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Fishery Management of Southern Bluefin Tuna (*Thunnus maccoyii*) Using EAFM in Benoa Harbor, Bali

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ABSTRACT

Benoa Harbor is the center of Indonesia's large-scale tuna fisheries. Southern bluefin tuna (*Thunnus maccoyii*), the most valuable tuna species in the world, has been overexploited, causing a drastic population decline. An EAFM-based management approach is necessary to evaluate southern bluefin tuna fishery resource utilization techniques. This study was conducted at Benoa Harbor in Denpasar, Bali. Data were collected four times from June to September 2024. The observed indicators were destructive fishing methods, modification of fishing gear and aids, fishing capacity and catching effort, fishing selectivity, conformity of the function and size of fishing vessels with legal documents, and certification of fishing vessel crews in accordance with regulations. The domain status assessment of fishing techniques based on the ecosystem approach for southern bluefin tuna fisheries management in Benoa Harbor is in the excellent category, with a composite score of 83.33. The indicators of destructive and/or illegal fishing show a frequency of violations of less than five cases per year, a target species size of less than Lm, a fishing capacity ratio of less than one, high fishing selectivity, a proportion of targets greater than bycatch (68% to 32%), a low mismatch of function and size of vessels with legal documents of less than 30%, and a certified crew of greater than 75%. Southern bluefin tuna fisheries management in Benoa Harbor can be improved by following the National Working Group on EAFM's suggestions related to the assessment of low indicators. These suggestions include controlling the utilization of fish resources and imposing fishing quotas based on target, fishing gear, fishing ground, and operating time.

INTRODUCTION

Benoa Port is the center of large-scale tuna fishing activities in Indonesia and plays a vital role in the fishing industry. Its strategic location in the middle of the resource-rich

Indonesian Fisheries Management Area (FMA) 573 makes it a central point for large-scale tuna fishing activities. The waters of FMA 573 and beyond the Exclusive Economic Zone or international waters are important areas for southern bluefin tuna fishing. Benoa Harbor is the port where most of Indonesia's bluefin tuna catch is landed **(Farley *et al.*, 2021)**. Southern bluefin tuna (*Thunnus maccoyii*) is one of the most valuable tuna species in the world. This resource is very important to Indonesian fisheries because the country has vast marine waters and diverse ecosystems **(Sunoko & Huang, 2014)**. Southern bluefin tuna is a migratory fish species whose management is regulated by regional fisheries management organizations (RFMOs), particularly the Commission for the Conservation of Southern Bluefin Tuna (CCSBT), which allocates catch quotas to its member countries. The spawning ground for southern bluefin tuna (SBT) is located in an area between Indonesia and the northwest coast of Australia, where spawning occurs annually from September to April **(Farley & Davis 1998)**. For decades, the harvest of southern bluefin tuna has exceeded sustainable levels, leading to a drastic decline in its population. Overfishing is a major threat to marine biodiversity and resilience, along with climate change, habitat destruction, pollution, global trade and growing resource consumption **(Dulvy *et al.*, 2021)**.

Conservation of southern bluefin tuna is essential to maintain the balance of marine ecosystems and to ensure the sustainability of fishery resources. The Commission for the Conservation of Southern Bluefin Tuna (CCSBT), consisting of Japan, Australia, Indonesia, New Zealand, South Africa, South Korea, Taiwan and the EU, has contributed to successful conservation management and the optimal utilization of resources **(Mohri *et al.*, 2019)**. The Indonesian Ministry for Marine Affairs and Fisheries (MMAF) has implemented the Ecosystem Approach to Fisheries Management (EAFM) policy in all Fisheries Management Areas (FMAs) established under Ministerial Regulation 18/PERMENKP/2014 (NWG-EAFM, 2014) (PERMEN-KP, 2014a). The purpose of this research was to assess the status of Southern Bluefin Tuna Fisheries in Benoa Port, with a specific focus on the fishing techniques domain of the EAFM status assessment methodology.

MATERIALS AND METHODS

The research was conducted in Benoa Harbor, Denpasar, Bali. The data were collected at Benoa Harbor, especially in the southwest pier and northwest pier, where these piers are used as fishing piers. This research was conducted from June 2024 to September 2024. The methods used in this research are based on the domain of fishing techniques based on the National Working Group on Ecological Approach Fisheries Management (EAFM) framework. The assessment indicators for the fishing techniques domain are shown in Table (1).

