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Productivity and Seasonal Index of Anchovy (*Stolephorus* sp) Fishing on Bagan Boat Fishing Gear at UPTD Regional Fisheries Port I (PPW1) Carocok Tarusan, West Sumatra

Produktivitas dan Indeks Musim Penangkapan Ikan Teri (Stolephorus Sp) pada Alat Tangkap Bagan Perahu di UPTD Pelabuhan Perikanan Wilayah I (PPW1) Carocok Tarusan Provinsi Sumatera Barat

Mega Lestari[1*], Arthur Brown[1], Jonny Zain[1]
[1]Department of Utilization of Fisheries Resources, Faculty of Fisheries and Marine, Universitas Riau, Pekanbaru 28293 Indonesia
**email: megalestari171@gmail.com*

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Abstract

Productivity and estimation of fishing season index in marine areas are very much needed to facilitate fishermen's fishing operations, so they are practical and efficient. This research was conducted from February 28, 2024, to March 9, 2024. This research was conducted at the UPTD Fishing Port Region I (PPW1), Carocok Tarusan, West Sumatra Province. This study aimed to calculate fishing productivity and the fishing season index of anchovies (*Stolephorus* sp) at the UPTD Fishing Port Region I (PPW1), Carocok Tarusan, West Sumatra Province. This research is based on a survey method involving observations and collecting primary and secondary data directly at the UPTD Fishing Port Region I (PPW1), Carocok Tarusan, West Sumatra Province. The highest CPUE value of anchovies occurred in 2021, 142.66 kg/ship. The lowest CPUE occurred in 2019, at 73.30 kg/boats. The peak season for anchovy landings at PPW1 Carocok was identified to occur from April to August, as indicated by an IMP value of more than 100%. The moderate season for anchovy landings was shown to occur from January to March and September to December, as indicated by an IMP value of more than 50%. No month was identified as a lean season where the IMP value was less than 50%.

Keywords: CPUE, Anchovies, Fishing Season, UPTD PPW1 Carocok

Abstrak

Produktivitas dan estimasi indeks musim penangkapan ikan di wilayah laut sangat dibutuhkan untuk mempermudah nelayan dalam melakukan operasi penangkapan, agar efektif dan efisien. Penelitian ini dilaksanakan pada 28 Februari 2024 sampai 09 Maret 2024. Penelitian ini dilaksanakan di UPTD Pelabuhan Perikanan Wilayah I (PPW1) Carocok Tarusan Provinsi Sumatera Barat. Tujuan dari penelitian ini adalah untuk menghitung produktivitas penangkapan dan menghitung indeks musim penangkapan ikan teri (*Stolephorus* sp) di UPTD Pelabuhan Perikanan Wilayah I (PPW1) Carocok Tarusan Provinsi Sumatera Barat. Penelitian ini didasarkan pada metode survei dengan melakukan pengamatan dan pengambilan data primer dan data sekunder secara langsung di UPTD Pelabuhan Perikanan Wilayah I (PPW1) Carocok Tarusan Provinsi Sumatera Barat. Nilai CPUE ikan teri tertinggi terjadi pada tahun 2021 yaitu sebesar 142,66 kg/jumlah kapal. Sedangkan CPUE terendah terjadi pada tahun 2019 yaitu sebesar 73,30 kg/jumlah kapal. Musim puncak penangkapan ikan teri yang didaratkan di PPW1 Carocok teridentifikasi terjadi pada bulan April sampai bulan Agustus yang ditunjukkan

dengan nilai IMP lebih dari 100%. Musim sedang penangkapan ikan teri diindikasikan terjadi pada bulan Januari hingga Maret dan September hingga Desember yang ditunjukkan dengan nilai IMP lebih dari 50%. Tidak ada bulan yang diidentifikasikan sebagai musim paceklik dimana nilai IMP kurang dari 50%.

