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Catch, Effort and Distribution of Small Pelagic Fisheries in the Java Sea

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ABSTRACT
Fisheries management area (FMA) 712 or the Java Sea is one of Indonesia's most extensively exploited waters and is renowned for its productivity as a fishing ground. The dynamics of fish resource utilization in these waters are indicative of the high complexity of the extant fisheries system, with small pelagic fish resources having been subject to exploitation through various changes in gear technology thus increasingly competitive fishing grounds. Therefore, there is a need data on current distribution and catch trend of small pelagic fisheries in the Java Sea through the use of fishery dependent data as an integral part of sustainable fisheries management. The present study utilizes fishing logbook data to analyze the status of small pelagic fish resource utilization in the Java Sea. The study utilized fishing logbook data downloaded from the database application of the Fishing Logbook Information System of the Indonesian Ministry of Marine Affairs and Fisheries, covering the period from 2018 to 2022. The subsequent processing of catch data was conducted using Microsoft Excel software, whereas the distribution of fishing areas was analyzed using QGIS tools. The analysis revealed a tendency for a decline in the catch of small pelagic fisheries for the Indian Mackerel (*Rastrelliger kanagurta*), Short Mackerel (*Rastrelliger brachysoma*), Fringescale Sardinella (*Sardinella fimbriata*) and Shortfin Scad (*Decapterus macrosoma*). Only Yellowstripe Scad (*Selaroides leptolepis*) showed an increased catch trend in that period. It was further observed that the fishing grounds of all fish species remained consistent on an annual basis. The Shortfin Scad fishing grounds were found to be uniformly dispersed within FMA 712, exhibiting a tendency to congregate along the Java Sea border with Borneo waters. Short Mackerel have been observed to be frequent in fishing grounds of the eastern to western Java Sea. In contrast, Indian Mackerel have been noted to be more prevalent in the waters of South Borneo and the western Java Sea. The distribution of Yellowstripe Scad fishing grounds appears to be uniform within FMA 712. Fringescale Sardinella fishing grounds have been identified as being predominantly concentrated in the western Java Sea and in Borneo waters.

Keywords: Catch and Effort, Distribution, Fishing Logbook Data, Java Sea, Small Pelagic Fisheries

INTRODUCTION

The Fisheries Management Area of the Republic of Indonesia 712 (FMA 712) or better known as Java Sea is a dense waters of capture with various forms of fishing gear that are passive and active (Suwarso *et al.* 2021). These waters have a variety of abundant fisheries resource potentials, especially small pelagic fish. Based on the survey using the acoustic method obtained the number of maximum sustainable yield small pelagic fisheries is 364.663 ton, with the value of total allowable catch or TAC (80% from MSY) is 291.730 ton. Small pelagic fisheries caught among *Sardinella* spp., *Rastrelliger brachysoma*, *Dusumieria acuta*, *Selar* spp, *Selar crumenophthalmus*, *R. kanagurta*, *Amblygaster sirm*, *Megalaspis cordyla* (Suman *et al.* 2019).

Meanwhile the results of the study of fisheries stock that issued by Ministry of Marine Affairs and Fisheries through the Decree of the Minister of Marine Affairs and Fisheries Number 19 of 2022 stated that the estimated small pelagic potential was 275.486 ton and TAC 247.937 ton (Kementerian Kelautan dan Perikanan 2022).

Small pelagic fisheries have been used in a very long period. Utilization of small pelagic fish resources in the Java Sea is known to have lasted at least more than five decades with various changes in tools and shifts of increasingly competitive fishing areas (Atmaja and Nugroho, 2019). The peak of pelagic fish catch was achieved in 1994, which is around 100.000 tons in Pekalongan and 62.00 tons in Juana.

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In 2005 total landing only reached 39.000 tons in Pekalongan and 20.000 tons in Juana, even in 2006 only 22.000 tons in Pekalongan. Depreciation of Pelagic Stock (Biomass) in the Java Sea and Makassar Strait due to an uncontrolled increase in fishing capacity is a source of causes of disadvantages (Suwarso *et al*. 2017).

Khatami *et al* (2019) found that five of six small pelagic fish species caught have exploitation rates surpassing the optimal limit of 50% and are classified as overexploited. During the last eight years (2009-2016) the distribution of the number of fishing captures operating in FMA 712 experienced fluctuating changes. The highest total number of fishing vessels was in 2014, with a total of 98,828 units of fishing vessels which were nominated by ships sized <30 GT. The number of ships that can operate in the regional capture zone in accordance with the potential and JTB in force at the moment is 44,243 fishing vessels, with the distribution of capture zones of 30,723 units of ships sized <5 GT to 21-30 GT and 13,521 units of fishing vessels measuring 31-50 GT up to ships measuring> 200 GT (Ardiyani *et al*. 2019).

