Jurnal Teknologi Perikanan dan Kelautan
Vol. 17 No. 1, February 2026: 1-13
ISSN: 2087-4871
EISSN: 2549-3841
DOI: https://doi.org/10.24319/jtpk.17.1-13

OPEN ACCESS Check for updates

SPATIAL-TEMPORAL ANALYSIS OF FISHING BOAT MOVEMENTS BASED ON AIS IN THE INDONESIAN FISHERIES MANAGEMENT AREA (WPPNRI) 573

ANALISIS SPASIAL TEMPORAL PERGERAKAN KAPAL PERIKANAN BERBASIS AIS DI WPPNRI 573

Fathurrahman Arizqi[1], Denianto Yoga Sativa[1*], Lalu Samsul Rizal[1], Hamid[2]
[1]Study Program of Fisheries Resource Utilization, Faculty of Fisheries, University of 45 Mataram,
Jalan Imam Bonjol No. 45, North Cakranegara, Mataram 83239, Indonesia
[2]Study Program of Aquaculture, Faculty of Fisheries, University of 45 Mataram,
Jalan Imam Bonjol No. 45, North Cakranegara, Mataram 83239, Indonesia
*Corresponding author: denianto.u45mataram@gmail.com

(Received November 6, 2024; Revised August 3, 2025; Accepted September 25, 2025)

ABSTRACT

The movement patterns of fishing boats in the Indonesian Fisheries Management Area (WPPNRI) 573, particularly in the Indian Ocean, the Lombok Strait, and the Bali Strait, have not been recorded spatially and temporally. This study aims to monitor, analyze, and compare the spatial-temporal patterns of fishing boat movements, as observed over 6 months, based on AIS (Automatic Identification System) data in the GFW (Global Fishing Watch) geoportal. Remote sensing methods apply spatial-temporal analysis to the movement vectors of fishing boats and graph the fluctuations in the number of fishing ground points. AIS monitors boat movements based on broadcasting system transponders operated via Very High Frequency (VHF) radio waves, namely between 156 and 162 MHz. The results of monitoring AIS GFW data from January to June show a pattern of boat movements from the Bali Strait to the Indian Ocean. The density level of the boats in fishing operations is evenly distributed but concentrated in three fishing locations containing values (suitability of environmental parameters) of chlorophyll-a (mg/m^3), sea surface temperature-SST (°C), and salinity (psu), respectively, at 10°22'14.40" S/115°18'48.62" E (0.21, 29.5, 33.95); 12°58'40.58" S/119°10'47.99" E (0.12, 29.86, 34.71), and 12°45'56.08" S/117°46'20.03" E (0.11, 29.87, 34.66). The GFW Geoportal can detect, identify, compare, and analyze boat movements (including data filtration, boat grouping, downloading movement data, and fishing points) as well as environmental parameters. The movement patterns of fishing boats in this study were influenced by increased chlorophyll a and low SST, which resulted in increased fishing activity between April and June.

Keywords: AIS, Global Fishing Watch, spatial-temporal, WPP 573

ABSTRAK

Pola pergerakan kapal perikanan di WPPNRI 573, terutama di Samudera Hindia, Selat Lombok, dan Selat Bali, belum terdata secara spasial-temporal. Penelitian ini bertujuan memantau dan menganalisis, serta membandingkan pola spasial temporal pergerakan kapal perikanan yang terpantau 6 bulan berbasis AIS (*Automatic Identification System*) dalam geoportal GFW (*Global Fishing Watch*). Metode penginderaan jauh menerapkan analisis spasial temporal vektor pergerakan kapal perikanan dan pembuatan grafik fluktuasi jumlah titik *fishing ground*. AIS memantau pergerakan kapal berdasarkan transponder sistem penyiaran yang dioperasikan melalui gelombang radio *Very High Frequency* (VHF), yaitu antara 156–162 MHz. Hasil pemantaun data AIS GFW dari bulan Januari hingga Juni menunjukkan pola pergerakan kapal dari Selat Bali menuju Samudra Hindia. Tingkat kepadatan kapal dalam operasi penangkapan tersebar merata namun terkonsentrasi pada tiga lokasi penangkapan yang terkandung nilai (kesesuaian parameter lingkungan) klorofil-a (mg/m^3), suhu permukaan laut-SPL (°C), salinitas (psu) masing-masing pada 10°22'14.40"LS/115°18'48.62"BT (0,21, 29,5, 33,95), 12°58'40.58"LS/119°10'47.99"BT (0,12, 29,86, 34,71), dan 12°45'56.08"LS/117°46'20.03"BT (0,11, 29,87, 34,66). Geoportal GFW mampu mendeteksi, mengidentifikasi, membandingkan, dan menganalisis pergerakan kapal (filtrasi data, pengelompokan kapal, pengunduhan data pergerakan dan titik penangkapan), dan parameter lingkungan. Pola pergerakan kapal perikanan dalam penelitian ini dipengaruhi oleh peningkatan klorofil-a dan rendahnya SPL yang mengakibatkan peningkatan aktivitas penangkapan antara bulan April–Juni.

Kata kunci: AIS, *Global Fishing Watch*, spasial-temporal, WPP 573

Copyright © 2026 by Authors, published by Jurnal Teknologi Perikanan dan Kelautan
This is an open-access article distributed under the CC BY-NC 4.0 License
https://creativecommons.org/licenses/by-nc/4.0/

INTRODUCTION

The Republic of Indonesia Fisheries Management Area (WPPNRI) 573 geographically encompasses southern Java, the Sawu Sea, southern Nusa Tenggara, the western Timor Sea, and the Indian Ocean. Its location between Indonesia and Australia makes the WPPNRI 573 unique geographically, such as the difference in seasonal variability between the Australian and Asian continents, the influence of three sea levels, and the occurrence of the east monsoon. This data indicates that WPPNRI 573 possesses abundant fish resources (Triyono *et al.* 2019). The abundance of fish resources leads to numerous fishing activities and the utilization of natural resources. The rapid advancement of fishing technology is currently very significant due to the widespread use of AIS (Automatic Identification System) in real-time monitoring of fish catches.

Capture fisheries in the Indian Ocean (WPPNRI 573) manage the fisheries area, including skipjack tuna, mackerel, and tuna. Fisheries by resources potential estimation is dominated large pelagic fish species like skipjack tuna, mackerel, and tuna. From 2005 to 2014, catches ranged from 127,815 to 218,359 tons per year, with an average of 182,034 tons per year (Decree of the Minister of Maritime Affairs and Fisheries Number 77/KEPMEN-KP/2016).