Indicator analysis of fisheries capacity and catch effort

$$FC = V \times C \times E$$

Description:
V = number of vessels (units)
C = total catch (tons)
E = total effort (trips)
Source: (NWG-EAFM, 2014)

Index value determination

$$Cat\text{-}I = Sat\text{-}i \times Wat\text{-}I$$

Description:
Cat-i = index value of the i-th attribute/indicator
Sat-i = score of the i-th attribute/indicator
Wat-I = weight of the i-th attribute/indicator
Source: (NWG-EAFM, 2014)
Determination of EAFM composite value

$$NK = (Cat/Cat\text{-}max) \times 100$$

Description:
NK : Composite value
Cat : Total index value of all indicators
Cat-max : Maximum total index value
Source: (NWG-EAFM, 2014)

Table 1. The assessment indicators for the fishing techniques domain

No.	Indicator	Data	Criteria	Weight (%)
1.	Destructive fishing methods	Use of destructive fishing gear and methods and/or not in compliance with applicable regulations	1 = Frequency of violations > 10 cases per year; 2 = Frequency of violations 5-10 cases per year; 3 = Violation frequency	30
2.	Modification of fishing gear and tools assessment	Use of fishing gear and aids that have a negative impact on SDIs	1 = >50% target species size <Lm 2 = 25-50% of target species size <Lm 3 = <25% target species size <Lm	25
3.	Fishing capacity and effort	Size of fishing capacity and activity	1 = Fishing capacity ratio <1 2 = Fishing capacity ratio =1 3 = Fishing capacity ratio >1	15

4.	Selectivity of catches	Percentage of primary catch compared to by-catch	1 = low (75% selective fishing gear) 2 = medium (50-75% selective fishing gear) 3 = high (>75% selective fishing gear)	15
5.	Compliance of vessel function and size with legal documents	Whether or not the function and size of the vessel is in compliance with legal documents	1 = Low suitability (>50% of samples do not match legal documents) 2 = Medium compliance (30-50% of samples do not match legal documents) 3 = High conformance (<30% of samples do not conform to legal documents)	10
6.	Crew certification in accordance with regulations	Qualification of fishing vessel crew skills (qualitative community panel)	1 = Certificate ownership <50% 2 = 50-75% certificate ownership 3 = Certificate ownership >75%	5

Source: **(NWG-EAFM, 2014)**.

The assessment of the EAFM indicators is a multi-criteria system that results in a composite index related to the level of achievement of fisheries management according to the EAFM principles. The composite index converts the total score of each EAFM domain. This process is necessary to obtain a standardized limit of the conversion value of the 1-100 scale to facilitate the categorization of each EAFM domain. The total index value obtained was analyzed in a simple composite based on the arithmetic mean (Table 2).

Table 2. EAFM composite score

Composite Value Range	Flag Model	Description
1-20		Bad
21-40		Less
41-60		Medium
61-80		Good
81-100		Excellent

Source: **(NWG-EAFM, 2014)**.

RESULTS

Tuna and tuna-like species are a group of fish that migrate far into the exclusive economic zones (EEZs) of one or more countries and the high seas. These species are included in WPP 573 **(Firdaus, 2018; Nurhayati *et al.*, 2018)**. Southern bluefin tuna are distributed across the southern Indian Ocean, Pacific Ocean, and Atlantic Ocean and then migrate to spawning grounds. Their spawning grounds are located between Indonesia and the northwest coast of Australia, where Indonesian fishermen operate longline fisheries **(Rochman *et al.*, 2019)**. Spawning occurs from September to April each year **(Farley & Davis, 1998)**. Southern bluefin tuna fishing operations occur from June to September in waters between 30 and 35°S **(Lu *et al.*, 2021)**.

Fig. 1. Southern bluefin tuna

The results of the status assessment of the Fishing Techniques Domain, based on the ecosystem approach to fisheries management (EAFM), are shown in Table (3).

Table 3. Category of EAFM implementation in the fishing technique domain

No	Indicator	Composite Value	Flag Model	EAFM Category
1	Destructive fishing methods	100		Excellent
2	Modification of fishing gear and tools assessment	100		Excellent
3	Fishing capacity and effort	33,33		Less
4	Selectivity of catches	66,67		Good
5	Compliance of vessel function and size with legal documents	100		Excellent
6	Crew certification in accordance with regulations	100		Excellent
	Average	83,33		Excellent

According to the EAFM assessment of southern bluefin tuna fisheries management at Benoa Port, the Fishing Technique Domain is placed in the “Excellent” category. The total value of the fishing technique domain index was 255, with a composite value of 83.33. Fishing capacity and effort were the only indicators in the "Less" category. Selectivity of catches was in the "Good" category, while most were in the "Excellent" category.

A positive correlation was found between monitoring performance (by stakeholders) and the series of activities undertaken by business actors in designing processes to regularly collect information—including scientific data—on the status of resources, ecosystems, and human populations **(Miswar *et al.*, 2019)**. This also includes evaluating the extent to which management has achieved the objectives outlined in the management plan. According to the **National Working Group on EAFM (2014)**, improvements are needed for fishing capacity and fishing effort indicators that currently have low composite values. These improvements include controlling the utilization of fishery resources and implementing catch quotas based on target species, fishing gear, fishing grounds, and operating times.