One important element in fisheries management is the collection of data and information as material for the preparation of fisheries management policies. Good data will produce good information and will provide concrete benefits in fisheries management. Regarding fisheries data, Bradley *et al*. (2019) stated that Fishery-dependent data are integral to sustainable fisheries management. A paucity of fishery data leads to uncertainty about stock status, which may compromise and threaten the economic and food security of the users dependent upon that stock and increase the chances of overfishing. Recent developments in the technology available to decreased rings productivity that took place simultaneously in 1995 to 2006, as well as providing lower capture and collect, manage and analyse fishery-relevant data provide a suite of possible solutions to update and modernize fisheries data systems and greatly expand data collection and analysis.

Fishing logbook data as a form of dependent data fisheries can be used in monitoring the development of the status of fisheries resources utilization. Some research has used the logbook of fishing logbooks as the main data base as has been done by Chang *et al*. (2011), Lezama-Ochoa *et al*. (2010), Michael *et al*. (2017) for tuna fisheries, and Hudaya *et al*. (2022) for coral and demersal fisheries. One of the information available in the fishing logbook data is the catch rate. Catch, Effort and Catch Per-Unit of Effort (CPUE) are three quantities related to interconnected. If two of the three quantities are known, the third quantity can be calculated. These three are the basic parameters needed in the study of stock using the application of the Surplus Production Model (Badrudin 2007).

This study using data logbook of fish caught for five years (2018-2022) to determine the catch and fishing effort, as well as the distribution of fishing areas in FMA 712. The results of the study are expected to be used to formulate more effective management strategies to ensure the sustainable use of pelagic fisheries in Java Sea.

MATERIAL AND METHOD

This study uses a time series of fishing logbook data (2018-2022) in FMA 712 (Figure 1). The choice of these data is based on the consideration that fishing logbook data reported during this period are more accurate and valid, as the reported data have not yet involved the payment of non-tax government revenue (PNBP).

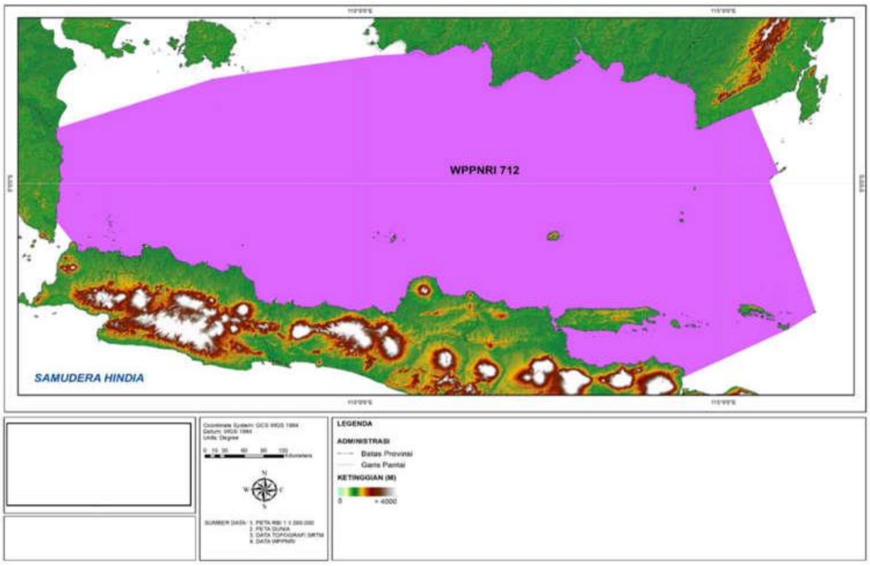

Figure 1. The research location of FMA 712

Meanwhile, fishing logbook data after the post-production policy, which began on 1 January 2023, tends to be invalid because it avoids paying more PNBP (Figure 1). The fishing logbook data used in this study were obtained from the Fishing Logbook Information System (SILOPI) database of the General Directorate of Capture Fisheries, Ministry of Marine Affairs and Fisheries. In addition, the processing of the fishing logbook data downloaded involved several steps, including synchronisation of Latin names, species codes, verification of trip data, days at sea and fishing dates. The prepared datasets were then analysed using Microsoft Excel and QGIS tools.

RESULT AND DISCUSSION

Result

Catch and Effort

Based on the analysis of catch and effort data for five small pelagic species in FMA 712 during 2018-2022, it was found that only Yellowstripe Scad (*Selaroides leptolepis*) whose catch increased consistently every year. The other four species, namely Indian Mackerel (*Rastrelliger kanagurta*), Short Mackerel (*Rastrelliger brachysoma*), Fringescale Sardinella (*Sardinella fimbriata*) and Shortfin Scad (*Decapterus macrosoma*), showed a downward trend in catch.