AIS devices were initially developed to complement Vessel Traffic Services (VTS) devices operating on Digital Selective Call (DSC) on VHF CH70. The increasing global use of AIS demonstrates its increasingly important role in monitoring fishing boat activity. In 2017, AIS detections from fishing boats reached 60,000. The increase in AIS users from 2014 to 2017 indicates that the total number of fishing boats increased by 10 to 30 percent per year (Simau *et al.* 2022).

AIS is universally used to detect large fishing boats (over 24 m or 300 GT), primarily from high- and middle-income countries, long-distance fleets, and boats operating on the high seas. AIS detection is less effective on smaller boats, as only a small proportion of boats under 24 m globally use AIS (Taconet *et al.* 2019). In line with advances in multi-spectral satellite remote sensing technology that acquires real-time in situ data on the Global Fishing Watch geoportal, the spatial-temporal analysis of fishing boat movement patterns in WPP 573 can be studied. AIS technology can be used by the public for free to monitor the movement of fishing vessels, which has only been carried out by the government through the Ministry of Maritime Affairs and Fisheries. The government responded to AIS technology in Regulation of the Minister of Transportation Number 7 of 2019, requiring fishing boats to install AIS devices. This is for further real-time identification and monitoring of fishermen conducting fishing operations. This study aims to monitor fishing boat movements, analyze fishing boat movements, and compare the spatial-temporal patterns of fishing boat movements monitored for 6 months based on AIS (Automatic Identification System) in the Global Fishing Watch (GFW) geoportal.

METHODS

Time and location

This research was conducted in January–June 2024, focusing on the southern waters of Bali-Nusa Tenggara, which are included in the waters of WPPNRI 573. The research location was limited to the geographical coordinate range of 8°–14°S and 114°–120°E with an area of 28,751.97 ha (Figure 1).

Research tools and materials

The use of tools and materials is presented in Tables 1 and 2. Information in Table 1 is the basic capital for using tools, both software and hardware, while Table 2 explains the research materials in the form of the GFW geoportal.

Data collection technique

Observation

This research observation involved spatial-temporal observations of AIS data and aquatic environmental data, involving full online access to the GFW geoportal. GFW access, from interpretation and monitoring to downloading spatial-temporal data, requires registering an email account as a GFW account.

Documentation

The objects documented in this research activity were in the form of snapshots of the GFW stages, starting from the data collection stage on the Global Fishing Watch geoportal to the data processing stage. The documentation collected in this study consisted of data on fishing points, data on movement lines, fishing vessel data, statistical data on fishing boat movements, and data on aquatic environmental parameters.

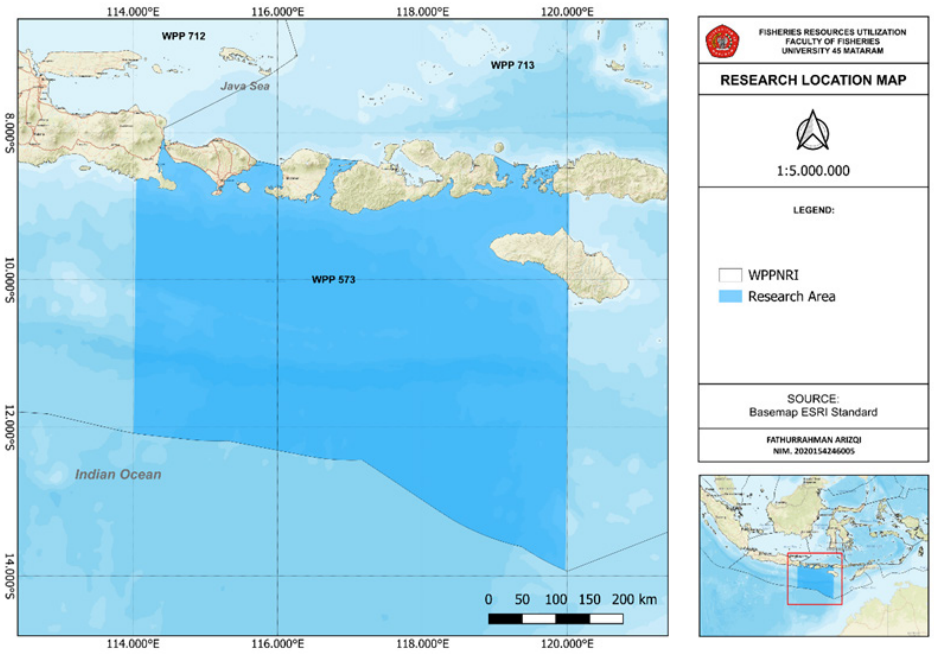


Figure 1. Location of monitoring of boat movement patterns in part of WPPNRI 573.

Table 1. Software and hardware used for spatial-temporal analysis of fishing boat movements.

No	Equipment	Utility
1	QGIS 3.34	Analysis, visualization, and mapping of fishing boat movement patterns using AIS data.
2	ArcGIS 10.8	Map layout for data visualization.
3	Laptop	Operation of QGIS and ArcGIS software to analyze and manipulate geospatial data. Specific specification CPU minimum: 2 cores, simultaneous multithreading; Recommended: 4 cores. Platform x64. Storage minimum: 32 GB of free space. Recommended: 32 GB or more of free space on a solid-state drive (SSD). Memory/ RAM minimum: 8 GB, Recommended: 32 GB.

Table 2. Research materials of the GFW (Global Fishing Watch) geoportal.

No	Materials	Utility
1	Geoportal Global Fishing Watch https://globalfishingwatch.org/map	Visualization and identification of boat movement data, as well as an AIS information provider, and water analysis. GFW geoportal data consists of statistical data (Excel), vector data (shapefile), and raster data (PNG/GeoTiff)

Data analysis methods

The method used in this study was spatial-temporal analysis using remotely sensed data of fishing boat movement vectors and fishing grounds in graphical form. A graph of fluctuations in the number of fishing ground points was created by detecting and identifying the number of boat points within a specific time period.

RESULTS AND DISCUSSION

Fisheries management area 573

The geographical location of WPPNRI 573 is between 8°–11°S and 108°–113°E, directly bordering the Indian Ocean. Based on maritime boundaries, this strategic location contributes to the abundance of diverse marine biological resources in the waters of WPPNRI 573.