Kata kunci: CPUE, Ikan Teri, Musim Penangkapan, UPTD PPW1 Carocok

1. Introduction

UPTD Fishery Port Region I (PPW1) of West Sumatra Province is one of the fishing ports in West Sumatra. The fishing fleet based at UPTD Fishery Port Region I (PPW1) of West Sumatra Province currently consists of 126 units, including 60 units of bagan boat fishing gear, 45 units of payang, 20 units of trolling rods, and 1 unit of purse seine. Bagan boat fishing gear is the most dominant fishing gear, as seen from the number of ships operating more than others.

A boat lift net is a fishing tool operated by lowering it into the water and lifting it back up after many fish are on it. In its operation, it uses a boat to move to locations estimated to have many fish. Fishing efforts using boat-lift net fishing gear have the potential to produce catches of high economic value (Ramadhan et al., 2016). The main catch consists of tuna (*Auxis thazard*), selar (*Caranx leptolepis*), mackerel (*Rastrelliger kanagurta*), anchovies (*Stolephorus* sp), tuna (*Thunnus* sp), squid (*Mastigoteuthis flammea*), skipjack tuna (*Katsuwonus pelamis*), and tembang (*Sardinella flimbriata*). Bycatch consists of japuh fish (*Dussumeria accuta*), tamban fish (*Spratelloides gracilis*), and peperek (*Leiognathus spendens*) (Akmaliatulkomariah, 2021).

According to Rahman et al. (2022), the capture fisheries business using the boat lift net fishing gear is a potential business with high economic value catches, namely small pelagic fish that have a high selling price, as seen from the catch based on records of the UPTD Regional Fisheries Port I (PPW1) of West Sumatra Province in 2019, namely 1,547,249 kg with a value of IDR 25,691,810,000, - and the dominant type of fish caught as a superior commodity is anchovies as much as 167,559 kg with a value of IDR 4,128,535,000.

Productivity and estimation of the fishing season index in the sea area are very much needed to facilitate fishermen's fishing operations, so they are practical and efficient. Productivity and estimation of the season index are interrelated, because it can be seen from the productivity data that the abundance of fish catches varies from January to December. If the number of catches increases, that month is the fishing season, so the expected fishing operations can reduce the risk of losses to fishermen.

According to Dahuri et al. (2008), the condition of fish catch utilization in marine areas is divided into three conditions, namely under exploited, namely marine fish catch that is not optimal in terms of the amount of utilization, fully exploited, namely marine fish catch that is already optimal and needs to be maintained its utilization, and over exploited, namely excessive marine fish catch, resulting in reduced catches and worsening conditions of the marine ecosystem so that it can no longer be utilized. The two categories of conditions are determined by assessing the balance between the growth and sustainability of the marine ecosystem, with the amount of catch from time to time.

Anchovy fishing efforts carried out by bagan perahu vessels can affect anchovy production in the future. Therefore, one way to determine the rate or dynamics of anchovy stocks in the area is to study the productivity of the fishing gear used, because the productivity obtained will describe the effort used and is comparable to the fish caught. Determining the fishing season can also make fishing operations, especially for anchovies, more effective in carrying out fishing operations. Research on anchovies' productivity and seasonal patterns has not been widely conducted. Therefore, such a study is needed to inform fishermen to facilitate anchovy fishing operations and reduce the risk of losses in fishing operations.

According to research by Rahman et al. (2022), anchovies are the dominant type of fish caught as a superior commodity (*Stolephorus* sp). Fishery productivity is the number of fish caught per unit of effort. Excessive productivity can cause a decrease in fish production. The fishing season index is used to determine the fishing season pattern. The fishing season index is important for fishermen to maximize their catch. The fishing season index is calculated using time series data and the moving average method. So far, the estimation of the time fishermen use to catch fish has only been based on the personal experience of each fisherman and previous catches. So, sometimes fishermen get less than satisfactory catches. Therefore, to optimize the catch, fishermen need a method for predicting the fishing period over 8 years to obtain a trend pattern of catches. Therefore, this study needs to be carried out using data on anchovies landed at the UPTD Regional Fisheries Port I (PPW1) of West Sumatra Province for the last 8 years. This study aimed to calculate anchovies' fishing productivity and fishing season index (*Stolephorus* sp) at the UPTD Regional Fisheries Port I (PPW1), Carocok Tarusan, West Sumatra Province.

