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FISHING PRODUCTIVITY OF SCADS RELATED TO SEA SURFACE TEMPERATURE AND CHLOROPHYLL-A IN CENTRAL JAVA WATERS

PRODUKTIVITAS PERIKANAN IKAN LAYANG TERKAIT SUHU PERMUKAAN LAUT DAN KLOROFIL-A DI PERAIRAN JAWA TENGAH

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ABSTRACT

Intensive exploitation of small pelagic resources in Central Java threatens long-term sustainability. This study aims to investigate fishing productivity of scads related to sea surface temperature and chlorophyll-a at Bajomulyo Fishing Port to provide an evidence-based foundation for sustainable management. Fishing productivity is expressed as catch weight per setting, focusing on two main species, i.e., shortfin scads - SS (*Decapterus macrosoma*) and Indian scads - IS (*Decapterus russelli*). Research was carried out from December 2022 to March 2023 to collect catch data of the fishing boat. Onboard observations were carried out to obtain data of scads, the catch (in kg) and effort data (number of settings) were collected monthly. Monthly fishing productivity was calculated as catch per unit effort (CPUE), and its relationships with environmental variables, namely chlorophyll-a concentration and sea surface temperature (SST), were analyzed using regression analysis. The highest CPUE was recorded in October 2022 (i.e. 1,054 kg/setting for SS and 1,081 kg/setting for IS), while the lowest was in January 2023 (189 kg/setting) and February 2023 (242 kg/setting), respectively. The CPUE and the fishing effort do not show linear relationships: CPUE = -16.36f + 829.62 (R^2 = 0.2610 for SS), and CPUE = -12.143f + 706.79 (R^2 = 0.1555 for IS). Seasonal fluctuations in CPUE were closely associated with changes in environmental conditions, i.e. high CPUE corresponds with high concentration of chlorophyll-a and low SST.

Keywords: chlorophyll-a, CPUE, *Decapterus macrosoma*, *D. russelli*, sea surface temperature

ABSTRAK

Eksploitasi intensif sumber daya pelagis kecil di Jawa Tengah mengancam keberlanjutan jangka panjang. Penelitian ini bertujuan untuk menginvestigasi produktivitas penangkapan ikan layang dikaitkan dengan suhu permukaan laut dam klorofil-a di Pelabuhan Perikanan Bajomulyo untuk menyediakan landasan berbasis bukti bagi manajemen yang berkelanjutan. Produktivitas diukur sebagai hasil tangkapan per *setting*, dengan fokus pada spesies target utama shortfin scad (*Decapterus macrosoma*) dan Indian scad (*Decapterus russelli*). Penelitian ini dilakukan dari Desember 2022 hingga Maret 2023 untuk mengumpulkan data hasil tangkapan pada kapal penangkap ikan. Pengamatan di atas kapal dilakukan untuk mendapatkan data ikan layang, data tangkapan (dalam kg) dan upaya (dalam *setting*) dikumpulkan setiap bulan. Produktivitas penangkapan ikan bulanan dihitung sebagai tangkapan per unit upaya (atau CPUE), dan hubungannya dengan variabel lingkungan, yaitu konsentrasi klorofil-a dan suhu permukaan laut (SST), dianalisis menggunakan analisis regresi. CPUE tertinggi tercatat pada Oktober 2022, yaitu 1.054 kg/*setting* untuk SS dan 1.081 kg/*setting* untuk IS, sedangkan yang terendah terjadi pada Januari 2023 (189 kg/*setting*) dan Februari 2023 (242 kg/*setting*). CPUE dan upaya penangkapan ikan tidak menunjukkan hubungan linier: CPUE = -16,36f + 829,62 dengan R^2 = 0,2610 untuk SS, dan CPUE = -12,143f + 706,79 dengan R^2 = 0,1555 untuk IS. Fluktuasi musiman dalam CPUE erat terkait dengan kondisi lingkungan, di mana konsentrasi klorofil-a yang lebih tinggi berkorelasi dengan peningkatan tangkapan, sementara kenaikan SST menunjukkan hubungan terbalik dengan CPUE.

Kata kunci: CPUE, *Decapterus macrosoma*, *D. russelli*, klorofil-a, suhu permukaan laut

INTRODUCTION

Small pelagic species captured by fishing boats from Bajomulyo Fishing Port in the Java Sea (WPPNRI 712) and Makassar Strait (WPPNRI 713) were dominated by two species of scads, i.e. shortfin scad (*Decapterus macrosoma*) and Indian scad (*Decapterus russelli*) (Nugroho 2006; Larasati *et al.* 2024). However, despite the dominance of these two scad species in the catches, information on boat-level fishing productivity and operational performance of small-scale fishing boat operating from Bajomulyo Fishing Port remains limited. Therefore, this study was conducted to provide empirical evidence on fishing productivity based on catch per setting, using a case study of a single fishing boat, to support fisheries assessment and management in the Java Sea and surrounding waters.