Destructive and/or illegal fishing

The assessment of destructive and/or illegal fishing indicators aims to determine the impact of the use of fishing gear on the sustainability of fish stocks. The results of assessment of destructive and/or illegal fishing indicators are shown in Table (4).

Table 4. Destructive and/or illegal fishing methods

Year	Type of Infringement	Sanctions	Frequency
2022	Non-compliance with the fishing area	First warning letter	1 vessel
2023	Non-compliance with the fishing area	First warning letter	6 vessels
2024	Non-compliance with the fishing grounds	First warning letter	4 vessels

Based on the last three-years, the frequency of destructive and/or illegal fishing methods infringements in the Benoa port area remained low, averaging less than 5 cases per year. According to the National Working Group on EAFM **(NWG-EAFM, 2014)**, these indicators included the use of fishing methods that damage habitats or violate fisheries regulations as applicable, including the use of explosives or poisons, prohibited fishing gear, and illegal fishing. The most common types are those recorded with a failure to comply with the fishing area, transshipment, failure to comply with the location of the base and fishing by hand (OTT). Specifically, in 2022 there was only one infringement among 290 active vessels. This increased to six infringements in 2023, with 275 active vessels, and then decreased to four infringements in 2024, with 266 active vessels. This corresponds to an infringement frequency of one vessel in 2022, six vessels in 2023 and four vessels in 2024, resulting in an average of less than 5 cases per year, which can be considered very low.

The indicator for destructive and/or illegal fishing methods carries the highest importance weight at 30%, highlighting its significant concern in the evaluation of EAFM based fishing techniques. As stipulated in Decree Number 50 of 2012 by the Minister of Maritime Affairs and Fisheries **(KEPMEN-KP, 2012)**, violations in the Benoa Port area specifically involve non-compliance with permitted fishing routes and areas. This substantial weighting reflects the immense impact that irresponsible fishing practices have on the sustainability of fish stocks and marine ecosystems. Research by **Nilsson *et al.* (2019)** indicates that southern bluefin tuna fisheries, which collapsed due to heavy impacts from illegal, unreported, and unregulated (IUU) fishing, particularly on the high seas, showed poor overall scores in areas such as industry, governance, and management.

Modification of fishing gear and tools assessment

According to the EAFM module by the National Working Group on EAFM **(NWG-EAFM, 2014)**, the indicator for assessing gear modification is measured indirectly by comparing the size of the fish caught to the length at maturity (Lm), which is the length at which the fish first reaches gonadal maturity. The size distribution of southern bluefin tuna catches assessment is presented in Fig. (1).

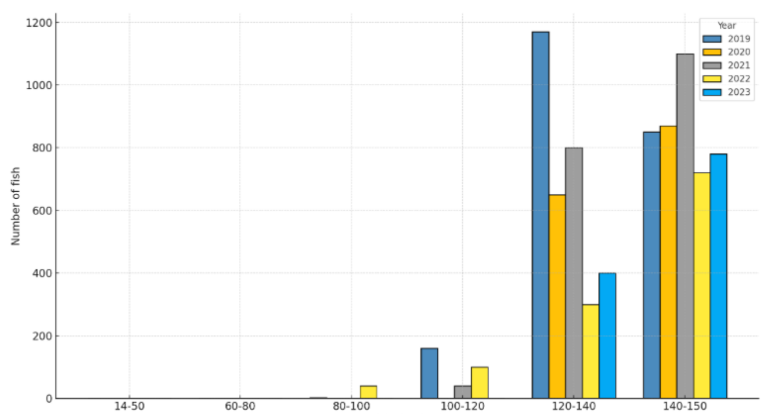

Fig. 1. Catch size distribution of southern bluefin tuna (2019-2023)

The graph shows that fewer than 25% of the target species are smaller than the Lm size threshold. This results in an assessment indicator score of 3 and an excellent composite index of 75 for EAFM implementation. The comparison between the length of gonadally immature fish and those with mature gonads reveals a ratio of 96 to 4%. The fork length (FL) of the captured southern bluefin tuna was predominantly between 120-150cm. The total length (FL) of the southern bluefin tuna entering the spawning area ranged from 121 to 191cm, and the fish were between five and 22 years old, higher than the average length of southern bluefin tuna in the nursery area, which ranged from 113.70 to 116.50cm FL **(Lin & Tzeng, 2010)**. Southern bluefin tuna typically reach gonadal maturity at a maximum FL of 245cm, with an average range of 160– 200cm **(Food and Agriculture Organization of the United Nations, 2022)**.