2. Materials and Methods

2.1. Time and Place

This research was conducted from February 28, 2024, to March 9, 2024. This research was conducted at the UPTD Regional Fisheries Port I (PPW1), Carocok Tarusan, West Sumatra Province, as shown in Figure 1.

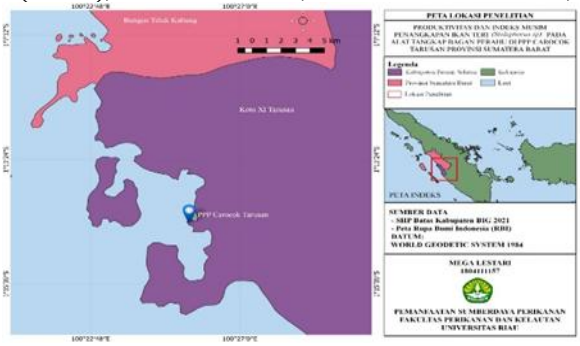

Figure 1. Research location

2.2. Methods

Sampling was done using purposive sampling. Purposive sampling involves taking samples non-randomly or intentionally collecting data on specific groups of fishermen to obtain complete and accurate information related to anchovy fishing activities using boat lift nets. Fishermen selected purposively as respondents were fishermen who carried out anchovy fishing operations and landed their catch at the UPTD Regional Fisheries Port I (PPW1), Carocok Tarusan, West Sumatra Province.

2.3. Data Analysis

2.3.1. Analysis of Anchovy Fishing Productivity

According to Gulland (1982), Catch Per Unit Effort (CPUE) is a method used to determine the results of the amount of marine fisheries production averaged over the year. The CPUE results will later determine whether fisheries production in an area has increased or decreased. The formula used to determine the CPUE value is as follows:

$$CPUE_i = \frac{Catch_i}{Effort_i}$$

Information:

CPUEi : catch per fishing effort in year-i (tons/trip)
Catch i : catch in year-i (tons)
Effort I : fishing effort in month-i (trip)

CPUE is the annual fisheries catch rate obtained from time series data for at least 8 years. The longer the time series used, the sharper the prediction will be.

2.3.2. Analysis of Fishing Season Patterns

Determination of the fishing season index using time series analysis of monthly data of anchovy catches for 8 years, followed by calculation of the moving average. With the following steps (Wahju et al., 2011):

Compiling a CPUE series over 8 years

$$CPUE_i = n_i$$

Information:

n_i : CPUE 1st order (Month)
i : 1,2,3, …, 60

Construct a 12-month CPUE moving average (RG) = $RG^i = \frac{1}{12}\sum_{i=i-6}^{i+5} CPUE_i$

Information:

Rgi : 12-month moving average of the i-th order
CPUEi : Ith order CPUE-i = 7, 8, 9, …, n-5

Constructing a centered CPUE moving average (RGP) = $RGP_i = \frac{1}{2}\sum_{i=i}^{i=1} \sum RG_i$

Information:

RGPi : i-th centered CPUE moving average
Rgi : 12-month moving average of i-th order = 7, 8, …,

Compile the average ratio each month (Rb)= $Rb_i = \frac{CPUE_i}{RGP_I}$

Information:

Rbi : average ratio of each month i
CPUEi : CPUE of the i-th month
RGPi : average ratio of each month i

Average ratio for month i (RBBi)= $RBB_i = \frac{i}{n}\sum_{j=1}^{n} Rb_{ij}$

Information:

RBBi : average Rbij for the i-th month
Rbij : monthly average ratio in a matrix of size i×j
i : 1 , 2 .., .., 12
j : 1, 2, 3, …, n

Monthly average ratio amount (JRBBi)= $RBB_i = \sum_{i=1}^{12} RBB_i$

2.3.3. Fishing Season Index (IMP)

Ideally, the JRBB value is 1200, but many factors cause the JRBB not to always be equal to 1200; therefore, the average monthly ratio value must be corrected with a correction value called the Correction Factor (FK) value.

$$FK = \frac{1200}{JRBB} ; IMP_i = RBB_i \times FK$$

IMP value ≥ 100% = Peak season; 50% ≤ IMP Value < 100% = Medium season; IMP value < 50% = Lean season.

3. Result and Discussion

3.1. General Conditions of the Research Area

The Coastal Fishing Port located in Carocok Tarusan, a charming area west of Pesisir Selatan Regency, is one of the strategic points directly adjacent to the sea. Pesisir Selatan Regency, part of West Sumatra Province, is spread between the coordinates 0°59'–2°28' LS and 100°19'–101°18' BT, with an area of 5,749.89 km² and a coastline stretching 218 km. This regency is also known to have three main fishing ports, namely PPI Surantiah, PPI Kambang, and Carocok Tarusan Coastal Fishing Port, all of which play an important role in supporting the fisheries activities in this area.

A trolling rod is a rectangular fishing tool with the same length and width. The construction of this Bagan Perahu fishing tool consists of nets, bamboo, iron pipes, ropes, lights, and motorized boats. The net part of this bag is made of woven material that is formed into a bag. The bag consists of sheets of waring assembled or sewn to form a square-shaped bag due to the frame formed by bamboo and iron pipes (Sagala, 2016).

Bagan boats are generally operated with two boats as supports, and in the middle is a Bagan house made of bamboo. Bagan boats at UPTD PPW I Carocok Tarusan are operated by one boat, with one net on the left side. The fish collection tool used on bagan boats is a lamp, because this fishing gear's target fish are positively phototactic (like light), such as anchovies. In addition, bagan boats also catch various other types of pelagic fish, including squid, mackerel, tembang, layang, peperek, and selar, as shown in Figure 2 (Warsini & Iskandar, 2021).

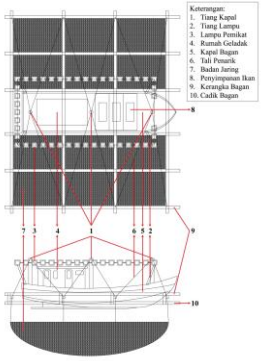

Figure 2. Illustration of a Bagan boat fishing gear

3.2. Catch

The catch refers to the number of fish species or other marine animals successfully caught during fishing. Meanwhile, capture fisheries production results from fish caught in both the sea and public waters, both at and outside ports. One species often landed at UPTD PPW I Carocok Tarusan is anchovies (*Stolephorus* sp), which are generally caught using bagan fishing gear. The contribution of bagan fishing gear to anchovy catches varies

annually, as seen in Figure 3. Anchovy production data from 2016 to 2023 shows that the highest catch of bagan occurred in 2021, 397,886 kg, and the lowest occurred in 2022, 140,448 kg. The monthly catch of anchovies over the past 8 years (2016 to 2023) has always fluctuated. This can be seen in Figure 4:

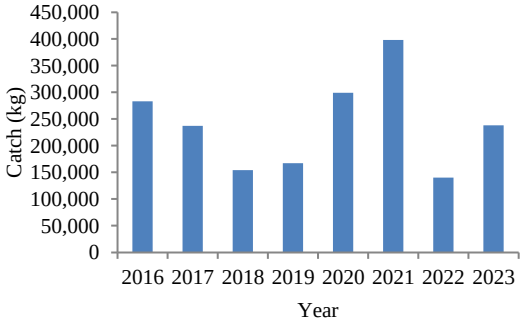

Figure 3. Anchovy catch at UPTD PPW1 Carocok

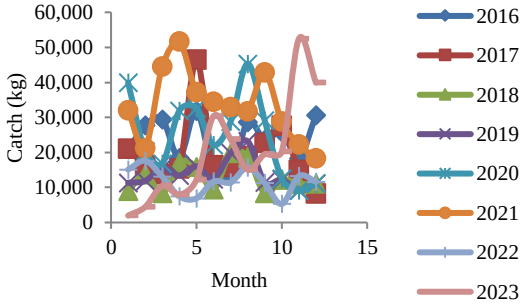

Figure 4. Monthly anchovy catch

Fisheries production data for the past eight years show that anchovy catches peak in November, with a total catch of 52,441 kg per month. In contrast, January often records the lowest catch, reaching only 1,965 kg monthly. Various factors, such as the presence of fish, the number of fishing efforts, and the success rate of the fishing operation itself, influence this catch fluctuation. The decrease and increase in anchovy catches in certain months are also influenced by seasonal conditions and decreasing fish stocks in fishing ground areas. Environmental factors also play a significant role in fish abundance, while the amount of fishing effort also affects the results obtained. For example, in 2021, anchovy catches increased sharply due to high fishing efforts and abundant fish stocks in the waters. However, in 2018, catches tended to be low due to the decreasing abundance of anchovies caused by overfishing in previous years (Mardyani et al., 2020).

In addition, the size of the vessel also affects the catch. Larger vessels usually have stronger propulsion engines, larger nets, and more holding capacity, making fishing easier and increasing the catch. Other factors that affect fishing operations using boat charts include fishing gear dimensions, fuel consumption, engine power, number of operating days, and use of lights.

3.3. Effort

Efforts to catch anchovies at the Carocok Coastal Fishing Port were made using bagan fishing gear. The number of vessels (effort) from bagan fishing gear and its development in the last 8 years (2016-2023) can be seen in Figure 5.

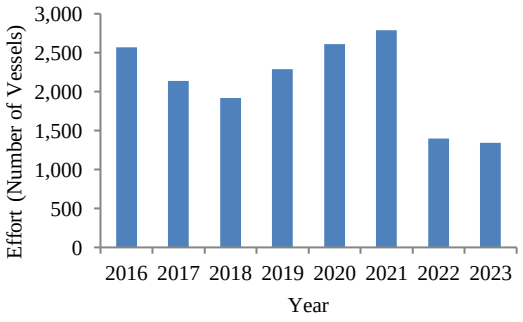

Figure 5. Monthly anchovy effort

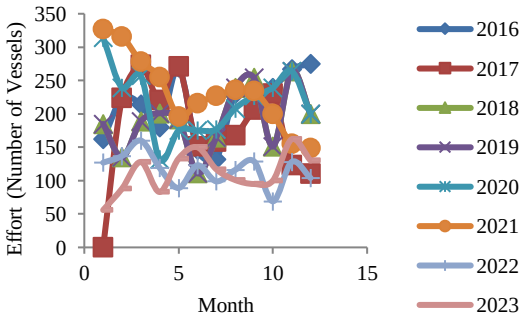

Figure 6. Monthly anchovy effort (trip)

Based on Figure 5, it can be seen that anchovy fishing efforts peaked in 2021 with a total of 2,789 vessels using bagan fishing gear. In contrast, the lowest fishing effort was recorded in 2023, with only 1,343 vessels. During the last 8-year period (2016-2023), anchovy fishing efforts have fluctuated significantly. The increase in fishing efforts in 2021 was due to the abundance of fish catches that year, which encouraged fishermen to increase the number of fishing vessels. However, the data also shows that in 2022 and 2023, the number of vessels per year decreased. This decrease was influenced by several factors, such as the increasingly distant fishing locations. As a result, many vessels have difficulty continuing fishing operations due to limited capital.