This study assesses the fishing productivity of small pelagic species based on a six-month case study of KM Tirta Putra Kencana I landed at Bajomulyo Fishing Port (Central Java). Fishing productivity is expressed as catch per settings (or catch per unit effort–CPUE) of focusing on the two main species or target species. Furthermore, the study seeks to examine the effect of sea temperature and chlorophyll-an on CPUE, as fishing productivity of pelagic fishing boat may be influenced by oceanographic variability, particularly the chlorophyll-a and sea surface temperature (SST), which affect water mass dynamics and habitat suitability of pelagic species, and consequently influence their distribution and catch rates (Abidin *et al.* 2020)

Catch per unit effort (CPUE) can be used to express the relative abundance of fish if total fishing efforts and total catch produced from all fishing operations are accounted (Gulland 1974; Beverton and Holt 1993). This approach relies on the fundamental assumption that CPUE is directly proportional to stock size, governed by a constant catchability coefficient (Maunder *et al.* 2006).

Regarding its applicability today, raw or nominal CPUE is increasingly problematic and rarely reflects true abundance in modern fisheries management without extensive correction (Harley *et al.* 2001; Maunder *et al.* 2020). Changes in fishing technology (such as GPS, sonar, and Fish Aggregating Devices/FADs) mean that modern fishing effort is no longer easily defined, often leading to “hyperstability”—a dangerous phenomenon where CPUE remains deceptively high even as the actual fish population is collapsing (Harley *et al.* 2001; Setyadji *et al.* 2025). Therefore, while the core concept remains applicable, CPUE can only serve as a reliable indicator of abundance if the data undergo advanced statistical standardization (e.g., using Generalized Linear Model (GLM), Generalized Additive Model (GAM), or spatio-temporal modeling) to remove the distorting effects of non-abundance factors (Hinton and Maunder 2004; Maunder *et al.* 2020).

CPUE is also an indicator of the business performance of fishing companies, therefore CPUE or fishing productivity plays a critical role in monitoring and management of capture fisheries. Fluctuation in abundance of (target) species from an area can be identified from CPUE (Sari *et al.* 2024). The CPUE as fish abundance index is calculated by dividing the total fish captured with the total fishing effort made by the fishing boats. If the specifications of fishing boats, fishing gears, and modes of fishing operation of boats vary among fishing boats, then the total fishing efforts must be calculated on the basis of standardized fishing effort.

The calculation of fishing productivity as business performance is straightforward by dividing the total catch with the total fishing effort. The catch is in principle the output of the fishing activity, while the effort required is in principle the input of the fishing activity. In economic terms, the ratio of output to input reflects the productivity level of each input use or efficiency level. In other words, a higher value of catch per effort reflects a higher level of productivity in fishing activities (Nahib 2008).

According to the Government Regulation of the Republic of Indonesia Number 11 of 2023 concerning Measurable Fishing in the Fisheries Management Areas of the Republic of Indonesia, the study area is located within fishing areas dedicated for local fishers of non-enterprise-based industrial fisheries, i.e. WPPNRI 712 and WPPNRI 713 (Figure 1). This study aims to investigate fishing productivity of scads related to sea surface temperature and chlorophyll-a at Bajomulyo Fishing Port to provide an evidence-based foundation for sustainable management. Therefore, this study provides some information required to support the fisheries management of these areas.

METHODS

Location and time of research

This research was conducted from October 2022 to March 2023. The fishing boat KM. Tirta Putra Kencana I was registered in Bajomulyo Coastal Fishing Port, Juwana

District, Pati Regency, Central Java. The fishing grounds of the boat include fisheries management area WPPNRI 712 (the Java Sea) and WPPNRI 713 (the Makassar Strait, Bone Bay, Flores Sea, and Bali Sea) (Figure 1). The boat is one of three purse seiners owned by PT Matahari Timur, a company located in Juwana, Central Java. KM Tirta Putra Kencana I is 27.6 m (length), 8 m (breadth), 2.7 m (depth) (Figure 2).

Data analysis

Primary data obtained in this research activity was obtained from direct practice on the ship. Catch data were processed to provide information on species composition, proportion of each species, and confirmation of target species. Monthly fishing productivity was calculated by dividing total catch of the two main species with monthly total number of fishing trips. Periodic data that have been collected were then analyzed to calculate the catch per unit effort (CPUE) value (Gulland 1983):

$$CPUE_t = \frac{catch_t}{effort_t\,(f_t)}$$

$$CPUE_t = a + b\,(f_t)$$

Determining the value of the correlation coefficient (R) which aims to determine the level of relationship between variables expressed by the correlation coefficient (R) (Walpole 1995; Jabnabillah and Margina 2022). The basis for decision making is as follows, if the correlation coefficient value (R) < 0.50, then the relationship is not close; R = 0.50–0.75, the relationship is close and (R) > 0.75, then the relationship is very close.