Based on fishermen's questionnaires in Benoa Harbor, longline vessels are constructed from various materials, such as iron, fiberglass and fiberglass-coated wood, and carry longlines with hundreds to thousands of hooks. Engines are usually six-cylinder, with various brands including Yanmar, Tim, Sit F, Mitsubishi, Nissan and Xiuming. These vessels are powered by diesel fuel and are equipped accordingly. The specifications of the longline fishing gear include main line lengths ranging from 100 to over 1,000 meters, branch line lengths ranging from 100 to 1,000 meters, hook sizes ranging from 3 to 8 and the number of fishing lines used ranging from 100 to over 1,500. These vessels operate with fewer than 2,500 hooks and have a gross tonnage (GT) of over 30. The operational area covers fishing zone III in several FMA, including 571, 572, 573, 711, 712, 713, 714, 715, 716, 717, and 718 (PERMEN-KP, 2016). This variety demonstrates the operational flexibility of the vessels, enabling them to adapt their fishing techniques to water conditions and target fish.

According to Regulation No. 71/PERMEN-KP/2016 of the Republic of Indonesia's Minister of Marine Affairs and Fisheries concerning “Fishing Routes and the Placement of Fishing Gear in the Fisheries Management Area”, drifting longline fishing gear, particularly tuna longlines, is defined as passive fishing gear **(PERMEN-KP, 2016)**. Gear modifications adopted by Benoa Harbor fishermen include: the silver super-loop fishing line and the use of offsets, both designed to increase fishing selectivity and reduce bycatch and environmental impact. The Silver Super Loop modification involves forming a special knot at the end of the fishing line using silver wire. This knot is designed to provide high bond strength and resistance to strong drag when pulling fish, thereby reducing the risk of lost catches. Meanwhile, offset modification refers to adjusting the distance and angle between the hook eye and the hook rod, as well as their distance from each other along the main line. This technique allows for more precise setting of the fishing depth in the water. The use of the offset method is expected to minimize the catch of non-target species such as turtles, seabirds and sharks, and to promote more environmentally friendly fishing practices. Fishing activities that negatively impact ETP species, whether as target catch or bycatch, are considered unsustainable and receive a low score **(NWG-EAFM, 2014)**.

Fishing capacity and effort

The results of the fishing capacity and effort of southern bluefin tuna catches assessment is presented in Table (5).

Table 5. Fishing capacity and effort of southern bluefin tuna

Year	Catch	Effort	Vessel	Fishing capacity (VxCxE)	Ratio (Catch / Capacity)
2019	987	147	229	3.162.546.046	0,0000297
2020	1.300	171	248	5.727.928.080	0,0000236
2021	892	140	245	3.007.911.485	0,0000292
2022	846	175	290	3.060.240.806	0,0000197
2023	946	226	275	3.637.165.318	0,0000161
Total					0,0001183
Average					0,0000296

Based on the results, the amount of southern bluefin tuna caught during this period (2019-2024) fluctuated. In 2020, the highest catch was recorded with 1,300 tons, while the lowest was in 2022 (846 tons). Fishing intensity increased from 2019 (147) to 2023 (226), except for a decrease in 2021. The number of vessels involved in southern bluefin tuna fishing increased from 229 in 2019 to 275 in 2023, with a slight decrease in 2021. The estimated fishing capacity is calculated by multiplying vessel (V), catch (C), and effort (E), which increased significantly from 2019 to 2020 and then fluctuated, remaining higher than in 2019. A low catch-to-capacity ratio may indicate overcapacity. The ratio decreased from 2019 to 2023, with a slight increase in 2021.

The terms 'Fishing Capacity' and 'Fishing Effort' for the southern bluefin tuna refer to the magnitude and intensity of fishing operations targeting this species, undertaken by various countries or entities under the purview of international regulatory bodies like the Commission for the Conservation of Southern Bluefin Tuna (CCSBT). Member countries of the CCSBT engage in Southern Bluefin Tuna fishing activities utilizing a restricted number of vessels, typically deploying longline fishing, purse seining, or pole-and-line techniques **(Indriyani *et al.*, 2022)**. Intergovernmental fisheries management bodies use quotas, capacity limits, or effort limits to restrict the exploitation of resources and achieve economic, social, and environmental objectives **(Anderson *et al.*, 2018)**. The bluefin tuna catch quota is determined by international agreements made in forums such as the Commission for the Conservation of Southern Bluefin Tuna (CCSBT).

In 2010, Indonesia first received a bluefin tuna catch quota of only 750 tons. Since then, Indonesia has gradually increased its quota in line with its success in managing it. These quotas are determined based on an assessment of the bluefin tuna population. If the population is declining, the quota is reduced to allow it to recover. Between 2018 and 2020, the Commission for the Conservation of Southern Bluefin Tuna (CCSBT) set the total allowable catch (TAC) for southern bluefin tuna at 17,335 tons **(Indriyani *et al.*, 2022)**. Indonesia received an allocation of 1,023 tons of the total TAC **(Rochman *et al.*, 2020)**. This quota was allocated to companies through tuna associations (ATLI, ASTUIN, and ASPERTADU) **(Rochman *et al.*, 2020)**.