Based on Figure 6 above, it can be concluded that between 2016 and 2023, the highest monthly anchovy fishing effort occurred on average in January, while October recorded the lowest fishing effort. The decrease in effort is also influenced by several ships' change in landing locations, considering that one ship can have more than one base port (Novitasari et al., 2022). Fluctuations in monthly fishing effort are influenced by various factors, including economic conditions, fishermen's behavior, and environmental factors that vary in certain months.

3.4. Catch per Unit Effort (CPUE)

Based on the data on catch and efforts of anchovies over the last 8 years (2016-2023) at the Carocok Coastal Fishing Port, the CPUE (Catch per Unit Effort) value per year shows clear fluctuations, as listed in Table 2. This fluctuation is influenced by various factors, including the number of fishing units operating each year, the fishing season, and the availability of fish in the waters. This is closely related to the level of effort and catch, affecting the CPUE value recorded each year.

Table 1. CPUE value of anchovies at UPTD PPW1 Carocok 2016-2023

Year	Catch	Effort	CPUE
2016	283.192	2.566	110,36
2017	237.630	2.135	111,30
2018	154.767	1.920	80,61
2019	167.559	2.286	73,30
2020	299.716	2.607	114,97
2021	397.886	2.789	142,66
2022	140.448	1.400	100,32
2023	238.301	1.343	177,44
Average	239.937	2.131	113,87

The highest CPUE value of anchovies occurred in 2021, 142.66 kg/number of vessels. The lowest CPUE occurred in 2019, at 73.30 kg/number of vessels. While in other years, CPUE experienced various fluctuations. The average annual CPUE value of anchovies in the last 8 years was 113.87 kg/number of vessels, as shown in Figure 7.

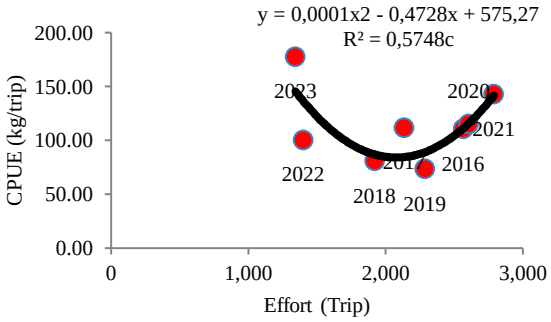

Figure 7. Relationship between CPUE and effort

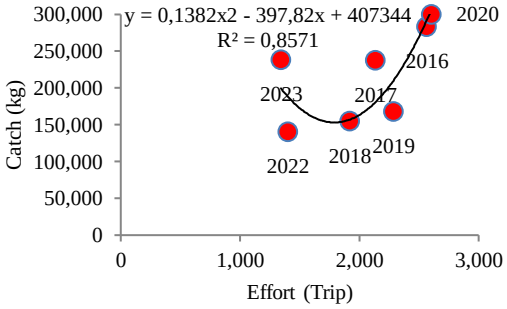

Figure 8. The relationship between catch and effort

In 2016–2019, the catch of anchovies at UPTD PPW 1 Carocok was low. This was caused by several climate disturbances, such as weak El Niño (2018–2019), which could impact sea surface temperatures and ocean currents. This could cause anchovies to migrate to more comfortable areas or delay spawning. In Figure 7, it can be seen that the analysis of the relationship between CPUE and effort produces a linear equation y = 0.0001x2 - 0.4728x + 575.27. The coefficient of determination (R2) of 0.5748 or 57.48% states that the effort value of 57.48% influences the rise and fall of CPUE, while 42.52% is influenced by other factors not discussed in this study. The relationship's closeness value (correlation coefficient/R /R/R) between CPUE and effort is 0.76, which comes from √0.5748. It can be interpreted that the relationship between CPUE and effort has a substantial closeness value because the correlation coefficient value is above 0.71. The closeness value is stated as strong if the correlation coefficient value ranges from 0.71 <KK < 0.90.