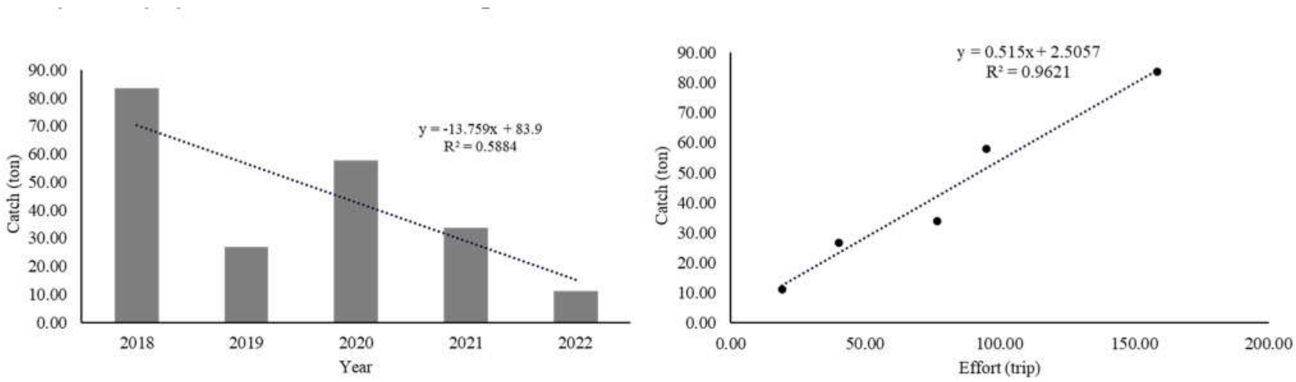

Figure 2. Catch of Indian Mackerel and relationship between catch and effort

The figure above shows that the lowest catch of Indian Mackerel occurred in 2022 with 11.26 tonnes, while the highest catch occurred in 2018 with 83.53 tonnes. The relationship between fishing effort and catch of Indian Mackerel in FMA 712 in 2018-2022 with a linear equation y = 0.515x + 2.5057. The slope value of 0.515 with an upward trend line indicates that the relationship between fishing effort and production is positive, i.e. each additional unit of fishing effort increases the catch of Indian mackerel by 0.515 tonnes. The value of R2=0.9261 shows that 92.61% of the decrease in catch (y) is caused by fishing effort (x), while 7.39% is caused by natural and biological factors cacthing study area.

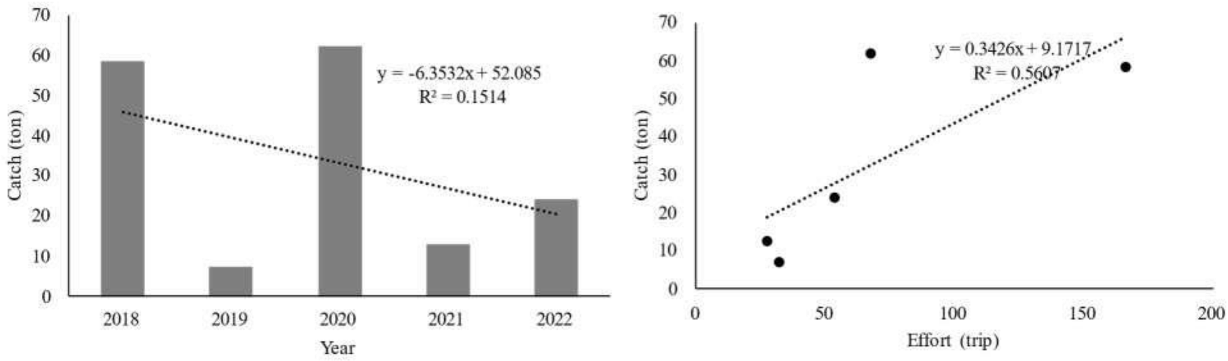

Figure 3. Catch of Short Mackerel and relationship between catch and effort

Based on Figure 3, the lowest short mackerel catch occurred in 2019 with 7,282 tonnes, while the highest catch occurred in 2020 with 62,296 tonnes. Meanwhile, the relationship between fishing effort and Short Mackerel catch in FMA 712 during 2018-2022 has a linear equation y=0.3426x + 9.1717. The slope value of 0.3426 with an upward trend line indicates that the relationship between fishing effort and catch is positive, i.e. each additional unit of fishing effort increases the catch of short mackerel by 0.3426 tonnes. The value of R2=0.5607 shows that 56.07% of the decrease in catch (y) is caused by fishing effort (x), while 43.93% is caused by natural and biological factors cacthing study area in Java Sea of FMA 712.