Selectivity of catches

The assessment of fishing selectivity indicators aims to understand the effectiveness of longline gear in capturing the target tuna while minimizing damage to marine ecosystems and reducing bycatch **(NWG-EAFM, 2014)**. The results of the fishing selectivity of catches assessment are presented in Fig. (2).

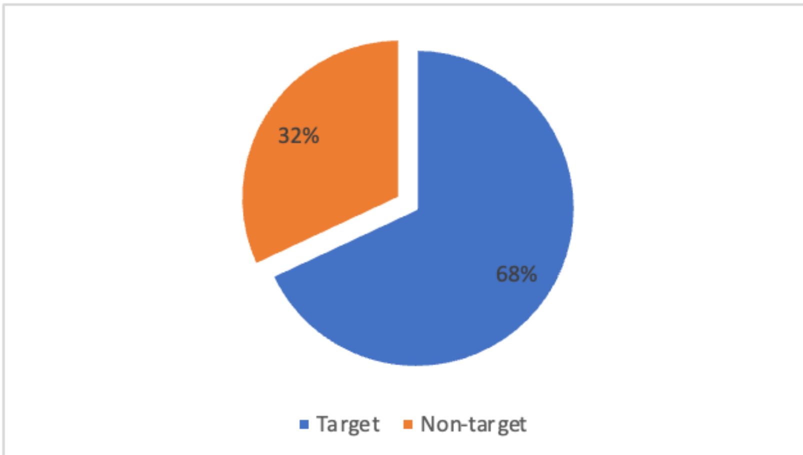

Fig. 2. Species composition of catches for the period 2019-2023

The results of the above analysis show that the proportion of the main catch to bycatch is 64:36. This value indicates that the longline fishing gear is highly selective. The greater the proportion of the main catch compared to the bycatch, the more selective the fishing gear. Longlines or tuna longlines are classified in the NWG EAFM module as a fishing gear with a relatively high level of selectivity **(NWG-EAFM, 2014)**. However, this level of selectivity is influenced by several factors, such as target species, line size and bait type. Bycatch of 60% or more, of which a significant portion is utilized, can be regarded as ecologically sustainable **(Firdaus *et al.*, 2017)**. According to **Rochman *et al.* (2020)**, southern bluefin tuna is a seasonal commodity and not the main target of tuna species in the Indian Ocean, so a comprehensive study needs to be conducted to answer the problems of the Indonesian longline fishery as a whole.

Longline vessels in Benoa target four types of tuna: albacore tuna (*Thunnus alalunga*), yellowfin tuna (*Thunnus albacares*), bigeye tuna (*Thunnus obesus*), and southern bluefin tuna (*Thunnus maccoyii*). Yellowfin tuna is the target catch with the highest total yield, while southern bluefin tuna has the lowest yield. Swordfish is the non-target fish with the highest proportion. According to **Heidrich *et al.* (2022)**, fishery catch statistics for longline and surface fisheries by CCSBT members include main target species such as the bigeye tuna (*Thunnus obesus*) and skipjack tuna (*Katsuwonus pelamis*), yellowfin tuna (*Thunnus albacares*), albacore tuna (Thunnus alalunga), Atlantic bluefin tuna (*Thunnus thynnus*), Pacific bluefin tuna (*Thunnus orientalis*), and the southern bluefin tuna (*Thunnus maccoyii*). These statistics also include targeted and non-targeted billfish, sharks, rays, neritic tuna, and other teleost fish species **(Heidrich *et al.*, 2022)**.

Compliance of vessel function and size with legal documents

Survey data and interviews revealed that the rate of noncompliance between vessel function and size documentation and legal documents in the Benoa Harbor area is low, at less than 30%. The assessment of the vessel function and size documentation compliance indicator resulted in a score of 3 (indicating high compliance, where <30% of samples showed discrepancies with legal documents), contributing to a composite index value of 30, which falls into the 'very good' category for EAFM implementation.

Based on Association of Indonesian Tuna Longline, vessels measuring 30 GT consistently dominated the registered tuna longline fishing fleet from 2013 to 2024. A total of 287 Indonesian vessels are registered with the Commission for the Conservation of Southern Bluefin Tuna (CCSBT), ranging in size from 14 to 214 gross tons (GT). Of these vessels, 256 are over 30 GT. According to Regulation Number 58/PERMEN-KP/2020Ministry of Marine Affairs and Fisheries of the Republic of Indonesia regarding “Fishing Business”, all fishing vessels with a gross tonnage (GT) of more than 30 operating in the Indonesian Fisheries Management Area (FMA) at a distance of more than 12 nautical miles or on the high seas must have valid licensing documents **(PERMEN-KP, 2020)**. This obligation includes possessing a Fishing Business License (SIUP), a Fishing Permit (SIPI), and a Fishing Vessel License (SIKPI). There are two internationally required documents for fishing vessels: vessel registration and fishing permits **(Hosch & Blaha, 2017)**. These provisions ensure legal, reported, and regulated fishing activities and support sustainable fisheries management in accordance with applicable regulations.