The relationship between Catch per Unit Effort (CPUE) and catch reflects fishing efficiency in a fishery. CPUE is calculated by dividing the total catch by the total effort, and typically decreases as fishing effort increases, indicating that increased effort does not necessarily result in greater catch. The Schaefer model describes this relationship quadratically, with maximum catch achieved at a given level of effort before declining (Figure 8).

Analyzing the relationship between catch and effort produces a linear equation y = 0.1382x2 - 397.82x + 407344. The coefficient of determination (R2) of 0.8571 or 85.71% states that the effort value of 85.71% influences the increase and decrease in catch, while 14.29% is influenced by other factors not discussed in this study. The closeness value (correlation coefficient/R/R/R) of the relationship between catch and effort is 0.93, which comes from √0.8571. This can be interpreted as the relationship between catch and effort having an extreme closeness value because the correlation coefficient is above 0.91. The closeness value is extreme if the correlation coefficient ranges from 0.91 <KK < 0.99.

Increased catch is usually followed by increased fishing effort. Success in catching anchovies is greatly influenced by the effort made by bagan perahu fishermen and other factors, such as the presence of fish and natural conditions, including large waves, strong winds, and other weather conditions. In addition, the decrease in catch is also thought to be related to the biological condition of the fish, affecting the fishing success level. (Prihatiningsih et al., 2018), The decrease in catch can also occur due to excessive fishing efforts, which are carried out when the fish should be in a new recruitment phase, such as when the fish are ready to spawn. However,

the fish were caught before they could spawn. In addition, the large catch and the high effort made are also greatly influenced by favourable weather conditions, which allow fishermen to catch anchovies optimally (Yanto & Susiana, 2020).

3.5. Anchovy Fishing Season Pattern

Information on the seasonal pattern of anchovy fishing landed at the Carocok Coastal Fishing Port is very important to determine the most appropriate time to catch. This anchovy fishing seasonal pattern is calculated based on monthly catch and fishing effort data for 8 years (2016-2023). The calculation uses time series analysis and the moving average method, producing each month's Fishing Season Index (IMP). This information can be seen in Table 3 to provide a clearer picture of the anchovy fishing seasonal pattern:

Table 2. Anchovy fishing season index value at UPTD PPW1 Carocok 2016-2023

Month	IMP Value (%)	Season in Indonesia	Fishing Season
January	81	West	Medium
February	84	West	Medium
March	79	Transition I	Medium
April	109	Transition I	Peak
May	117	Transition I	Peak
June	122	East	Peak
July	122	East	Peak
August	132	East	Peak
September	95	Transition II	Medium
October	95	Transition II	Medium
November	80	Transition II	Medium
December	84	West	Medium

The pattern of anchovy fishing season, based on the calculation of the Fishing Season Index (IMP) value as shown in Table 3, reveals that the peak season for anchovy fishing in PPW1 Carocok occurs between April and August, which is indicated by an IMP value of more than 100%. Meanwhile, the moderate season for anchovy fishing occurs between January and March and September and December, with an IMP value above 50%. Interestingly, no month is identified as a lean season, because no IMP value is less than 50%.

The highest IMP value, indicating the peak fishing season, was recorded in August during the east season, reaching 132%. In contrast, the lowest IMP value, at 79%, occurred in March during the transition season 1, indicating a moderate fishing season. The anchovy season pattern at the Carocok Coastal Fishing Port shows an interesting difference, where the peak fishing season occurs from April to August, while the moderate season occurs from January to March and September to December. However, what is different is that the peak anchovy season is also recorded in the eastern season. This difference is likely due to changes in the seasonal system at sea, which is reflected in the data on the number of recorded efforts and catches, ultimately affecting the calculation of the fishing season (Tilik et al., 2014).