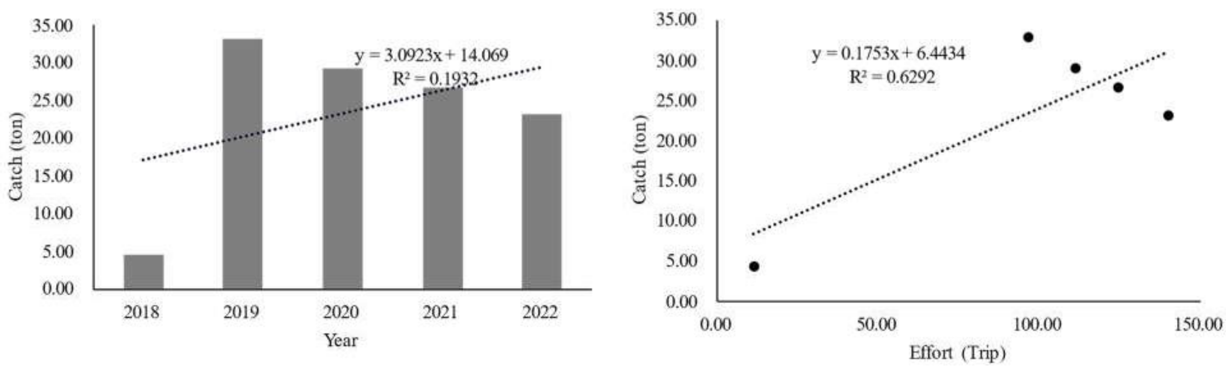

Figure 4. Catch of Yellowstripe Scad and relationship between catch and effort

Figure 4 shows the catch of Yellowstripe Scad in FMA 712 from 2018 to 2022. The lowest catch occurred in 2018 with 4.53 tonnes, while the highest catch occurred in 2019 with 33.8 tonnes. The relationship between fishing effort and catch of Yellowstripe Scad in FMA 712 from 2018-2022 has a linear equation y = 0.1753x + 6.4434. The slope value of 0.1753 with an upward trend line indicates that the relationship between fishing effort and production is positive, i.e. each additional unit of fishing effort increases the catch of yellowstripe scad by 0.1753 tonnes. The value of R2=0.6292 indicates that 62.92% of the decrease in catch (y) is caused by fishing effort (x), while 37.08% is caused by natural and biological factors.

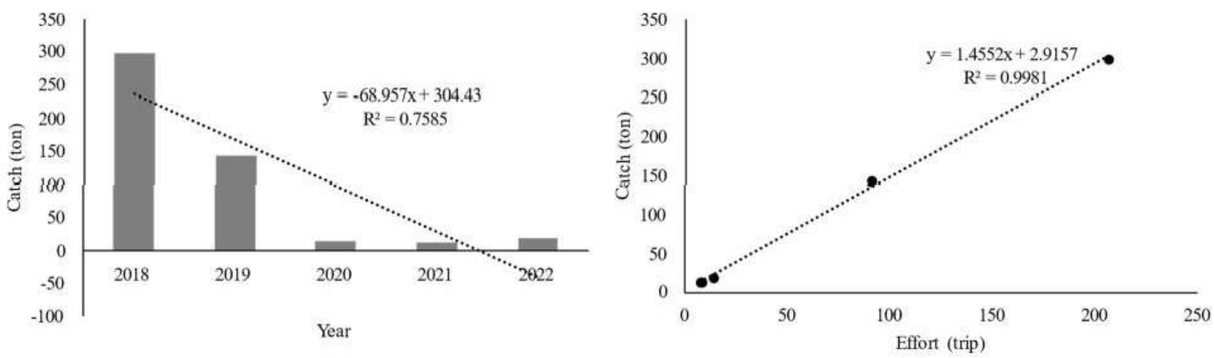

Figure 5. Catch of Fringescale Sardinella and relationship between catch and effort

From the graph above, we can see that the lowest catch of Fringescale Sardinella occurred in 2021 with 12.597 tonnes, while the highest catch occurred in 2018 with 298.147 tonnes. Meanwhile, the relationship between fishing effort and catch of Fringescale Sardinella in FMA 712 from 2018- 2022 has a linear equation y = 1.4552x + 2.9157. The slope value of 1.4552 with an upward trend line indicates that the relationship between fishing effort and catch is positive, i.e. each additional unit of fishing effort increases the catch of Fringescale Sardinella by 1.4552 tonnes. The value of R2=0.9981 indicates that 99.81% of the decrease in catch (y) is influenced by fishing effort (x) and 0.19% by natural and biological factors.