Commercial fishermen are obligated to initially tag southern bluefin tuna to ensure traceability from catch to market **(Indriyani *et al.*, 2022)**. This is essential for verifying the legality of catches and supporting conservation efforts within the framework of responsible fisheries management. The catch tagging form is a mandatory document included in the CDS report of the Commission for the Conservation of Southern Bluefin Tuna (CCSBT). The combination of trade documentation schemes (TDS) and trade sanctions has proven effective in identifying and eradicating fishing operations associated with flags of convenience **(Hosch, 2016)**. The catch documentation scheme (CDS) concept enables the identification and certification of legally transported catch units, as well as their tracking through international trade to the final market **(Hosch & Blaha, 2017)**.

According to international law, flag states are responsible for monitoring fishing vessels. This includes registering vessels, maintaining license lists, installing vessel monitoring systems (VMS), recording logbooks, implementing observer programs, and issuing permits for transshipment and landing fish **(Hosch & Blaha, 2017)**. In accordance with Indonesia's national legal framework, all fishing vessels failing to comply with logbook recording obligations will be subject to administrative sanctions **(Indriyani *et al.*, 2022)**. According to the most recent regulations from the Ministry of Marine Affairs and Fisheries **(PERMEN-KP, 2014b; PERMEN-KP, 2021)**, fishing logbooks must contain detailed information about the vessels, the gear used, the operations performed, and the results of the catch **(Raup *et al.*, 2023)**. Logbooks are important official records containing crucial information such as the type and quantity of catch, fishing area, and fishing effort, making this obligation highly significant.

According to international law, the flag state is responsible for monitoring fishing vessels. This includes registering vessels, maintaining license lists, installing vessel monitoring systems (VMS), keeping logbooks, implementing observer programs, and issuing permits for transshipment and landing of fish **(Hosch & Blaha, 2017)**. According to Indonesia's national legal framework, all fishing vessels that fail to comply with logbook recording obligations will be subject to administrative sanctions **(Indriyani *et al.*, 2022)**. In accordance with the latest Minister of Marine Affairs and Fisheries Regulation No. 33/PERMEN-KP/2021 and Minister of Marine Affairs and Fisheries Regulation No. 48/PERMENKP/2014, data in fishing logbooks must contain detailed information regarding fishing vessels, fishing gear used, fishing operations, and catch results. Logbooks are important official records containing crucial information such as the type and quantity of catches, fishing areas, and fishing efforts, so this obligation is very important.

Crew certification in accordance with regulations

The results of assessment of crew certification in accordance with regulations indicators are presented in Table (6).

Table 6. Crew certification in accordance with regulations

No	Ship's Crew Certificate	Observation and Interview Results	Compliance with government regulations
1	Fishing Vessel Crew Competency Certificate (SKAKP)	16 respondents answered that they had skills certificates such as Ankapin/Atkapin	Based on Article 107 Paragraph (1) of Minister of Maritime Affairs and Fisheries Regulation Number 33 of 2021, which requires all fishing vessel crew to have an ANKAPIN I, II, or III certificate (PERMEN-KP, 2021).
2	Training Certificate	83 respondents answered that they	Law Number 17 of 2008 concerning Shipping emphasizes

	had a Basic Safety Training (BST) certificate.	the importance of shipping safety and seafarer competence (*Undang-Undang Nomor 17 Tahun 2008 Tentang Pelayaran*, 2008).

* Total respondents: 109 people.

Crew certification indicators generally refer to official documents proving that a seafarer has met the specified education, training and work experience requirements. Based on the assessment, the crew certification indicator has a score of 3 (certificate ownership >75%), with a composite index value of 100, which is included in the excellent category in the implementation of EAFM. According to the National Working Group on EAFM **(NWG-EAFM, 2014)**, the ownership of crew certificates is also useful to ensure that the fishing process is carried out by fishermen who are familiar with the principles of responsible fishing so as not to jeopardize the sustainability of fish resources.

According to Government Regulation No. 7/2020 on Maritime Affairs, all crew members of fishing vessels are required to have either a nautical seafarer certificate (ANKAPIN) or a technical certificate (ATKAPIN) for fishing vessels I/II/III, depending on their field. The ANKAPIN certificate has three levels: ANKAPIN I (fishing vessel captain), ANKAPIN II (chief engineer and helmsman), and ANKAPIN III (other crew members).