Global Fishing Watch (GFW)

The GFW geoportal, comprised of Google Earth Outreach, SkyTruth, and Oceana, visualizes global boat movement activity based on AIS combined with the Vessel Monitoring System (VMS) (Wardhani *et al.* 2022). GFW recently revolutionized global data availability by analyzing the positions of boats tracked since 2012 using AIS. AIS is a safety device used to prevent collisions between boats at sea. It broadcasts information about a boat's position and direction every 2 seconds to 3 minutes. This information would be received by surrounding boats, by receivers within line of sight, and by low-orbiting satellites. While regulations for fishing boats vary by country, AIS is mandatory on almost all fishing boats larger than 300 GT. AIS is becoming mandatory or widely adopted for many smaller boats as small as 60 GT (sixty gross tons), and in the real world, AIS data has detected fishing boats up to 30 GT. GFW collects this data to map the distribution of AIS-tracked fishing boats at high temporal resolution, providing a transparent picture of global fishing activity. AIS messages provide a set of positions for each boat, which are then processed by two convolutional neural networks to characterize boats and detect periods of fishing activity (Guiet *et al.* 2019).

Principle of AIS (*Automatic Identification System*)

The 2002 International Maritime Organization (IMO) agreement and the International Convention for the Safety of Life at Sea (SOLAS) mandate that all international shipping boats above 300 GT activate AIS devices (Directorate General of Sea Transportation 2019). This emphasis is based on increasing safety at sea and avoiding collisions between boats. AIS information from boats not only broadcasts messages via radio but also provides the boat's IMO number, direction, speed, position (latitude and longitude), and identity. This broadcast information is received by the AIS devices of nearby boats and can serve as a warning to the navigating captain of the presence of other boats nearby. Typically, AIS on boats is capable of exchanging navigational information and boat data between the boat itself and other boats or with coast stations, as well as A to N (Aid to Navigation), as described in Thombre *et al.* (2020).

AIS data information was periodically transmitted and received by other boats within the range of a VTS (Vessel Traffic Services) base station. AIS data can be processed and displayed in the form of charts and maps on a computer or electronic navigation equipment. AIS data was received and transmitted by AIS satellites (Sat-AIS or S-AIS). AIS displays maritime navigation systems and inter-boat communication networks directly via VHF radio by issuing boat call signs and the names of the boats present at the time of dispatch (Ray *et al.* 2019). AIS, as shown in Figure 2, is an automatic tracking system that displays fixed boat data and dynamic data (boat movements) from the boat itself or other boats in the vicinity. This device has a broadcasting system transponder that operates via VHF radio waves (Simau *et al.* 2022).

Distribution of boat movement activities

As a universal data provider, the GFW geoportal provides AIS data for registered fishing boats operating internationally. Boat movements were detected by several Indonesian fishing boats operating within the study area, indicating the density of fishing operations between January and June 2024 (Figure 3).

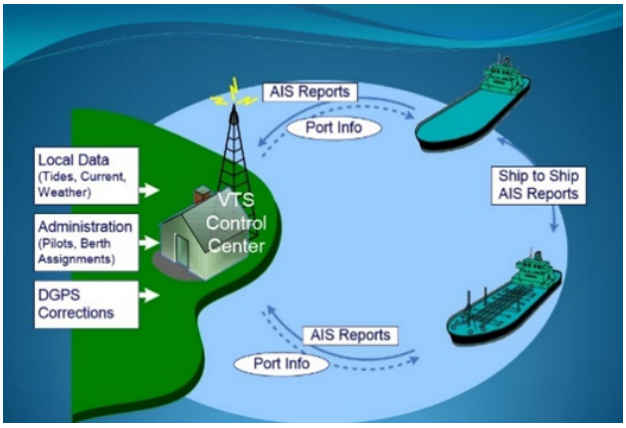


Figure 2. Illustration of Automatic Identification System (AIS) transmission (Sugianto 2022).



Figure 3. Distribution of fishing operation density levels from January to June 2024.

Identification of boat movements in WPP 573 is mostly centered in the Indian Ocean (24 boats), with details of boat names, flags (Indonesian-ID), gross tonnage (GT), and fishing gear available in Table 3. Execution of boat data sorting by eliminating fishing boat, and data operating within 6 months that do not meet the following requirements: (1) Lack of supporting data from the fishing boat, such as information on fishing gear used, gross tonnage, boat movement vector data, and number of boat fishing points; (2) Foreign boats conducting fishing activities in the research area; (3) Boats that do not operate entirely within the research area. Some boats were eliminated due to boat movements that were predominantly active outside the research location. A total of 6 boats detected are summarized in Table 4.

Fish resources in WPPNRI 573 are grouped into 9 main commodities, including small pelagic fish, large pelagic fish, demersal fish, reef fish, penaeid shrimp, lobster, crab, swimming crab, and squid. Fish resource production in WPPNRI 573 in 2019 was 592,006 tons, or approximately 44% of the potential fish resources in 2022, or approximately 8% of the total national fish resource production in 2019 (7,292,158 tons) (Azizah *et al.* 2023). The large potential of pelagic fish resources in WPP 573 makes purse seine fishing gear more dominantly used, due to its characteristics of confining schools of fish. Purse seine is a type of active fishing gear that is multi-species, as it catches more than one type of fish. Purse seine is very effective for catching small pelagic fish that gather in high densities (Kefi *et al.* 2013).

Spatial distribution of boat movement activities

The appearance of the activity of the boat population group was detected as a density of boats carrying out boat movements that were evenly distributed and concentrated at 10°–11°S and 115°–116°E, and at 12°–14°S and 115°–120°E. This is related to the suitability of aquatic environmental parameters. The acquisition of detection of the distribution of boat movement patterns varied but tended to be irregular in fishing operations (Tawaqal *et al.* 2020). Detection of fishing operation movement patterns was divided into three periods over 6 months as follows.

January–February period

Fishing activity in the study area was evenly distributed during the January–February period (Figure 4), with 24 fishing boats observed fishing within the study area. Five of these boats did not engage in fishing activity during January–February 2024 (Table 5).

March–April period

All boats (24 boats) conducted fishing activities during the March–April period, as indicated by an increase in the density of boat movement patterns. The following was a spatial and temporal distribution of fishing activities during March–April (Figure 5).

May–June period

Only one boat was found during the May–June period, the KM Bintang Bahagia 6, which did not conduct any fishing operations in the research area. This is likely because the boat did not activate its AIS device. Spatial and temporal patterns of boat movement were detected during May–June (Figure 6).

Table 3. List of boats recorded as carrying out fishing operations in WPP 573 during January–June 2024.