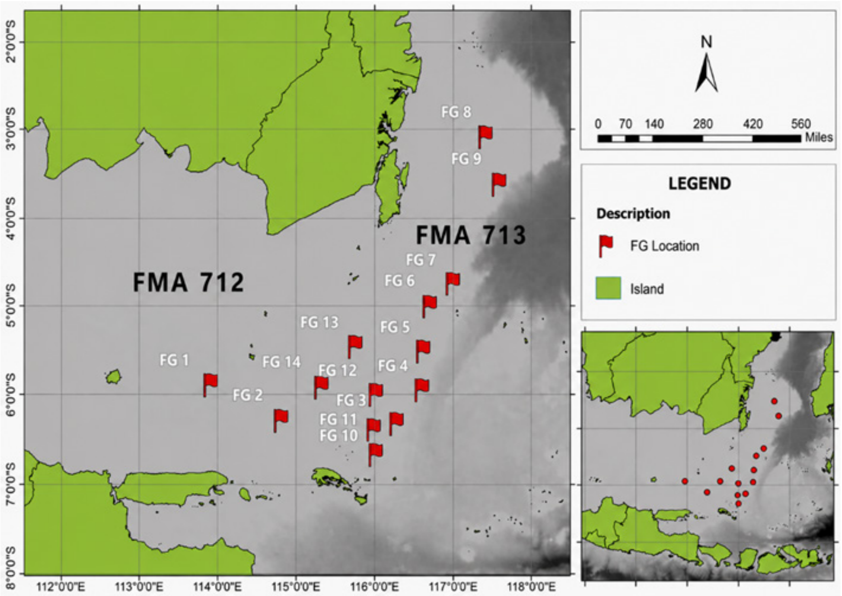

Figure 1. Map illustrating the sampling locations of shortfin scad (SS; *Decapterus macrosoma*) and Indian scad (IS; *Decapterus russelli*) used in this study.

Figure 2. The fishing boat of KM. Tirta Putra Kencana.

Sea surface temperature (SST) and chlorophyll-a monthly data were retrieved from processed MODIS satellite images for marine area between 2° and 7° S and 112°–118° E in the Java Sea to the Makassar Strait October 2022 to March 2023 study period. Monthly SST and chlorophyll-a values were extracted as area-averaged data for the entire study region. The relationship between monthly CPUE, monthly sea surface temperature (SST), and chlorophyll-a concentration was determined using linear regression analysis.

RESULTS AND DISCUSSION

The catch from the Java Sea and Makassar Strait consists of scads, sardines, mackerels, barracuda, and other small-sized pelagic fish. Small pelagic purse seine fishing boats at Bajomulyo Coastal Fishing Port mostly harvest scads, the dominant fish species in the Java Sea. The highest monthly fishing productivity for the short scads - SS (*Decapterus macrosoma*) occurred in October 2022, i.e. 1,054.43 kg/setting (Figure 3), while for the Indian scads - IS (*Decapterus russelli*) occurred in October 2022, i.e. 1,081.14 kg/setting (Figure 4).

The fishing productivity recorded in October for both species was significantly higher than that observed during the remaining five months. Furthermore, the monthly production of the IS boat demonstrated greater stability from September to March compared to the more fluctuant patterns observed in the SS boat. This occurs because during the month period, there is an increase and decrease in the number of fishing efforts. CPUE is influenced by the number of fishing efforts throughout the month to produce production.

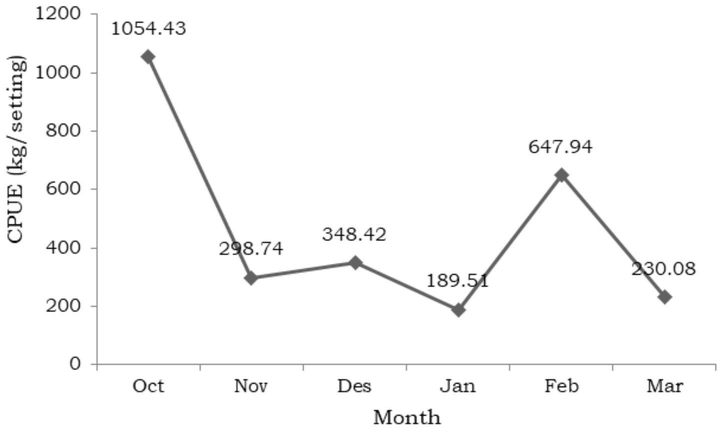

Figure 3. Monthly fluctuation of fishing productivity from shortfin scad (*Decapterus macrosoma*) at KM Tirta Putra Kencana I, a purse seine from Bajomulyo Fishing Port in October 2022–March 2023 (kg/setting).