CONCLUSION

Overall, the fisheries management based on fishing techniques were in the “Excellent” category in supporting sustainability. However, low scores were received for fisheries capacity and fishing effort. Therefore, to ensure the sustainability of the bluefin tuna fishery at Benoa Port, policies should be implemented based on the recommendations of the National Working Group on EAFM, particularly those related to controlling the utilization of fish resources by establishing catch quotas based on targets, fishing gear, fishing grounds, and operating times.

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REFERENCES

Anderson, C.M.; Krigbaum, M.J.; Arostegui, M.C.; Feddern, M.L.; Zachary, J.; Peter, K.; Christina, T.K.; Allen, C.I.; Melanie, A.; Courtney, J.D.; Ava, F.; Lee, Q.; Mcelroy, K.N. and Pons, M. (2018). How commercial fishing effort is managed. *Fish and Fisheries*, *19*(5), 1–18. https://doi.org/10.1111/faf.12339

Dulvy, N.K.; Pacoureau, N.; Rigby, C.L.; Pollom, R.A.; Jabado, R.W.; Ebert, D.A.; Finucci, B.; Pollock, C.M.; Cheok, J.; Derrick, D.H.; Herman, K.B.; Sherman, C.S.; VanderWright, W.J.; Lawson, J.M.; Walls, R.H.L.; Carlson, J.K.; Charvet, P.; Bineesh, K.K.; Fernando, D. and Simpfendorfer, C.A. (2021). Overfishing drives over one-third of all sharks and rays toward a global extinction crisis. *Current Biology*, *31*(21), 4773-4787.e8. https://doi.org/10.1016/j.cub.2021.08.062

Farley, J.H. and Davis, T.L.O. (1998). Reproductive Dynamics of Southern Bluefin Tuna, *Thunnus maccoyii*. *Fishery Bulletin*, *96*(2), 223–236.

Farley, J.; Sulistyaningsih, R.; Setyadji, B. and Mardi, S. (2021). *Review of Data to Estimate the Length and Age Distribution of SBT in the Indonesian Longline Catch*. CCSBT-ESC/2108/Info10.

Firdaus, I.; Fitri, A.D.P.; Sardiyatmo and Kurohman, F. (2017). Analisis Alat Penangkap Ikan Berbasis Code Of Conduct For Responsible Fisheries (CCRF) Di Tempat Pelelangan Ikan (TPI) Tawang, Kendal. *Journal of Marine Research*, *13*(1), 65–74.

Firdaus, M. (2018). Profil Perikanan Tuna Dan Cakalang Di Indonesia. *Buletin Ilmiah Marina Sosial Ekonomi Kelautan Dan Perikanan*, *4*(1), 23–34. https://doi.org/10.15578/marina.v4i1.7328

Food and Agriculture Organization of the United Nations. (2022). *Identifikasi Spesies Ikan Tuna dan Tuna Like di Kawasan Perikanan Lautan Hindi*. Indian Ocean Tuna Commission.

Heidrich, K.N.; Juan-Jordá, M.J.; Murua, J.H.; Thompson, C.D.H.; Meeuwig, J.J. and Zeller, D. (2022). Assessing progress in data reporting by tuna Regional Fisheries Management Organizations. *Fish and Fisheries*, *23*(5), 1264–1281. https://doi.org/10.1111/faf.12687

Hosch, G. (2016). *Trade Measures to Combat IUU Fishing: Country-Level Support for Catch Documentation Schemes*. FAO Fisheries and Aquaculture Technical Paper No. 619.

Hosch, G. and Blaha, F. (2017). Seafood traceability for fisheries compliance: country-level support for catch documentation schemes. *FAO Fisheries and Aquaculture Technical Paper*, *619*, 1–120.

Indriyani, R.; Rahim, A. and Azmi, R. (2022). Law Enforcement Against Unreported Fishing: What Does Beyond the Catch Record? *Sriwijaya Law Review*, *6*(2), 189–204. https://doi.org/10.28946/slrev.Vol6.Iss2

KEPMEN-KP. (2012). *Keputusan Menteri Kelautan Dan Perikanan Republik Indonesia Nomor KEP.50/MEN/2012 Tentang Rencana Aksi Nasional Pencegahan Dan Penanggulangan Illegal, Unreported, And Unregulated Fishing Tahun 2012-2016*.

Lin, Y. and Tzeng, W. (2010). Sexual Dimorphism in the Growth Rate of Southern Bluefin Tuna *Thunnus maccoyii* in the Indian Ocean. *Journal of Fisheries Science of Taiwan*, *37*(2), 123–134. https://doi.org/10.29822/JFST.201006.0006

Lu, C.-P.; Wang, S.-P.; Chang, S.-T. and Hish, M.-H. (2021). *Biological Parameters of Southern Bluefin Tuna in the Indian Ocean*. CCSBT-ESC/2108/22.

