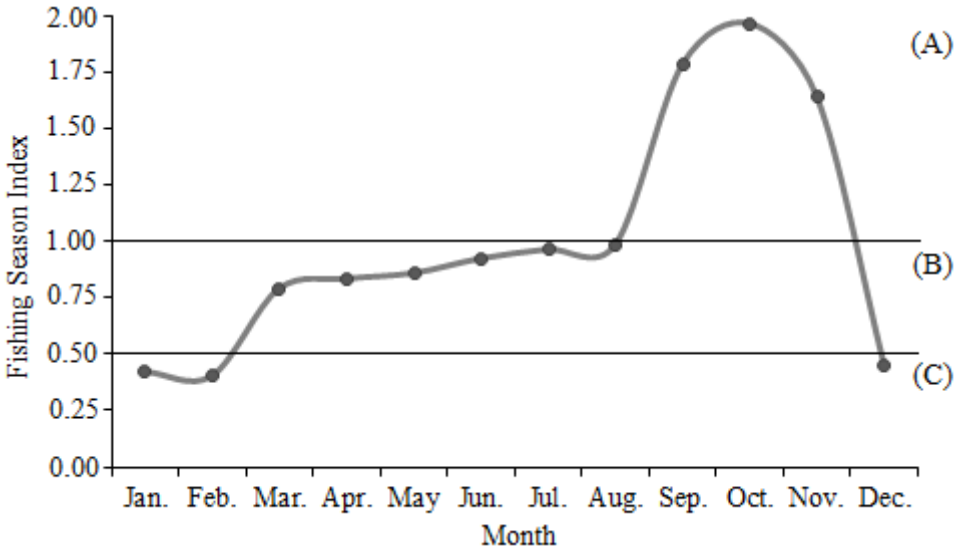

Fig. 3. Evaluation of the handline fleet fishing season based on the fishing season index showing: **(A)** Peak fishing season; **(B)** Moderate fishing season, and **(C)** Lean season

DISCUSSION

Handline is one of several small-scale fleets that carry out fishing operations around Palabuhanratu Bay and dock at the Palabuhanratu Nusantara Fishing Port, Sukabumi, West Java. This fleet is known to have ships measuring <5 GT, with an outboard motor power of 15-25 HP. Handline fleet ships have dimensions of 7.0-10.3 meters in length, 0.8-2.0 meters in width, and 0.7 - 1.3 meters in height. The vessel comprises a wooden frame made of kempas wood or ironwood **(Baihaqi & Annida, 2025)**.

Handline is known as one of the fishing fleets that carry out fishing operations with environmentally friendly traditional fishing gear. Handline only uses simple fishing gear. The fishing line consists of 10-25 meters of PA monofilament thread connected to 10-25 branch lines that end at each hook. The hooks of this fishing gear are made of galvanized steel with a size of 5-10. Each branch line of the hook is 1.0-1.5 meters apart. At the end of the main rope, there is a steel weight. This weight keeps the fishing gear in a vertical position in the water. Operating the fishing gear vertically allows it to obtain various types of fish from the catch, including demersal, reef, and pelagic. The construction of the fishing gear and the fishing mechanism of the handline fleet are illustrated in Fig. (4) **(Baihaqi & Annida, 2025)**.

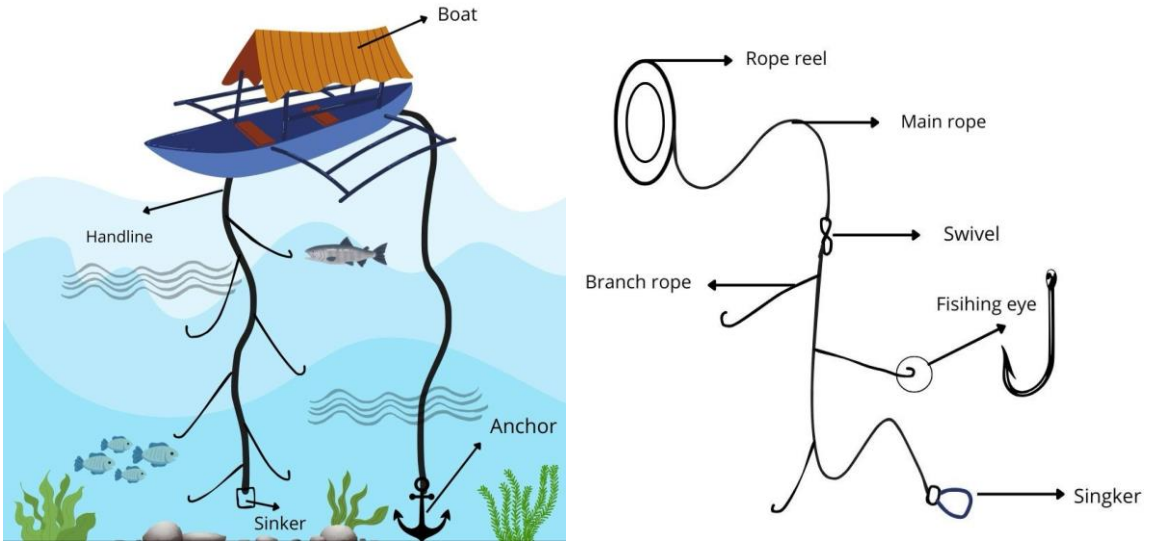

Fig. 4. Fishing operations and construction of handline fishing gear **(Annida & Baihaqi, 2025)**