No	Boat Name	Flag	GT	Fishing Gear
1	Anugrah Indah-A	IDN	144	Purse seine
2	Anugrah Abadi-18	IDN	73	Purse seine
3	Surya Samudra Sakti	IDN	187	Purse seine
4	Modern-A	IDN	189	Purse seine
5	Mina Baruna-I	IDN	92	Purse seine
6	Karya Rejeki	IDN	194	Purse seine
7	Halindo Utama	IDN	119	Purse seine
8	Bintang Bahagia-6	IDN	102	Purse seine
9	Azzam-82	IDN	148	Purse seine
10	Rejeki Terang-A	IDN	46	Drift longline
11	Nelayan Indah	IDN	97	Purse seine
12	Bintang Terang	IDN	98	Purse seine
13	Victory Utama	IDN	99	Purse seine
14	Mv. Tenggara Ranger	IDN	30	Drift longline
15	Victory Sentosa	IDN	150	Purse seine
16	Victory Jaya	IDN	170	Purse seine
17	Naga Mas Perkasa-VII	IDN	32.5	Drift longline
18	Naga Mas Perkasa-19	IDN	59	Drift longline
19	Bahari Nusantara-63	IDN	30	Drift longline
20	Bintang Mas Diamond	IDN	36	Drift longline
21	Primus Jaya	IDN	105	Drift longline
22	Bahari Nusantara-35	IDN	36	Drift longline
23	Victory Makmur	IDN	148	Purse seine
24	Haldy I	IDN	30	Drift longline

Note: IDN = Indonesia

Table 4. List of minor boats carrying out fishing operations within the research area.

No	Boat Name	Flag	GT	Fishing Gear
1	Kasih Setia-A	IDN	128.5	Purse seine
2	Harapan Surya Makmur	IDN	148	Purse seine
3	Damasha-6	IDN	188	Purse seine
4	Setia Bhakti-A	IDN	161.7	Purse seine
5	Surya Terang-02	IDN	89	Drift longline
6	Millenium Jaya-88	IDN	-	Purse seine

Note: IDN = Indonesia

Azizah *et al*. (2023) stated that the distribution of tuna longline fishing efforts in WPPNRI 573 is most predominantly located at coordinates 7°–10°S and 106°–110°E, as well as coordinates 11°–13°S and 115°–118°E, or in the southern part of West Java and Central Java waters, as well as the southern part of the Bali and West Nusa Tenggara waters; large pelagic purse seine with one boat in WPPNRI 573 is most dominant at coordinates 10°–14°S and 116°–125°E, or in the southern part of West Nusa Tenggara and the southern part of East Nusa Tenggara waters. Boat movement activities in Figure 7 are concentrated in 3 (three) dominant fishing locations. Each point contains the value of aquatic environmental parameters recorded in the point vector attribute data (results of the fishing center analysis). The Detection of

environmental parameters for the three vector points in Table 6 consists of chlorophyll-a (mg/m^3), sea surface temperature (°C), and salinity (psu).

The appearance of the movement patterns of boats conducting fishing activities outside the research area is shown in Table 4. The results of the boat elimination are reflected in the map of minority boat movements from January to June 2024 (Figure 8). Minor locations appear to track boats heading towards the Indian Ocean and away from WPP 573 while conducting fishing operations.

Temporal distribution of boat movement activity

Time will affect the number of fishing activity points. Therefore, it is necessary to observe the number of points using a graph to determine fluctuations in the number of fishing points within the study area (Figure 9).

Figure 9 shows that fishing activity in the study area increased in March–April and decreased in May. This is influenced by the year-round wind season, commonly known as the monsoon. Monsoons blow periodically and are categorized as a seasonal wind pattern (Haryanto *et al.* 2020). The rainy season, accompanied by strong winds, occurs in December–February, marking the peak of the west monsoon. The peak of the east monsoon (dry season) occurs in June–August, with relatively low rainfall.

Figure 10 shows the frequency of fishing activity (hours) by boats between July 2023 and June 2024, where the number of fishing activities in the six months before January 2024 was higher than in the six months afterward, due to the monsoon wind factor. Figure 11 compares the frequency of fishing activities in July 2023 and June 2024.

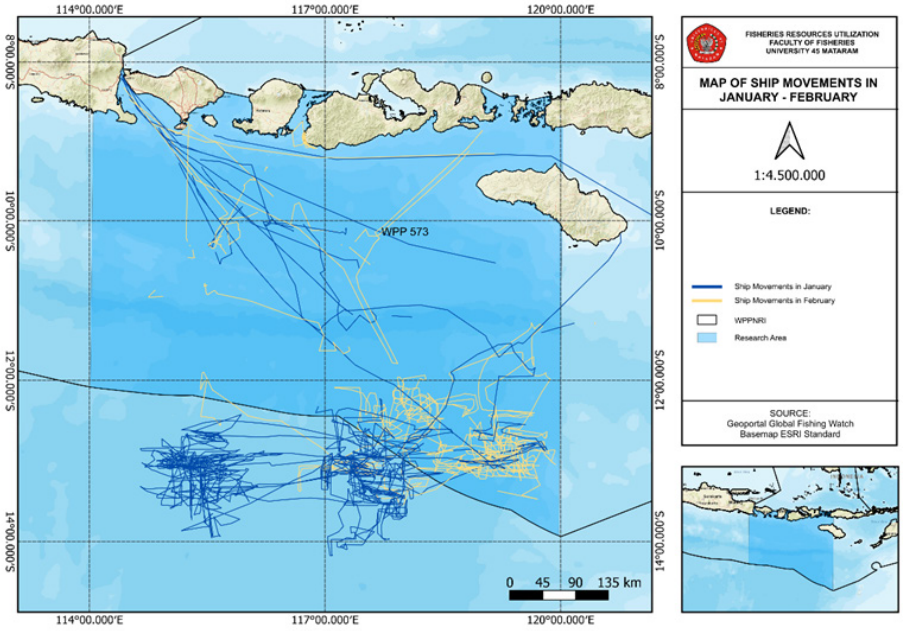


Figure 4. Map of boat movement patterns in the study area during January–February 2024.

Table 5. List of boats that did not carry out fishing activities during January-February 2024 in the study area.