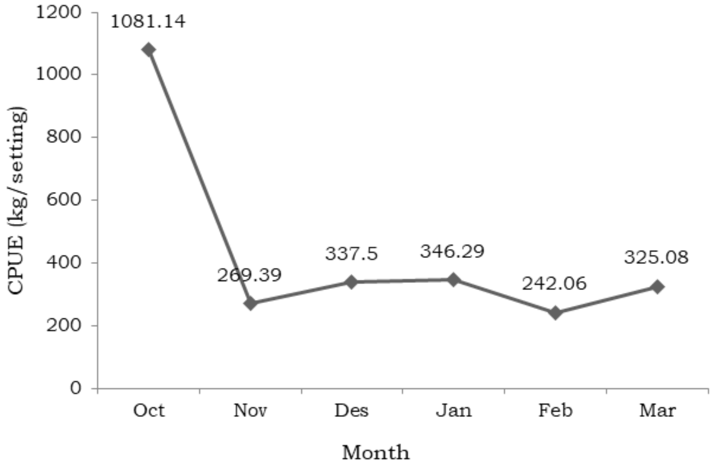

Figure 4. Monthly fluctuation of fishing productivity from Indian scad (*Decapterus russelli*) at KM Tirta Putra Kencana I, a purse seine from Bajomulyo Fishing Port in October 2022–March 2023 (kg/setting).

For the shortfin scads, the CPUE decreased as fishing effort increased. The relationship between CPUE and fishing effort is CPUE = -16.36 f + 829.62 with the coefficient of determination (R^2) of 0.2610. For the Indian scads, the relationship the two fisheries indicators are CPUE = -12.143 f + 706.79 (with R^2 = 0,155). Low values of R^2 indicate poor linear relationships between CPUE dan fishing effort. The presence of outliers (CPUE for October 2022) is likely responsible for the absence of linear relationships for both species. The outlier observed in October 2022 may be associated with favorable fishing conditions during the transition season, including higher fish aggregation and more effective fishing operations, which resulted in unusually high CPUE values compared to other months. In addition, environmental conditions during October, particularly sea surface temperature and chlorophyll-a concentration, may have been more suitable for the distribution and aggregation of small pelagic species in the fishing grounds. These conditions have potentially increased fish availability and catchability compared to the subsequent months of the study period.

The main catch is the fish that is the primary goal of fishing, the target fish is identified by identifying the fish that are valuable commercially and can be consumed (Nofrizal *et al.* 2018). The high catch in October (Figure 4) was due to October being the peak fishing season. Stated that the peak fishing season starts in July–November (east season) where the east season is an abundant shortfin scad fishing season (Hamka 2010). The peak catch in October can be explained by oceanographic conditions during the east season (July–November), when strong southeasterly monsoon winds in WPPNRI 712 and 713 drive coastal upwelling and nutrient enrichment in the Java Sea, Flores Sea, and surrounding waters. This process increases phytoplankton biomass, indicated by higher chlorophyll-a concentration, which subsequently enhances zooplankton abundance as prey for small pelagic fish such as shortfin scad. Together with favorable sea surface temperature ranges during this season, these conditions create productive fishing grounds that attract and aggregate schools of small pelagic fish, thereby resulting in higher catch rates in October (Nurmila *et al.* 2023; Syahdan *et al.* 2023).

The relationship between CPUE and fishing effort shown in Figures 5 and 6 is plausibly influenced by changing catchability (gear, skipper behaviour, and schooling/ aggregation of fish), strong influence of oceanographic variables (e.g., SST and chlorophyll-a) and possible lagged ecological responses, plus heterogeneity in the effort metric. Therefore, although the negative regression slope suggests a tendency for CPUE to decrease with increasing effort in our dataset, the result should be interpreted cautiously.

The shortfin scad and Indian scad production was most impacted by the rise in chlorophyll-a from October to December. Declining production of these can be impacted by depleting chlorophyll-a during January and February (Figure 7). In contrast, sea surface temperature (SST) has inversely related to catch (Figure 8). The findings indicate that, for both fish (shortfin scad and Indian scad), poor catches occur at high temperatures.

The seasonal variability of CPUE for Shortfin scad and Indian scad is closely linked to environmental conditions, particularly chlorophyll-a concentration and sea surface temperature (SST). Higher CPUE values observed during October–December coincided with elevated chlorophyll-a, reflecting enhanced primary productivity and prey abundance that support fish aggregation. In contrast, the decline in CPUE during January–February corresponded with reduced chlorophyll-a levels and increased SST, consistent with the ecological preference of small pelagic fishes for cooler, productive waters. This relationship explains why the simple CPUE–effort regression produced a low coefficient of determination (R^2), as fishing effort alone cannot account for the variability in catch rates. Environmental drivers such as chlorophyll-a and SST play a dominant role in shaping catchability and fish distribution, and their inclusion in CPUE standardization models would likely yield stronger explanatory power.

The fishing season factor, SST is also a factor in catches, the same thing is also stated by Kurnianingsih *et al.* (2017), which states that shortfin scad fish really like water temperatures in the range of 20–29 °C. In addition, fishing activities are carried out in the right month, in accordance with the statement of Hendiarti *et al.* (2005), which explains that shortfin scad and mackerel are caught in September–November.