During this period, the IMP value was not less than 50%, indicating that there was no lean season. Similar research on seasonal patterns with different fish species, conducted by Situmorang & Agustriani (2018) at the Sungailiat Nusantara Fisheries Port, also showed similar results, namely the absence of a lean season in fishing patterns at that location.

The peak season for anchovy fishing is from April to August. Meanwhile, the middle season occurs between January and March and September and December. In transition season 2 (from the east to the west season), which occurs between September and November, the surface currents in the Java Sea tend to be erratic. However, the salinity of the waters remains high, allowing anchovies to maintain their activity and metabolism without having to migrate to other areas. On the other hand, at the end of the west season (February) to the transition season, I (between March and May), unstable wind directions and decreased water salinity cause anchovies to migrate to other areas, resulting in a decrease in catches.

The peak season for anchovy fishing occurs between April and August. Based on research by Sudirman et al. (2004), the peak spawning of anchovies occurs between March and August. Anchovies spawn throughout the year, indicating an abundance of plankton in November and December. This finding is in line with the IMP value recorded in April. Anchovy migration highly depends on the movement of abundant plankton throughout the year. This is based on research by Situmorang & Agustriani (2018), which revealed that the anchovy fishing season lasts throughout the year with two peak periods, namely between April-July and September-November, indicating an abundance of plankton in those months. In addition, mackerel migration is also influenced by the movement of small pelagic fish, which are their food source.

The difference in the anchovy fishing season index each month is influenced by water conditions that affect the availability of food sources, affecting the abundance of anchovies in the waters. One crucial factor that affects the abundance of fish is the availability of the food they need. The availability of this food source is closely related to the fertility of the waters, which is often indicated by the abundance of phytoplankton, zooplankton, and high chlorophyll-a concentrations. The seasonal pattern of anchovy catches is closely related to the concentration of chlorophyll-a in the waters north of Java, which is influenced by the abundance of phytoplankton and zooplankton

as the primary food sources for anchovies. The availability of this anchovy food source is also influenced by the intensity of upwelling that occurs in these waters (Tilik et al., 2014). Upwelling is a marine phenomenon in which water masses from the depths move up to the surface. As a result, the water temperature on the surface becomes cooler than the surrounding area, while the water is also rich in nutrients lifted from the sea's bottom layer (Wahid, 2020).

In general, areas with upwelling phenomena most often occur along the coastline or around the equator, because there is a divergence of water masses on a large and long scale in this area. In Indonesia, several areas experience upwelling, but the strongest occurs in the waters south of Sumatra. The mass of water lifted to the sea surface is rich in nutrients, supporting seaweed and phytoplankton growth. Both of these organisms can produce their food because they contain chlorophyll, which allows them to photosynthesize with the help of energy from the sun. Chlorophyll, a green pigment found in the chloroplasts of plants and other photosynthetic organisms, is essential in photosynthesis because it helps absorb light energy from the visible light spectrum. These seaweed and phytoplankton then become the fundamental part of the marine food chain, the primary fish source. Therefore, the upwelling area is one of the most productive fisheries areas in the world (Wahid, 2020).

The upwelling process is characterized by a decrease in sea surface temperature caused by the movement of cold water from the lower layers to the surface. This rising water mass carries important nutrients, increasing primary productivity in surface waters, as seen from increased chlorophyll-a levels. Therefore, the anchovy season is greatly influenced by the level of water fertility produced by the upwelling process. The increased availability of food on the sea surface encourages schools of anchovies to move up, which has a direct effect on increasing anchovy catches in certain months (Tilik et al., 2014).

4. Conclusions

The lowest CPUE occurred in 2019, at 73.30 kg/number of vessels. The peak season for anchovy fishing landed at PPW1 Carocok was identified as occurring from April to August, as indicated by an IMP value of more than 100%. The moderate season for anchovy fishing is from January to March and September to December, as indicated by an IMP value of more than 50%. No months were identified as lean seasons where the IMP value was less than 50%.

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