No	Boat Name	Flag	GT	Fishing Gear
1	Anugrah Abadi-18	IDN	73	Purse seine
2	Karya Rejeki	IDN	194	Purse seine
3	Azzam 82	IDN	148	Purse seine
4	Rejeki Terang-A	IDN	46	Drift longline
5	Primus Jaya	IDN	105	Drift longline

Note: IDN = Indonesia

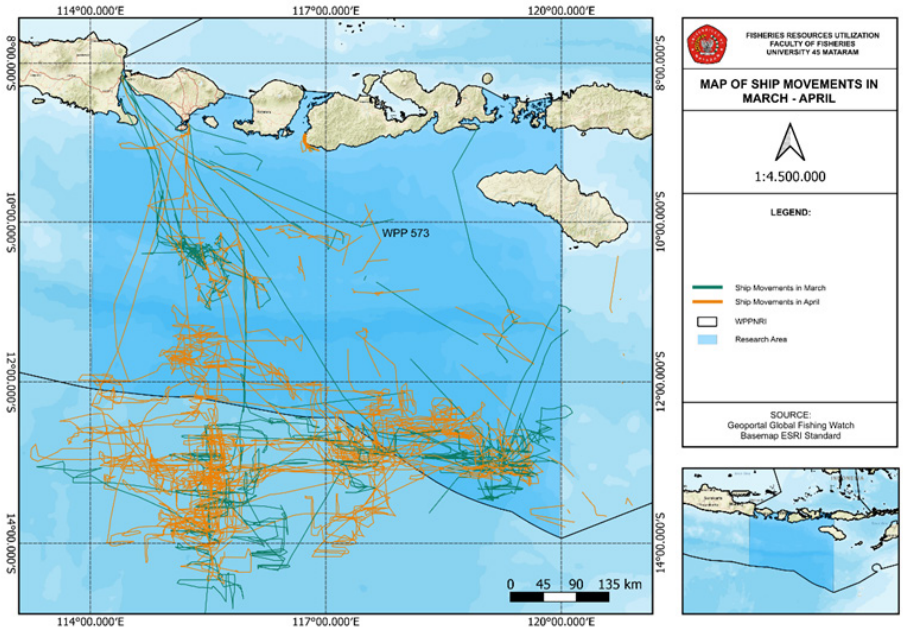


Figure 5. Map of boat movement patterns in the study area during March–April 2024.

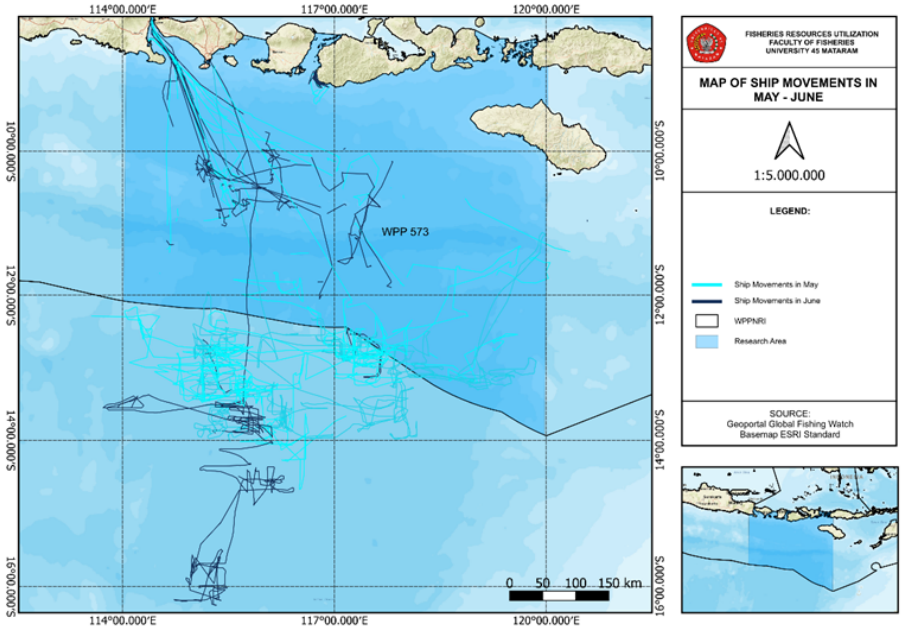


Figure 6. Map of boat movement patterns in the study area during May–June 2024.

Table 6. Spatial location of dominant centralized fishing accompanied by chlorophyll a, sea surface temperature, and salinity parameters.

No	Coordinate	Value		
		Chlorophyll-a (mg/m^3)	Temperature (°C)	Salinity (psu)
1	10° 22'14.40" LS 115° 18'48.62" BT	0.21	29.50	33.95
2	12° 58'40.58" LS 119° 10'47.99" BT	0.12	29.86	34.71
3	12° 45'56.08" LS 117° 46'20.03" BT	0.11	29.87	34.66

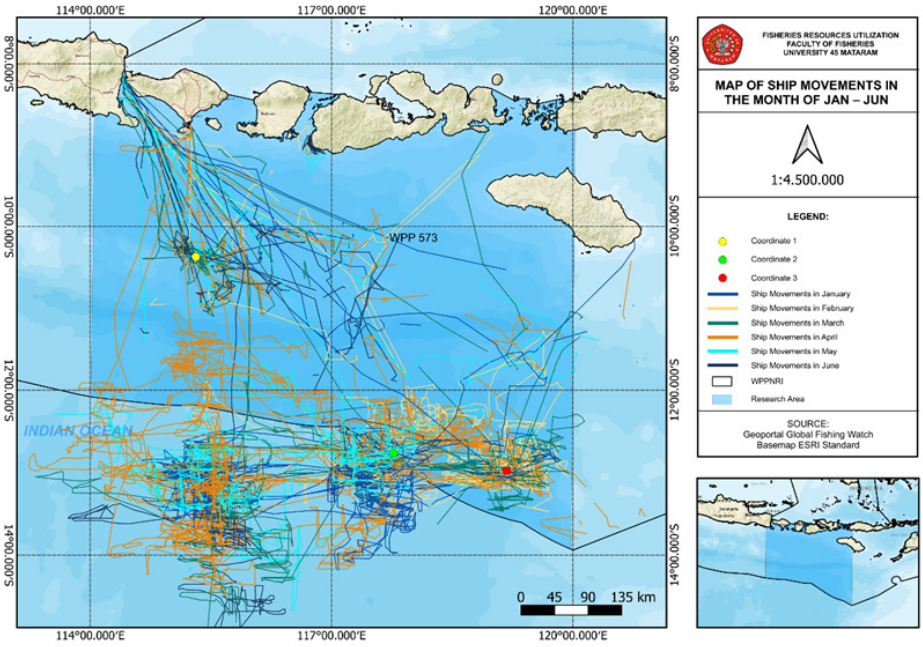


Figure 7. Boat movement pattern with fishing ground points in the study area.