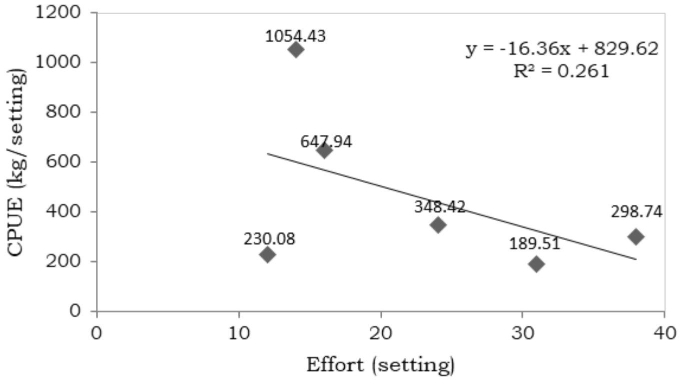

Figure 5. Relationship between CPUE and fishing effort for shortfin scad (*Decapterus macrosoma*).

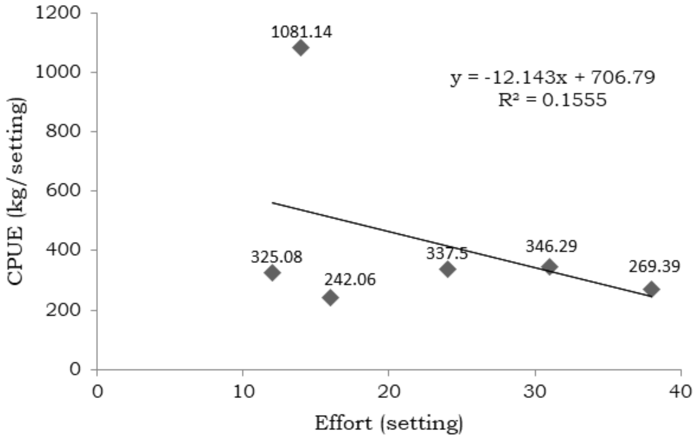

Figure 6. Relationship between CPUE and fishing effort for Indian scad (*Decapterus russelli*).

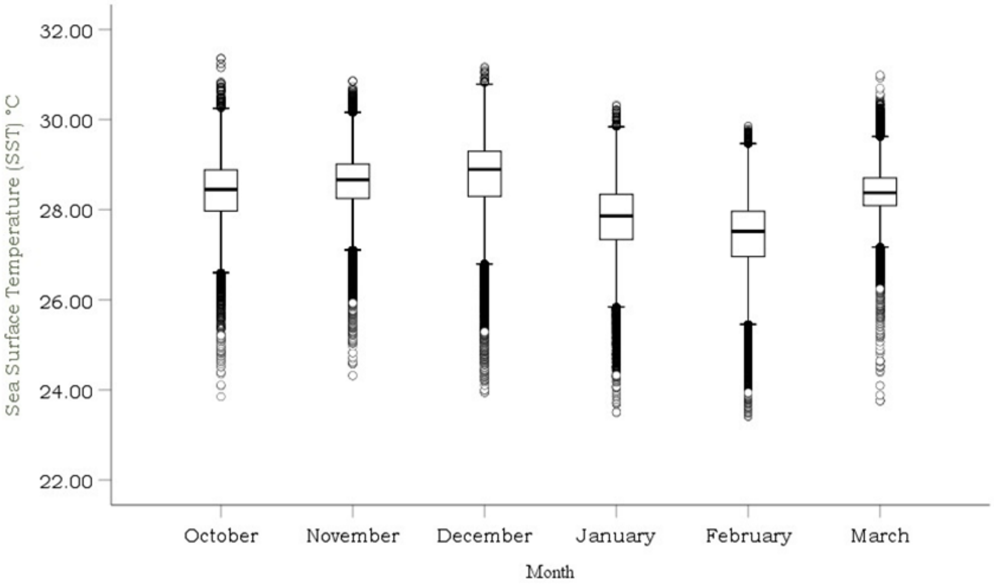

Figure 7. Sea surface temperature (SST), recorded in °C, was derived from satellite-based observations in the Java Sea to the Makassar Strait (2°–7° S; 112°–118° E) during October 2022–March 2023.