The small-scale handline fleet docked at the Palabuhanratu Nusantara Fishing Port has 15 identified catch species. The ribbonfish (*Trichiurus lepturus*) is the most dominant catch species and the main catch of this fleet. In other studies, this species is also known to be the main catch for the boat seine fleet, another small-scale fishing fleet operating around Palabuhanratu Bay **(Annida *et al.*, 2024)**.

Several researchers stated that Palabuhanratu Bay is one of the areas that is the distribution center of the ribbonfish species **(Airlangga *et al.*, 2018; Putra *et al.*, 2018; Imron *et al.*, 2021)**. This species is known to be one of the demersal fish widely distributed around coastal areas or deep seas rich in nutrients and food sources. The condition of Palabuhanratu Bay, which is quite deep and rich in nutrients around its coast, has the potential to support the life of this fish. This is also the reason why Palabuhanratu Bay is known as an area that produces the highest catch of the ribbonfish species in Indonesia **(Airlangga *et al.*, 2018; Putra *et al.*, 2018; Rahmawaty *et al.*, 2021)**.

The main catch's productivity and the handline fleet's total catch showed a trend that tended to decline in the last 5 years. Observations based on data from 2019 to 2023 showed a decrease in the productivity of the total catch by 4.26% per year and a reduction in the productivity of the main catch (*Trichiurus lepturus*) by 4.01% per year. The decline in catch productivity can indicate several things such as a decrease in the natural population conditions of each species caught as a result of overfishing **(Annida *et al.*, 2021, 2023, 2024; Baihaqi & Annida, 2024b)** which can lead to a possible decrease in the business performance of a capture fisheries business **(Baihaqi & Annida, 2024a)**. Furthermore, the decline in catch productivity over time can also occur as a result of several other things, such as declining environmental conditions in the waters, climate

change, and changes in the distribution and distribution of target fish **(Monnereau & Oxenford, 2017; Erauskin-Extramiana *et al.*, 2023)**.

The variation in catch productivity through monthly comparisons shows that the highest conditions occur in October and the lowest in February. In line with that, the analysis of the fishing season evaluation based on the main catch results through the fishing season index also shows that the peak fishing season for the handline fleet occurs explicitly in the transition season between the east and west seasons from September to November, with the highest peak in October. The lean season is in the west season from December to February, with the lowest point in February. Similar conditions are also found when estimating the fishing season for the seine boat and troll line fleets. The seine boat fleet, which also carries out fishing around Palabuhanratu Bay, is known to reach its peak fishing season in the east season to the transition season. However, the highest tendency is in the transition season between the east and west seasons **(Imron *et al.*, 2022)**. Still in line with that, the estimation of the fishing season for the troll line fleet is also reported to reach its peak fishing season at the beginning of the east season in June to the middle of the transition season from the east to the west season in October **(Baihaqi & Annida, 2024b)**.

Pramuwardani *et al.* (2018) stated that monsoon wind conditions generally influence the seasonal changes in Indonesia. The east season is characterized by blowing east monsoon winds that move from the Australian region to the Asian region. In these conditions, Australia experiences winter, and Asia experiences summer. The east monsoon winds that move from the Australian region pass through narrow gaps and several deserts, such as Gibson, Great Australia, and Victoria, causing rainfall in Indonesia to be low. Therefore, Indonesia will experience a summer or dry season **(Wheeler *et al.*, 2007)**. In the transition season, wind changes begin to occur gradually. Where the east monsoon winds switch to the west monsoon winds, and the west monsoon winds move from the Asian continent to the Australian continent. The wind brings with it humid water vapor from the Asian region, which will gradually increase humidity in the Indonesian region and has the potential to reduce rain **(Pramuwardani *et al.*, 2018)**. The temperature decreases slowly in the transition season from the east to the west season. The water temperature, which was initially very warm, decreases gradually. The gradual decrease in temperature often creates dynamic water mass mixing, especially in coastal areas. This makes nutrients evenly distributed and quite rich around the coast. In this condition, the distribution of fish is generally relatively abundant. This is also the scientific basis for the high productivity of catches during the transition season **(Pramuwardani *et al.*, 2018; Junnaedhi *et al.*, 2023; Bolan *et al.*, 2024)**.

CONCLUSION

Evaluation of the handline fleet fishing season based on the moving average productivity value of the main catch commodity, the ribbonfish (*Trichiurus lepturus*),

illustrates the dynamics of changes in the fishing season. The peak fishing season is transitioning from the east season to the wet season, from September to November, with the highest peak in October. Meanwhile, the lean season is in the west season from December to February, with the lowest point in February.

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