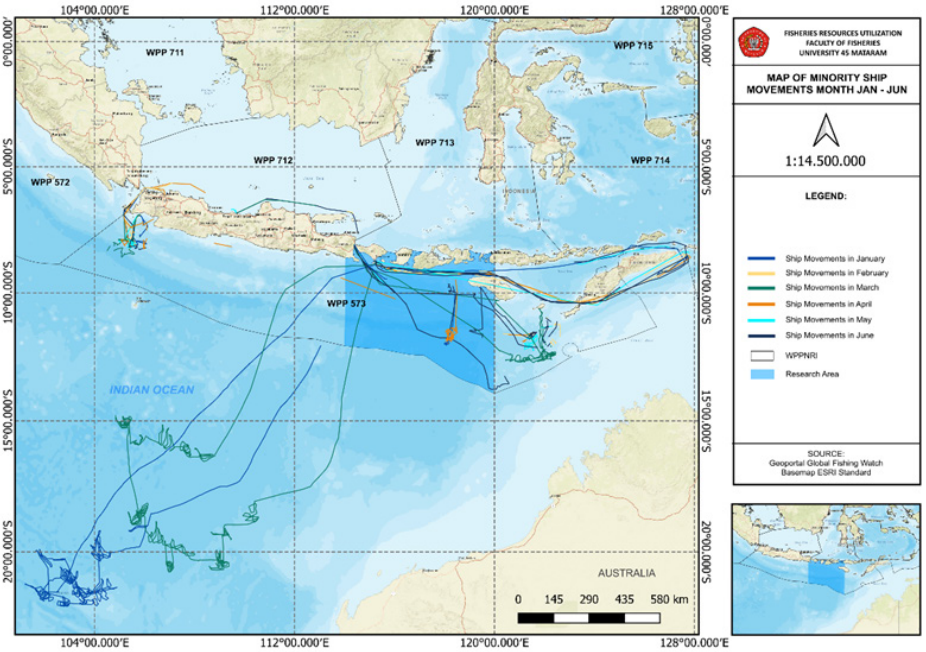


Figure 8. Minority boat movement patterns in the study area during January–June 2024.

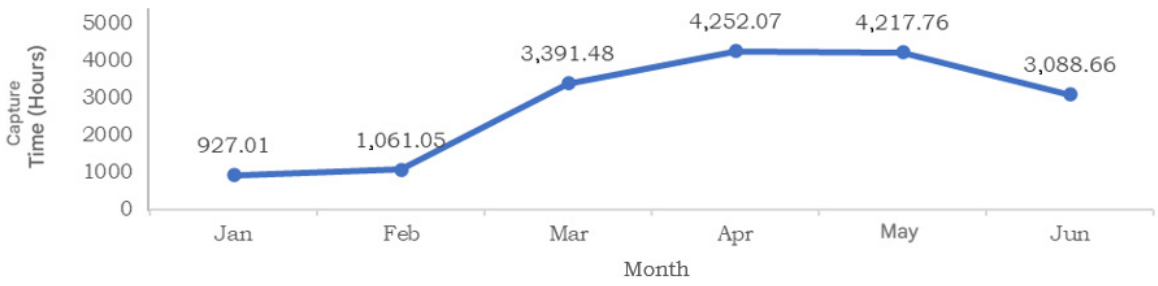


Figure 9. Fluctuations in fishing time for fishing operations conducted in January–June 2024.

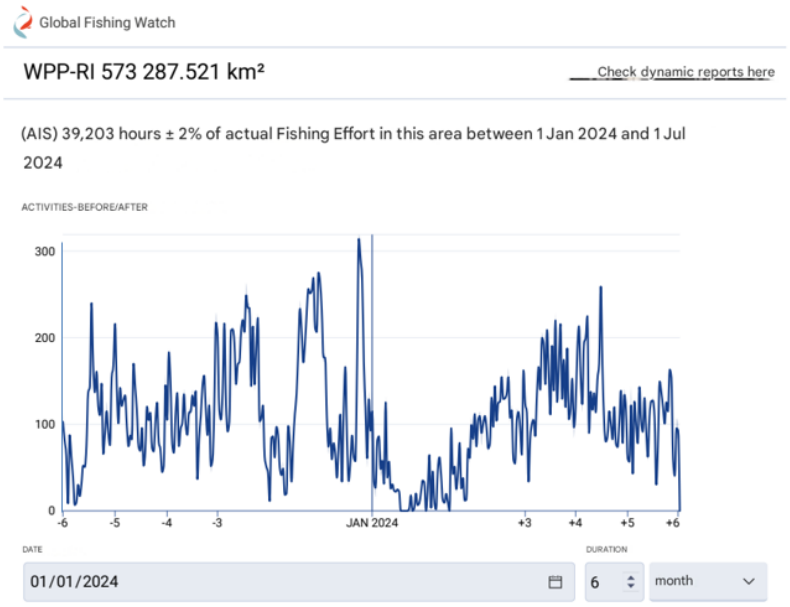


Figure 10. Frequency of fishing activity (hours) by boats from July 2023 to June 2024.

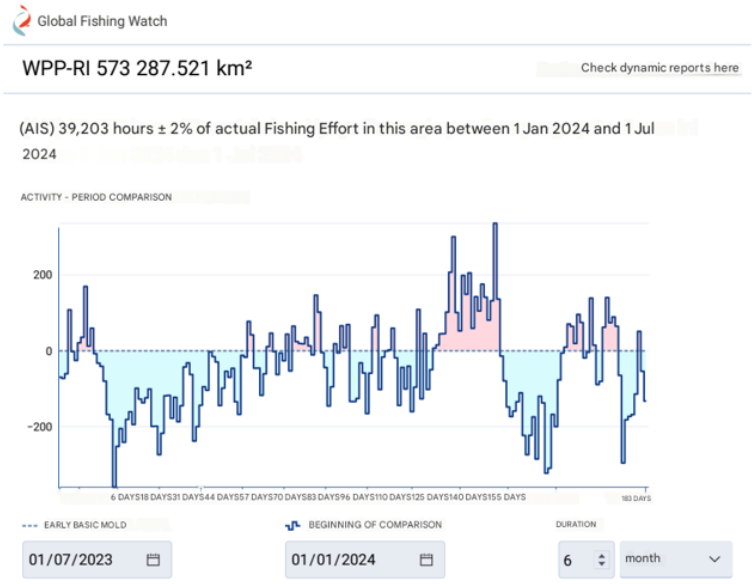


Figure 11. Comparison of fishing activity frequency (hours) in July 2023 and June 2024.

Oceanographic characteristics of the waters of WPP 573 south of Bali–Nusa Tenggara

Oceanographic parameters or environmental parameter, of waters in the GFW can be measured temporally, including sea surface temperature, chlorophyll a, depth, and salinity. The oceanographic parameter measurement step was carried out using one of the tools available in the GFW map, which focused on the research area of WPPNRI 573, south of Bali-Nusa Tenggara. The next step was to take several points in areas with relatively high levels of fishing activity to measure the oceanographic characteristics in those areas. Ma'mun *et al.* (2018) stated that large pelagic fish groups prefer high salinity levels (33.9–34.2 psu), warm temperatures (28–30 °C), chlorophyll a (1–2.5 mg/m^3), and dissolved oxygen (5.6–6.2 mg/m^3). These characteristics are the reason for the high fishing activity that occurs in this area.