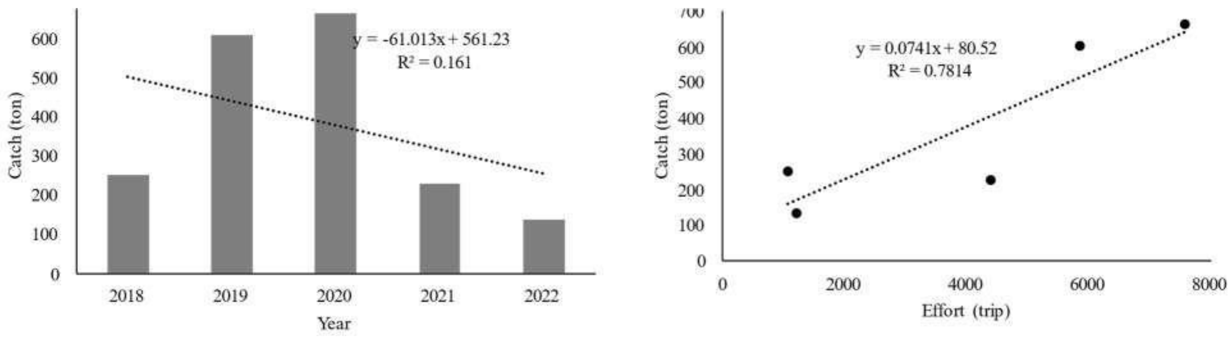

Figure 6. Catch of Shortfin Scad and relationship between catch and effort

Figure 6 shows the catch of shortfin scad in FMA 712 during 2018-2022. The lowest catch occurred in 2022 with 137,041 tonnes and the highest catch occurred in 2020 with 665,405 tonnes. The graph of the relationship between fishing effort and catch of shortfin scad in FMA 712 from 2018-2022 has a linear equation y = 0.0741x + 80.52. The slope value of 0.0741 with an upward trend line indicates that the relationship between fishing effort and catch is positive. This study means that each additional unit of fishing effort increases the catch of shortfin scad by 0.0741 tonnes. The value of R2=0.7814 indicates that 78.14% of the increase in catch (y) is due to fishing effort (x) and 21.86% is due to natural and biological factors in the catch of shortfin scad during 2018-2022.

Distribution of Fishing Area

The Java Sea in FMA 712 area is divided into several seasons, including western season (December-February), transitional season I (March-May), eastern Season (June-August), Transitional Season II (September-November) (Rizal *et al*. 2023). Below is a map showing the fishing distribution of Shortfin Scad, Short Mackerel, Indian Mackerel, Yellowstripe Scad and Fringescale Sardinella.

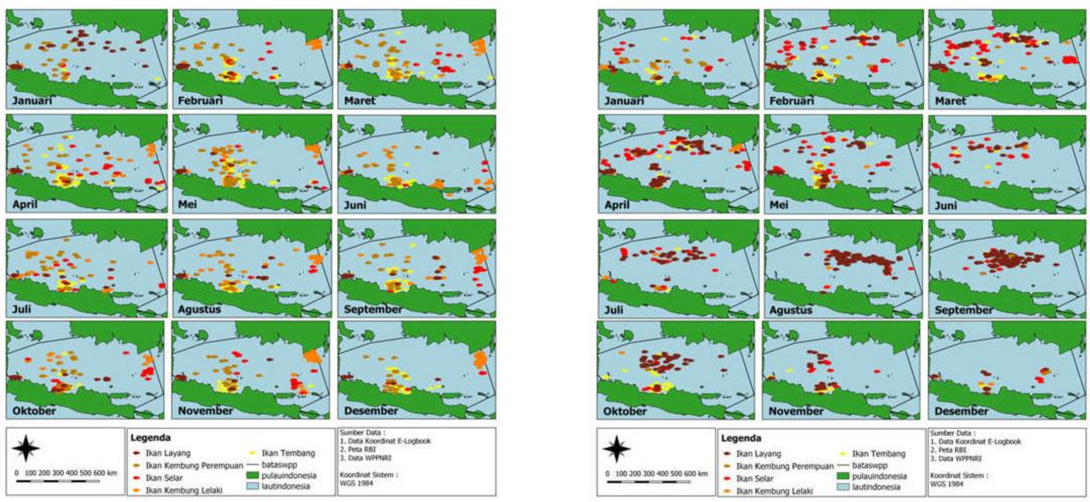

Figure 7. Maps of Distribution of five species small pelagic fisheries year 2018 (left) and 2019 (right)

The figure above shows that the distribution of small pelagic fish tends to follow the seasons, shifting between the eastern, central and western regions of the Java Sea. The fishing grounds of shortfin scad are more dynamic than those of other species, especially during the transitional season. Short mackerel and Fringescale Sardinella have a more stable distribution pattern, especially in the western Java Sea. Fishing intensity for shortfin scad and Indian mackerel tends to be low in certain seasons, such as the western season for Indian mackerel and transitional season I for shortfin scad. In 2019, fish distribution patterns tended to shift more towards Kalimantan waters compared to 2018, especially for Shortfin Scad and Indian Mackerel. Fishing intensity and activity was more variable in 2019 compared to 2018.

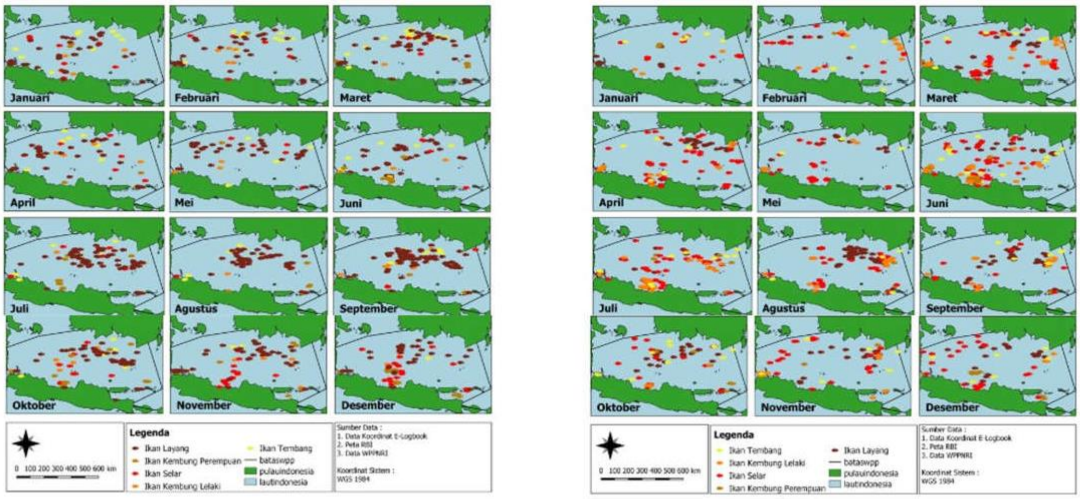

Figure 8. Maps of Distribution of five species small pelagic fisheries year 2020 (left) and 2021 (right)