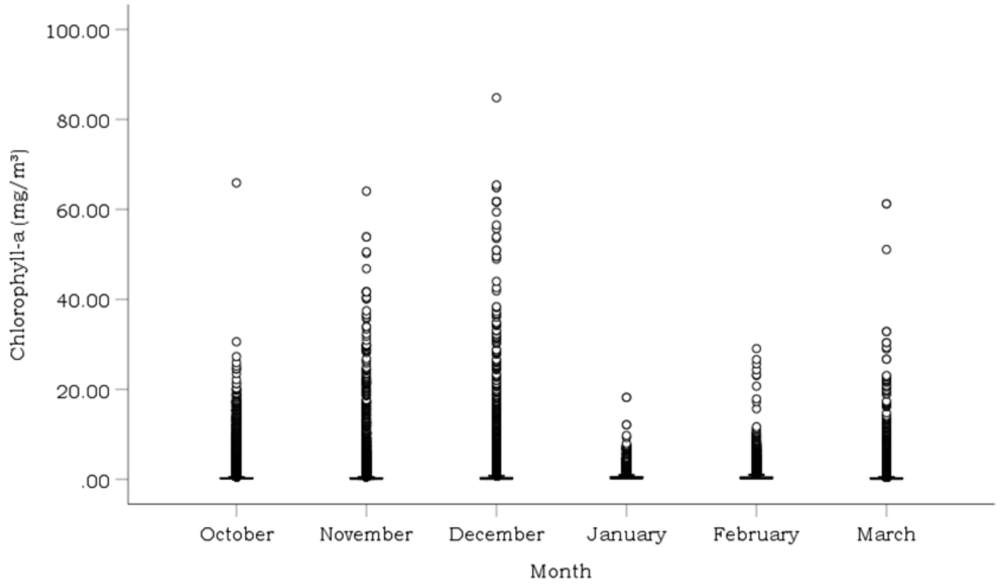

Figure 8. The concentration of chlorophyll-a (mg/m³) was obtained from satellite data in the Java Sea to the Makassar Strait (2°–7° S; 112°–118° E) during October 2022–March 2023.

The lowest catch in January of 189.51 kg/setting for shortfin scad (Figure 3) and February of 242.06 kg/setting for Indian scad (Figure 4). Entering December, the catch began to decline, the decline in catches was due to the shortfin scad fishing season. Stated that the western season occurred in December, which is the western season is a season of little shortfin scad fishing, in addition to the influence of the rainy season, which causes SST to increase (Hamka 2010). The high SST in December causes the catch to decrease because the commodity of scad, which is a small pelagic fish, tends to like relatively cold temperatures (Kurnia *et al.* 2016).

CPUE values fluctuate based on Figures 3 and 4. The increase and decrease in CPUE value is strongly influenced by the size and number of boats operating, the type and size of fishing gear, the ability of human resources on board, the location of the fishing ground, and natural conditions during fishing operations (Kusmini *et al.* 2016). In addition to these technical and operational factors, environmental drivers such as chlorophyll-a concentration and sea surface temperature (SST) also play a dominant role. Higher CPUE values during October–December coincided with elevated chlorophyll-a, reflecting enhanced primary productivity and prey abundance, while lower CPUE values in January–February was associated with reduced chlorophyll-a and higher SST, conditions less favorable for small pelagic aggregation. Although only descriptive patterns are presented here, the observed consistency between CPUE trends and variations in chlorophyll-a and SST suggests that these environmental factors significantly influence catch variability. A more detailed statistical analysis incorporating such covariates is recommended for future studies to quantitatively strengthen this relationship.

Catches are also influenced by the shortfin scad and Indian scad fishing season. The east season occurs from July to October, while the west season occurs from January to June. The fishing season will affect the catch landed by fishermen, which will continue to the amount of production. In addition to the fishing season, the catch is also influenced by the pattern of the migration (Febrianti *et al.* 2013).

Catches are also influenced by the speed of the boat according to Wijopriono and Genisa (2003), boats with relatively high speeds can block or compete with the speed of fish. Therefore, a boat that moves relatively faster than the swimming speed of the fish will increase the chance of catching fish. The power of the engine is large, so the process of encircling schools of fish is also faster so that the possibility of fish to escape is also smaller.

According to Hidayat *et al.* (2021), an abundance of small pelagic fish, such as scad, which are plankton feeders, is caused by the high concentration of plankton shown by the increase in chlorophyll-a concentration. Hendiarti *et al.* (2004), Adnan (2010), Kunarso *et al.* (2011), and Ashari *et al.* (2014), state that it is evident from the increasing chlorophyll-a content that causes an increase in catch. According to Gaol and Sadhotomo (2007), there is a movement of chlorophyll-a concentration that takes place between October and December in the eastern Java Sea, and this movement is synchronised with the abundance of pelagic fish.

Based on Figure 8 sea surface temperature (SST) has inversely related to catch. According to Ashari *et al.* (2014) SST details that were specific to each site catchment and the average for the whole study area had a modest degree of correlation with scad catch. Sea surface temperature (SST) showed an inverse relationship with catch productivity, where lower SST values tended to correspond with higher CPUE. This condition may indicate that cooler waters during certain months created more favorable habitats and feeding conditions for small pelagic species, leading to higher fish aggregation in the fishing grounds. In addition, variations in chlorophyll-a concentration may reflect changes in primary productivity that influence food availability and subsequently affect fish distribution and catch rates.

CONCLUSION

The highest CPUE values for shortfin scad and Indian scad were in October, at 1,054.43 kg/setting and 1,081.14 kg/setting, respectively. The increase in chlorophyll-a content is in line with the increase in catch yield, while sea surface temperature has an inverse relationship with catch yield. Higher chlorophyll-a enhances prey availability and supports fish aggregation, leading to higher CPUE, while elevated sea surface temperature reduces habitat suitability and results in lower CPUE.