Chlorophyll-a (*CHL*)

The analysis results from January to June 2024 revealed a 6-month distribution pattern of chlorophyll-a concentrations in the study area, indicating a relative concentration

ranging from 0.12 to 0.17 mg/m^3. Chlorophyll -a concentrations increased temporally from April to May, peaking in June (Figure 12).

Chlorophyll-a, found in phytoplankton (an active pigment), functions as an indicator of water fertility. This active pigment plays a crucial role in photosynthesis in aquatic environments. High concentrations of chlorophyll a provide information on the presence of phytoplankton, which are then followed by zooplankton and pelagic fish, forming the food chain (Kasim *et al.* 2014).

The presence of high levels of chlorophyll a in a water area does not guarantee that all points within that area contain fish. Fish need time to adapt and migrate to specific locations that are rich in chlorophyll a. Therefore, even if a catchment area shows high levels of chlorophyll a, this does not necessarily mean that many fish are present at that location, as the fish may still be migrating to that location (Ashari *et al.* 2014).

Sea surface temperature (*SST*)

SST concentrations during January-June 2024 (Figure 13) show that the highest SST concentrations occurred in March (30.13 °C) and the lowest in June (28.26 °C), with an average SST of 29.61 °C. The decrease in SST in June was influenced by the upwelling phenomenon. Fluctuations in SST are caused by climate change conditions, current strength, air temperature, and seabed relief conditions. Daily SST changes usually do not exceed 0.2–0.4 °C, while SST changes near the coast can reach several degrees Celsius (Sahidi *et al.* 2015).

Salinity

Salinity is an oceanographic characteristic that plays a crucial role in the survival of marine organisms. Extreme changes in salinity levels can disrupt diffusion and osmosis processes, which in turn can lead to fish mortality. Salinity penetration results detected in the GFW during the January-June period show a decreasing trend in salinity values from February to May and an increase in salinity from January to February and from May to June (Figure 14). The highest recorded salinity value was 34.46 psu (in February), and the lowest value was 34.01 psu (in May). According to Tangke *et al.* (2017), salinity variations in offshore areas tend to be lower than in coastal areas. The phenomenon of coastal water salinity, where frequent dilution occurs, results in low salinity concentrations. Conversely, a drastic increase in salinity values occurs in areas with very strong evaporation (Barwana *et al.* 2015).

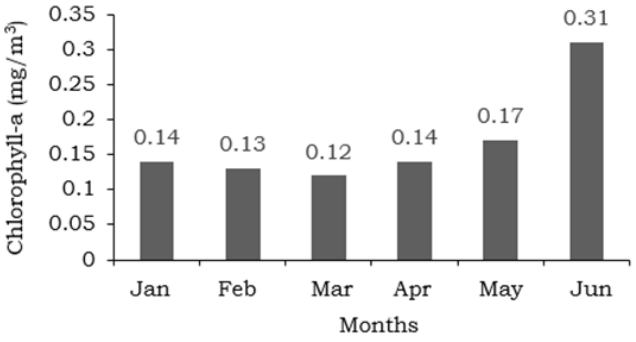


Figure 12. Temporal variation of chlorophyll-a concentration in the study area from January to June 2024.

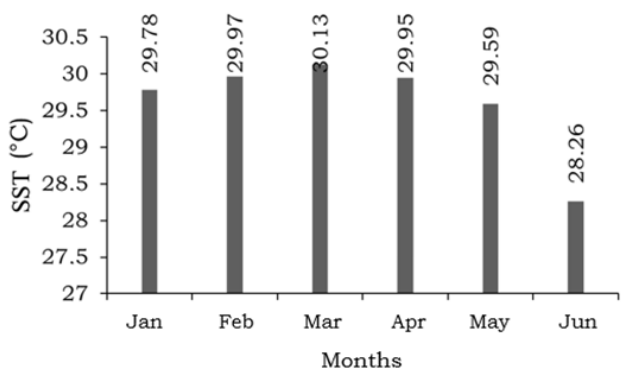


Figure 13. Temporal variation of sea surface temperature (SST) in the study area from January to June 2024.

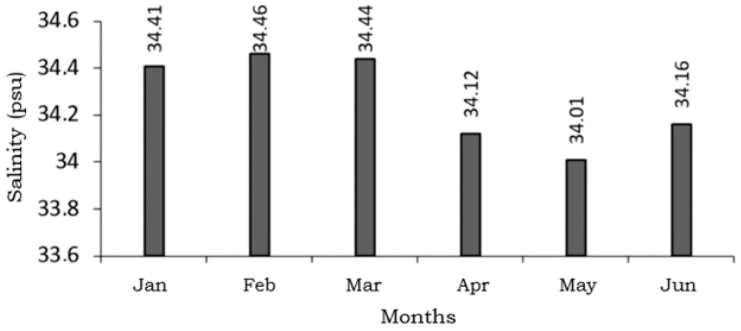


Figure 14. Temporal variation of salinity in the study area from January to June 2024.

Depth

Water depth is the vertical distance from the surface to the bottom, measured in meters (m). As depth increases, marine organisms experience changes. The average depth in this study area was 3,378.59 m, with minimum and maximum values detected at 1 m and 7,097.24 m, respectively. Deeper waters result in changes in temperature, salinity, and organism distribution. Variations in water depth will affect the potential catch, resulting in more diverse results (Elasari *et al.* 2021).

CONCLUSION

The GFW Geoportal can detect, identify, compare, and analyze boat movements (data filtration, boat grouping, downloading movement data, and fishing points) and aquatic environmental parameters, as indicated by: (1) GFW AIS data monitoring from January to June shows boat movement patterns from the Bali Strait to the Indian Ocean; (2) Analysis of boat movements shows that the density of boats in fishing operations is evenly distributed; (3) Comparison of spatial-temporal patterns of boat movements concentrated in three fishing locations containing values (suitability of aquatic environmental parameters) of chlorophyll-a (mg/m^3), sea surface temperature-SST (°C), and salinity (psu) at 10°22'14.40" S/115°18'48.62" E (0.21, 29.5, 33.95), 12°58'40.58" S/119°10'47.99" E (0.12, 29.86, 34.71), and 12°45'56.08" S/117°46'20.03" E (0.11, 29.87, 34.66).

REFERENCES

Ashari F, Redjeki S, Kunarso. 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.