The figure above shows that the distribution of small pelagic fish (shortfin scad, short mackerel, yellowstripe scad, Indian mackerel and Fringescale Sardinella) is found in the eastern to western Java Sea and Kalimantan waters. The waters of South Kalimantan, Central Kalimantan and the North Sea of Java are the main locations of small pelagic fisheries in different seasons. The distribution of fish tends to shift from east to west or vice versa depending on the season. In the western season (December-February), fish are more likely to be found in Kalimantan waters and the eastern Java Sea. In the eastern season (June-August), fish tend to migrate from the western Java Sea to Kalimantan waters. Fishing intensity varies, e.g. shortfin scad has a fishing intensity that tends to be the same throughout the season. On the other hand, the fishing intensity of Short Mackerel in the first transitional season (March-May) is very low compared to other seasons. Fringescale Sardinella has a relatively even distribution along the Kalimantan and Java Sea waters in all seasons. Indian Mackerel and Yellowstripe Scad species have lower fishing intensity in the eastern season. The year 2021 shows an expansion of the fishing area into the western waters of the Java Sea compared to 2020.

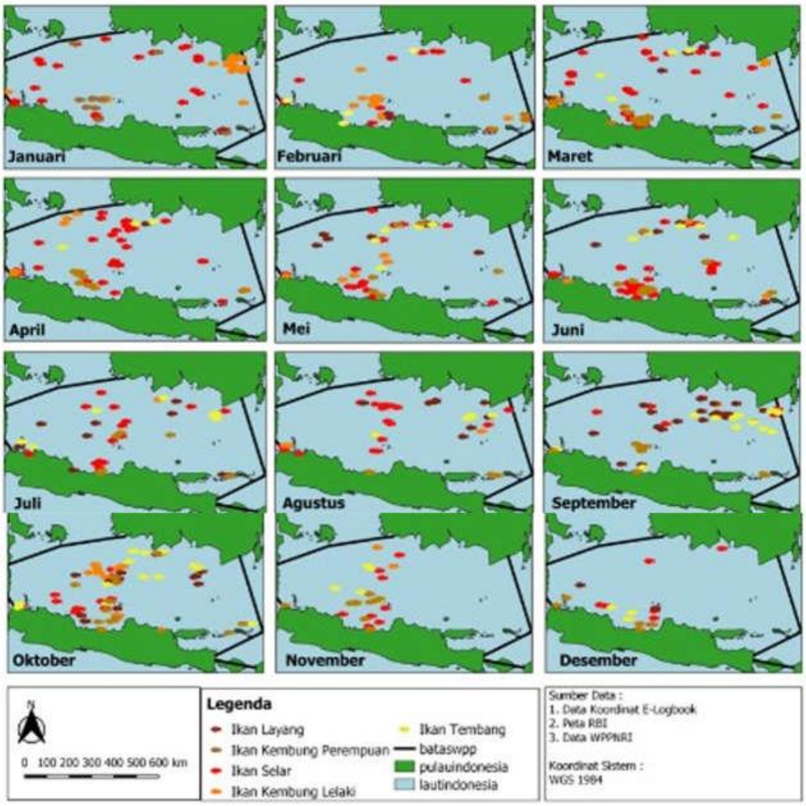

Figure 9. Maps of Distribution of five species small pelagic fisheries year 2022

Figure 9 shows the distribution pattern of small pelagic fish (shortfin scad, short mackerel, yellowstripe scad, Indian mackerel and Fringescale Sardinella) consistently in Kalimantan waters (south and central) and the eastern to western Java Sea. The distribution of small pelagic fishes in the Java Sea generally follows seasonal changes, with shifts from east to west or vice versa. Seasonal shift patterns were observed for shortfin scad and Indian mackerel, while yellowstripe scad and Fringescale Sardinella had a more uniform distribution. Shortfin Scad have a dynamic distribution pattern with significant shifts from Kalimantan waters to the western Java Sea in certain seasons. Indian Mackerel distribution patterns change significantly between seasons, with lower concentrations in the eastern season. Fishing intensity varies, with shortfin scad being fished at low intensity during the first transitional season (March-May). Similarly, Indian Mackerel had low fishing intensity in the eastern season and Fringescale Sardinella in the western season.