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REFERENCES

Abidin AF, Amron A, Marzuki MI. 2020. Relationship Between Chlorophyll-a and Sea Surface Temperature to Tuna Catch in the Southern Water of Java. *Jurnal Penelitian Sains*. 22(2): 55–68. DOI: https://doi.org/10.56064/jps.v22i2.582.

Adnan A. 2010. Analisis SPL dan Klorofil-a Data Inderaja Hubungannya dengan Hasil Tangkapan Ikan Tongkol (*Euthynnus affinis*) di Perairan Kalimantan Timur. *Jurnal “Amanisal” PSP FPIK Unpatti-Ambon*. 1(1): 1–12.

Ashari F, Redjeki S, Kunarso K. 2014. Keterkaitan Jumlah Tangkapan Ikan Pelagis Kecil dengan Distribusi Klorofil-a dan Suhu Permukaan Laut Menggunakan Citra Modis di Laut Jawa dan Selat Makassar. *Journal of Marine Research*. 3(3): 366–373. DOI: https://doi.org/10.14710/jmr.v3i3.6009.

Beverton RJH, Holt SJ. 1993. *On the Dynamics of Exploited Fish Population*. Dordrecht (NL): Springer Science+Business Media.

Febrianti SS, Boesono H, Hapsari TD. 2013. Analisis Faktor-Faktor yang Mempengaruhi Harga Ikan Manyung (*Arius thalassinus*) di TPI Bajomulyo Juwana Pati. *Journal of Fisheries Resources Utilization Management and Technology*. 2(3): 162–171.

Gaol JL, Sadhotomo B. 2007. Karakteristik dan Variabilitas Parameter-Parameter Oseanografi Laut Jawa Hubungannya dengan Distribusi Hasil Tangkapan Ikan. *Jurnal Penelitian Perikanan Indonesia*. 13(3): 201–211. DOI: http://dx.doi.org/10.15578/jppi.13.3.2007.201-211.

Government Regulation of the Republic of Indonesia Number 11 of 2023 concerning Measurable Fishing. Jakarta.

Gulland JA. 1974. *The Management of Marine Fisheries*. Seattle (US): University of Washington Press.

Gulland JA. 1983. *Fish Stock Assessment: A Manual of Basic Methods*. Rome (IT): FAO/Wiley Series on Food and Agriculture.

Hamka E. 2010. Pemetaan Daerah Penangkapan Potensial Ikan Layang (*Decapterus* sp.) di Laut Banda [Thesis]. Bogor (ID): IPB University.

Harley SJ, Myers RA, Dunn A. 2001. Is Catch-per-Unit-Effort Proportional to Abundance?. *Canadian Journal of Fisheries and Aquatic Sciences*. 58(9): 1760–1772. DOI: https://doi.org/10.1139/cjfas-58-9-1760.

Hendiarti N, Siegel H, Ohde T. 2004. Investigation of Different Coastal Processes in Indonesian Waters Using SeaWiFS Data. *Deep Sea Research Part II: Topical Studies in Oceanography*. 51(1–3): 85–97. DOI: https://doi.org/10.1016/j.dsr2.2003.10.003.

Hendiarti N, Suwarso, Aldrian E, Amri K, Andiastuti R, Sachoemar SI, Wahyono IB. 2005. Seasonal Variation of Pelagic Fish Catch Around Java. *Oceanography*. 18(4): 112–123. DOI: https://doi.org/10.5670/oceanog.2005.12.

Hidayat T, Boer M, Kamal MM, Zairion, Suman A. 2021. The Characteristic of Neritic Tuna Fisheries in the Java Sea and Adjacent Water. *International Symposium on Aquatic Sciences and Resources Management, 16–17 November 2020, Bogor, Indonesia*. IOP Conference Series: Earth and Environmental Science. DOI: https://doi.org/10.1088/1755-1315/744/1/012029.

Hinton MG, Maunder MN. 2004. Methods for Standardizing CPUE and How to Select among Them. *Collective Volume of Scientific Papers ICCAT*. 56(1): 169–177.

Jabnabillah F, Margina N. 2022. Analisis Korelasi Pearson dalam Menentukan Hubungan antara Motivasi Belajar dengan Kemandirian Belajar pada Pembelajaran Daring. *Jurnal Sintak*. 1(1): 14–18.

Kunarso K, Hadi S, Ningsih NS, Baskoro MS. 2011. Variabilitas Suhu dan Klorofil-a di Daerah *Upwelling* pada Variasi Kejadian ENSO dan IOD di Perairan Selatan Jawa sampai Timor. *Ilmu Kelautan: Indonesian Journal of Marine Sciences*. 16(3): 171–180. DOI: https://doi.org/10.14710/ik.ijms.16.3.171-180.

Kurnia K, Purnawan S, Rizwan T. 2016. Pemetaan Daerah Penangkapan Ikan Pelagis Kecil di Perairan Utara Aceh. *Jurnal Ilmiah Mahasiswa Kelautan Perikanan Unsyiah*. 1(2): 185–194.