Azizah Y, Marlina I, Agustina S, Natsir M. 2023. *Kondisi Stok Perikanan di WPPNRI 573*. Bogor (ID): Fisheries Resources Center of Indonesia, Rekam Nusantara Foundation.

Barwana IGPZ, Sari DTEY, Usman MS. 2015. Effect of Environmental Parameters to Purse Seine Catches in Bali Strait. *Jurnal Online Mahasiswa Fakultas Perikanan dan Ilmu Kelautan Universitas Riau*. 2(1): 1–13.

Decree of the Minister of Maritime Affairs and Fisheries Number 77/KEPMEN-KP/2016 of 2016 concerning the Fisheries Management Plan for the Fisheries Management Area of the Republic of Indonesia 573. Jakarta.

Directorate General of Sea Transportation. 2019. AIS Must Be Installed on Vessels Sailing in Indonesian Waters. https://hubla.dephub.go.id/home/post/read/5864/ais-wajib-dipasang-di-kapal-yang-berlayar-di-perairan-indonesia-06-03-2. [15 Juli 2024].

Elasari N, Perdanawati RA, Mauludiyah M. 2021. Analisis Korelasi Parameter Oseanografi terhadap Hasil Tangkapan Jaring *Purse Seine* di Perairan Kranji, Kecamatan Paciran Kabupaten Lamongan. *Jurnal Perikanan dan Kelautan*. 27(3): 371–381. DOI: https://doi.org/10.31258/jpk.27.3.371-381.

Guiet J, Galbraith E, Kroodsma D, Worm B. 2019. Seasonal Variability in Global Industrial Fishing Effort. *PLoS ONE*. 14(5): 1–17. DOI: https://doi.org/10.1371/journal.pone.0216819.

Haryanto YD, Agdialta R, Hartoko A. 2020. Analisis Monsun di Laut Jawa. *Berkala Perikanan Terubuk*. 48(2): 492–500.

Kasim K, Triharyuni S, Wujdi A. 2014. Hubungan

Ikan Pelagis dengan Konsentrasi Klorofil-a di Laut Jawa. *BAWAL Widya Riset Perikanan Tangkap*. 6(1): 21–29. DOI: http://dx.doi.org/10.15578/bawal.6.1.2014.21-29.

Kefi OS, Katiandagho EM, Paransa IJ. 2013. Sukses Pengoperasian Pukat Cincin Sinar Lestari 04 dengan Alat Bantu Rumpon yang Beroperasi di Perairan Lolak Provinsi Sulawesi Utara. *Jurnal Ilmu dan Teknologi Perikanan Tangkap*. 1(3): 69–75. DOI: https://doi.org/10.35800/jitpt.1.3.2013.1345.

Ma'mun A, Priatna A, Herlisman H. 2018. Pola Sebaran Ikan Pelagis dan Kondisi Oseanografi di Wilayah Pengelolaan Perikanan Negara Republik Indonesia 715 (WPPNRI 715) pada Musim Peralihan Barat. *Jurnal Penelitian Perikanan Indonesia*. 24(3): 197–208. DOI: http://dx.doi.org/10.15578/jppi.24.3.2018.197-208.

Ray C, Dreo R, Camossi E, Jousselme A-L, Iphar C. 2019. Heterogeneous Integrated Dataset for Maritime Intelligence, Surveillance, and Reconnaissance. *Data in Brief*. 25: 1–17. DOI: https://doi.org/10.1016/j.dib.2019.104141.

Regulation of the Minister of Transportation of the Republic of Indonesia Number 7 of 2019 concerning the Installation and Activation of Automatic Identification Systems for Ships Sailing in Indonesian Waters. Jakarta.

Sahidi S, Sapsuha GD, Laitupa AF, Tangke U. 2015. Hubungan Faktor Oseanografi dengan Hasil Tangkapan Pelagis Besar di Perairaan Batang Dua Propinsi Maluku Utara. *Agrikan: Jurnal Agribisnis Perikanan*. 8(2): 53–63. DOI: https://doi.org/10.29239/j.agrikan.8.2.53-63.

Simau S, Prakoso I, Manengkey JI, Manohas JJ, Peggy P, Gomez GK. 2022. Kajian Pemanfaatan AIS (*Automatic Identification System*) dalam Melacak Aktivitas *Illegal Fishing* pada kapal dan AIS Hybrid sebagai Alat Bantu Penangkapan Ikan. *Jurnal Bluefin Fisheries*. 4(2): 102–128.

Sugianto CP. 2022. Mengenal AIS (*Automatic Identification System*): A–Z. https://mandiriweb.com/mengenal-ais-kapal-automatic-identification-system/. [15 Juli 2024].

Taconet M, Kroodsma D, Fernandes J. 2019. *Global Atlas of AIS-based Fishing Activity*. Rome (IT): FAO.

Tangke U, Karuwal J, Mallawa A, Zainuddin M. 2017. Analisis Hubungan Suhu Permukaan Laut, Salinitas, dan Arus dengan Hasil Tangkapan Ikan Tuna di Perairan Bagian Barat Pulau Halmahera. *Jurnal IPTEKS Pemanfaatan Sumberdaya Perikanan*. 3(5): 368–382. DOI: https://doi.org/10.20956/jipsp.v3i5.1927.

Tawaqal MI, Yusfiandayani R, Imron M. 2020. Analisis *Fishing Activity* Kapal Tuna *Longline* Menggunakan *Vessel Monitoring System* yang Berbasis di Benoa Bali. *Jurnal Teknologi Perikanan dan Kelautan*. 10(1): 109–119. DOI: https://doi.org/10.24319/jtpk.10.109-119.

Thombre S, Zhao Z, Ramm-Schmidt H, Garcia JMV, Malkamaki T, Nikolskiy S. 2020. Sensors and AI Techniques for Situational Awareness in Autonomous Ships: A Review. *IEEE Transactions on Intelligent Transportation Systems*. 23(1): 64–83. DOI: https://doi.org/10.1109/TITS.2020.3023957.

Triyono, Arifin T, Nugroho D, Novianto D, Rahmawati H, Ika RH, Amri SNAS, Faizah R, Prihatiningsih, Nurfiarini A, *et al*. 2019. *Potensi Sumberdaya Kelautan dan Perikanan WPPNRI 573*. Jakarta (ID): Amafrad Press.

Wardhani LTAL, Herawati R, Pinilih SAG, Ristyawati A. 2022. Global Fishing Watch System as a Solution in the Control of the Fishing Industry in Indonesia. *Aquaculture, Aquarium, Conservation & Legislation Bioflux*. 15(4): 1807–1816.