Discussion

The results of the analysis of fishing logbook data for 5 years (2018-2022) in FMA 712 show that the catch of small pelagic fish, especially Indian Mackerel, Short Mackerel, Fringescale Sardinella and Shortfin Scad shows a decreasing trendline which means there is a decrease in catches every year. Meanwhile, Yellowstripe Scad has an increasing trend line, meaning that catches are increasing each year. On the other hand, the fishing effort graph of five small pelagic species in the Java Sea from 2018 to 2022 shows an increasing trend line, which means that every additional unit of fishing effort will increase the catch. One of the factors affecting the catch is fishing effort, which includes vessel size and number of trips. The size of the vessel, or gross tonnage, because the larger the gross tonnage, the more fish that can be accommodated. The number of trips can also affect the catch, as the opportunity to catch fish is greater if the frequency of fishing activities is greater (Khatimah *et al*. 2021). Increasing fishing effort can increase catches, but if inappropriate gear is used, environmental conditions and biological aspects are ignored, it has the potential to reduce catches (Ariefandi dan Isdianto, 2023) and vulnerability and risk of stock (Yonvitner, et al, 2020).

Fish catches are also influenced by natural factors such as seasonality, sea surface temperature, chlorophyll-a distribution, salinity, etc. (Rizal *et al*. 2023). In addition, the growth of fishery resources is dynamic; fish stocks in nature will recover in accordance with the carrying capacity of nature and reproductive activities. However, it will be disrupted if there is overfishing (Asmawati dan Nasir, 2019). Another factor influencing the low catch and effort data is that the electronic logbook or e-logbook application is currently under development in the form of an Android application. As a result, the application is not functioning optimally and the possibility of unreported data is quite high. Human error in entering catch data by skippers during fishing operations and damage to equipment also contribute to the inaccuracy of catch reports.

The fishing grounds for all species tend to be the same from year to year. Shortfin scad fishing grounds are evenly distributed in FMA 712 and tend to cluster around the Java Sea border with Kalimantan. Short mackerel fishing grounds tend to be in the eastern to western Java Sea. Indian Mackerel fishing grounds tend to be near the waters of South Kalimantan and the western Java Sea. Yellowstripe scad fishing grounds tend to be evenly distributed throughout FMA 712. Fringescale Sardinella fishing grounds tend to be concentrated in the western Java Sea and Kalimantan waters. The western part of the Java Sea with many fishing grounds is Semarang to Cirebon, then the westernmost part of the Java Sea is DKI Jakarta to Serang. Fishermen in FMA 712 tend to reduce fishing activities in the western season because this season has high wind and wave conditions (Aritonang *et al*. 2021). According to Rizal *et al*. (2023), the peak fishing season is in March-April and October.

Aquatic environmental conditions can have significant impact on fish populations, including temperature, salinity, food availability, etc. The Java Sea is influenced by winds that cause an upwelling phenomenon, which increases chlorophyll-a and thus impacts the fertility of the Java Sea. The upwelling phenomenon occurs during the eastern season (June-August). Chlorophyll-a significantly affects the dynamics of fish catches in the Java Sea. Chlorophyll-a availability influences food availability because fish are at the upper and middle trophic levels, so fish heavily depend on the amount of biomass at lower trophic levels, including phytoplankton and zooplankton. These natural factors influence the movement of fishing grounds (Rizal *et al*. 2023).

CONCLUSION

The Catch of small pelagic fish for the period 2018-2022 in FMA 712, based on fishing logbook data, show a decreasing trend each year for Indian Mackerel, Short Mackerel, Fringescale Sardinella and Shortfin Scad. Only Yellowstripe Scad showed an increasing trend in catches. Meanwhile, fishing effort on small pelagic species showed an increasing trend each year. The distribution of small pelagic fishing grounds in the Java Sea in 2018-2022 tends to follow seasonal patterns. Most of fish show a shiftting from the eastern Java Sea to the western or vice versa, with concentrations in Kalimantan waters and the western Java Sea. Fringescale Sardinella and Yellowstripe Scad have stable distribution patterns across seasons and years. Shortfin Scad showed a more dynamic shifting pattern compared to other fish, with higher fishing intensity in certain seasons (e.g. eastern season).

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REFERENCES

Atmaja SB, Nugroho D. 2019. Recovery Pattern of Small Pelagics Fish Biomass in Java Sea. *Jurnal Penelitian Perikanan Indonesia* 25(3): 179–189. http://dx.doi.org/10.15578/jppi.25.3.2019.179-189.

Ardiyani WJ, Iskandar BH, Wisudo SH. 2019. Estimasi Jumlah Kapal Penangkap Ikan Optimal di WPP 712 Berdasarkan Potensi Sumber Daya Ikan. *ALBACORE Jurnal Penelitian Perikanan Laut*. 3(1): 95–104. 10.29244/core.3.1.95-104

Ariefandi MF, Isdianto A. 2023. Identification of Types and Production Volume of Catched Fish at Pondokdadap Beach Fishing Port (PPP), Malang Regency. *Journal Marine and Coastal Science*. 12(3): 88–96. 10.20473/jmcs.v12i3.42923

Aritonang SIS, Jabbar MA, Suharti R, Rahardjo P, Suyasa IN, Zulkifli D, Sabariyah N, Bramana A. 2021. Musim Penangkapan dan Kelimpahan Layang Benggol di Perairan Laut Jawa. *Jurnal Penelitian Perikanan Indonesia*. 27(4): 179– 186.

http://dx.doi.org/10.15578/jppi.27.4.2021.%25p

Asmawati A, Nasir M. 2019. Analisis Status Eksploitasi Sumberdaya Perikanan Provinsi Aceh. *Jurnal Humaniora*. 1(2): 109–118.