Miswar, E.; Rahmah, A.; Nazwar, F.B.; Irham, M.; Afwanuddin, A.; Ulfah, M. and Iqbal, T.H. (2019). The effectiveness of Panglima Laot of Simeulue and its coherence with fisheries management industry based on EAFM (Ecosystem Approach to Fisheries Management). *IOP Conference Series: Earth and Environmental Science*, *348*, 012093. https://doi.org/10.1088/1755-1315/348/1/012093

Mohri, M.; Tanoue, H.; Inoue, Y.; Oidaira, H.; Nagai, S.; Yokota, S.; Kashino, Y.; Kobayashi, Y.; Fukami, K. and Tadashi, K. (2019). Longline Fishing for Southern Bluefin Tuna in Mid-latitude South Indian Ocean areas in 2017. *Mathematical and Physical Fisheries Science*, *16*, 8–23.

Nilsson, J.A.; Johnson, C.R.; Fulton, E.A. and Haward, M. (2019). Fisheries sustainability relies on biological understanding, evidence-based management, and conducive industry conditions. *ICES Journal of Marine Science*, *76*(5), 1436–1452. https://doi.org/10.1093/icesjms/fsz065

Nurhayati, M.; Wisudo, S.H. and Purwangka, F. (2018). Produktivitas dan Pola Musim Penangkapan Tuna Madidihang (*Thunnus albacares*) di Wilayah Pengelolaan Perikanan 573. *Akuatika Indonesia*, *3*(2), 127–136. https://doi.org/10.24198/jaki.v3i2.23400

NWG-EAFM. (2014). *Modul Penilaian Indikator untuk Pengelolaan Perikanan dengan Pendekatan Ekosistem*. National Working Group on Ecosystem Approach to Fisheries Management.

PERMEN-KP. (2014a). *Peraturan Menteri Kelautan Dan Perikanan Republik Indonesia Nomor 18/PERMEN-KP/2014 Tentang Wilayah Pengelolaan Perikanan Negara Republik Indonesia*.

PERMEN-KP. (2014b). *Peraturan Menteri Kelautan Dan Perikanan Republik Indonesia Nomor 48/PERMEN-KP/2014 Tentang Log Book Penangkapan Ikan*.

PERMEN-KP. (2016). *Peraturan Menteri Kelautan Dan Perikanan Republik Indonesia Nomor 71/PERMEN-KP/2016 Tentang Jalur Penangkapan Ikan Dan Penempatan Alat Penangkapan Ikan Di Wilayah Pengelolaan Perikanan Negara Republik Indonesia*.

PERMEN-KP. (2020). *Peraturan Menteri Kelautan dan Perikanan Republik Indonesia Nomor 58/Permen-KP/2020 Tentang Usaha Perikanan Tangkap*.

PERMEN-KP. (2021). *Peraturan Menteri Kelautan Dan Perikanan Republik Indonesia Nomor 33 Tahun 2021 Tentang Log Book Penangkapan Ikan, Pemantauan Di Atas Kapal Penangkap Ikan Dan Kapal Pengangkut Ikan, Inspeksi, Pengujian, Dan Penandaan Kapal Perikanan, Serta Tata Kelola Pen*.

Raup, S.; Yonvitner; Sulistiono; Zulhamsyah, I.; Mashar, A.; Patmiarsih, S. and Juniar, R. (2023). Integration of tuna fishery data collection in the Southern Waters of Java (FMA-573). *IOP Conference Series: Earth and Environmental Science*, *1221*, 012007. https://doi.org/10.1088/1755-1315/1221/1/012007

Rochman, F.; Ni Luh, W. and Eswaryanti Kusuma, Y.L.P. (2019). Southern Bluefin Tuna (*Thunnus maccoyii*) Caught by Indonesia's Tuna Longliners in the Spawning Area. *Indonesian Fisheries Research Journal*, *25*(2), 75–90. https://doi.org/10.15578/ifrj.25.2.2019.75-90

Rochman, F.; Agustina, M. and Arnenda, G.L. (2020). Total Allowable Catch of Indonesian Southern Bluefin Tuna *Thunnus maccoyii* and Its Potential Resources in The Indian Ocean. *E3S Web of Conferences, 147,* 02013. https://doi.org/10.1051/e3sconf/202014702013

Sunoko, R. and Huang, H.W. (2014). Indonesia tuna fisheries development and future strategy. *Marine Policy*, *43*, 174–183. https://doi.org/10.1016/j.marpol.2013.05.011

Undang-Undang Nomor 17 Tahun 2008 Tentang Pelayaran. (2008). *Republic of Indonesia Law No. 17 of 2008 Concerning Shipping*.