Kurnianingsih TN, Sasmito B, Prasetyo Y, Wirasatriya A. 2017. Analisis Sebaran Suhu Permukaan Laut, Klorofil-A, dan Angin terhadap Fenomena *Upwelling* di Perairan Pulau Buru dan Seram. *Jurnal Geodesi Undip*. 6(1): 238–248. DOI: https://doi.org/10.14710/jgundip.2017.15387.

Kusmini II, Putri FP, Prakoso VA. 2016. Bioreproduksi dan Hubungan Panjang-Bobot terhadap Fekunditas pada Ikan Lalawak (*Barbonymus balleroides*). *Jurnal Riset Akuakultur*. 11(4): 339–345. DOI: http://dx.doi.org/10.15578/jra.11.4.2016.339-345.

Larasati RF, Jaya MM, Mahardi IGNKH, Putra A, Bramana A, Aini S, Hamdani H, Ariana M. 2024. Observasi Daerah Penangkapan Ikan di Perairan Laut Jawa dan Selat Makassar. *Jurnal Teknologi Perikanan dan Kelautan*. 15(2): 203–210. DOI: https://doi.org/10.24319/jtpk.15.203-210.

Maunder MN, Sibert JR, Fonteneau A, Hampton J, Kleiber P, Harley SJ. 2006. Interpreting Catch per Unit Effort Data to Assess the Status of Individual Stocks and Communities. *ICES Journal of Marine Science*. 63(8): 1373–1385. DOI: https://doi.org/10.1016/j.icesjms.2006.05.008.

Maunder MN, Thorson JT, Xu H, Oliveros-Ramos R, Hoyle SD, Tremblay-Boyer L, Lee HH, Kai M, Chang SK, Kitakado T, *et al*. 2020. The Need for Spatio-temporal Modeling to Determine Catch-per-unit Effort Based Indices of Abundance and Associated Composition Data for Inclusion in Stock Assessment Models. *Fisheries Research*. 229: 105594. DOI: https://doi.org/10.1016/j.fishres.2020.105594.

Nahib I. 2008. Analisis Bioekonomi Dampak Keberadaan Rumpon terhadap Kelestarian Sumberdaya Perikanan Tuna Kecil (Studi Kasus di Perairan Teluk Palabuhanratu Kabupaten Sukabumi) [Thesis]. Bogor (ID): IPB University.

Nofrizal, Jhonnerie R, Yani AH, Alfin. 2018. Hasil Tangkapan Sampingan (*Bycatch* dan *Discard*) pada Alat Tangkap Gombang (*Filter Net*) Sebagai Ancaman Bagi Kelestarian Sumberdaya Perikanan. *Marine Fisheries: Jurnal Teknologi dan Manajemen Perikanan Laut*. 9(2): 221–233. DOI: https://doi.org/10.29244/jmf.9.2.221-233.

Nugroho D. 2006. Kondisi Trend Biomassa Ikan Layang (*Decapterus* spp.) di Laut Jawa dan Sekitarnya. *Jurnal Penelitian Perikanan Indonesia*. 12(3): 167–174. DOI: http://dx.doi.org/10.15578/jppi.12.3.2006.167-174.

Nurmila WO, Asmadin A, Mustafa A, Saenuddin, Sadarun B, Indrayani, Ogbonna DN. 2023. The Analysis of Clorophyll-a Distribution and Sea Surface Temperature for Estimation of Skipjack Fishing Grounds (*Katsuwonus pelamis*) Based on Different Seasons in South Buton Waters. *Coastal and Marine Journal*. 1(2): 67–77. DOI: https://doi.org/10.61548/cmj.v1i2.17.

Sari IP, Satyawan NM, Rahayu SM. 2024. Stock Study of Bali Sardinella Fisheries at Pengambengan Nusantara Fishing Port, Bali. *Journal of King Abdulaziz University: Marine Sciences*. 34(1): 29–39. DOI: https://doi.org/10.4197/

Mar.34-1.3.

Setyadji B, Spencer M, Kell L, Wright S, Ferson S. 2025. A Multi-Species Ratio Approach to Estimate Eastern Little Tuna (*Euthynnus affinis*) Abundance Independent of Fishing Effort in the Indian Ocean. IOTC-2025-WPNT15-15. Working Party on Neritic Tunas, Indian Ocean Tuna Commission.

Syahdan M, Athmadipoera AS, Susilo SB, Gaol JL. 2023. Determining the Potential Fishing Zone of Small Pelagic Fishes Based on Spatial and Temporal Variability of Remote Sensing Satellite Data. *Egyptian Journal of Aquatic Biology and Fisheries*. 27(3): 967–978. https://doi.org/10.21608/ejabf.2023.306903.

Walpole RE. 1995. *Pengantar Statistika*. Jakarta (ID): Gramedia Pustaka Utama.

Wijopriono, Genisa AS. 2003. Kajian terhadap Laju Tangkap dan Komposisi Hasil Tangkapan *Purse Seine* Mini di Perairan Pantai Utara Jawa Tengah. *Jurnal Ilmu Kelautan dan Perikanan Torani*. 13(1): 44–50.