Badrudin. 2007. *Analisis Data Catch and Effort Untuk Pendugaan MSY*. Bahan Ajar disampaikan pada Diklat Analisis Data Perikanan di Jakarta.

Bradley D, Merrifield M, Miller KM, Lomonico S, Wilson JR, Gleason MG. 2019. Opportunities to improve fisheries management through innovative technology and advanced data systems. *Fish Fish*. 20(3): 564–583. 10.1111/faf.12361

Chang SK, Hoyle S, Liu HI. 2011. Catch rate standardization for yellowfin tuna (Thunnus albacares) in Taiwan's distant-water longline fishery in the Western and Central Pacific Ocean, with consideration of target change. *Fisheries Research*. 107(1–3): 210–220. 10.1016/j.fishres.2010.11.004

Hudaya Y, Ilham I, Sutriyono S, Natsir M. 2022. Monitoring the Performance of Set Longlines Fishing Vessels at Fisheries Management Area 718 Indonesia. *Journal of Marine Fisheries Technology and Management*. 12(2): 185–194. 10.29244/jmf.v12i2.37292

Kementerian Kelautan dan Perikanan. 2022. Keputusan Menteri Kelautan dan Perikanan Republik Indonesia Nomor 19 Tahun 2022 Tentang Estimasi Potensi Sumber Daya Ikan, Jumlah Tangkapan Ikan Yang diperbolehkan, dan Tingkat Pemanfaatan Sumber Daya Ikan di Wilayah Pengelolaan Perikanan Negara Republik. Jakarta, Indonesia hlm 7.

Khatami AM, Yonvitner and Setyobudiandi I. 2019. Vulnerability of Small Pelagic Fish Based on Fishing Gear in Northen Java Sea: Tingkat Kerentanan Sumberdaya Ikan Pelagis Kecil Berdasarkan Alat Tangkap Di Perairan Utara Jawa. *Journal of Tropical Fisheries Management*. 2(1): 19–29. https://doi.org/10.29244/jppt.v2i1.25318

Khatimah BH, Harmoko, Novita UD. 2021. Fish Production Analysis on 2015–2018 (Case Study: Pelabuhan Perikanan Nusantara (PPN) Pemangkat). *Nekton Jurnal Perikanan dan Ilmu Kelautan*. 1(1): 44–51.

Lezama-Ochoa A, Boyra G, Goñi N, Arrizabalaga H, Bertrand A. 2010. Investigating relationships between albacore tuna (Thunnus alalunga) CPUE and prey distribution in the Bay of Biscay. *Progress in Oceanography*. 86(1–2): 105– 114. 10.1016/j.pocean.2010.04.006

Michael PE, Wilcox C, Tuck GN, Hobday AJ, Strutton PG. 2017. Japanese and Taiwanese pelagic longline fleet dynamics and the impacts of climate change in the southern Indian Ocean. *Deep Sea Research Part II: Topical Studies in Oceanography*. 140: 242–250. 10.1016/j.dsr2.2016.12.003

Rizal DR, Adnina GSN, Agustina S, Natsir M. 2023. *Status Perikanan di WPPNRI 712*. Bogor: Fisheries Resources Center of Indonesia. Rekam Nusantara Foundation.

Suman A, Satria F, Amri K, Priatna A, Mahiswara, Suwarsono, Zamroni A, Taufik M, Panggabean AS, Nurdin E. 2019. Potensi Perikanan 2016 Pengelolaan Perikanan Negara Republik Indonesia (WPPNRI) Tahun 2015.

Suwarso, Taufik M, Zamroni A. 2021. Dinamika Perikanan Cantrang Berbasis di Tegalsari, Tegal: Perubahan Upaya Penangkapan dan Komposisi Hasil Tangkapan Ikan. *Jurnal Penelitian Perikanan Indonesia*. 26: 211–220. http://dx.doi.org/10.15578/jppi.26.4.2020.211-220.

Suwarso, Wudianto, Atmaja SB. 2017. Perubahan Upaya Dan Hasil Tangkapan Ikan Pelagis Kecil Di Sekitar Laut Jawa: Kajian Paska Kolaps Perikanan Pukat Cincin Besar. *Bawal Widya Riset Perikanan Tangkap*. 2(1): 17. doi:10.15578/bawal.2.1.2008.17-26

Yonvitner Y, Lloret J, Boer M, Kurnia R., Akmal SG, Yuliana E, Yani DE, Gomez S, Setijorini LE. 2020. Vulnerability of marine resources to small-scale fishing in a tropical area: The example of Sunda Strait in Indonesia. *Fisheries Management and Ecology*. *27*(5): 472-480. https://doi.org/10.1111/fme.12428