PROCEEDING BOOK OF

Tuna Talks on Interfacing Science and Management for Sustainable and Regenerative Tuna Fishery

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Department of Fisheries Resources Utilization
Faculty of Fisheries and Marine Science
IPB University

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Tuna Talks on Interfacing Science and Management for Sustainable and Regenerative Tuna Fishery

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PREFACE

The Tuna Talks 2023 entitled 'Interfacing Science and Management for sustainable and regenerative Tuna Fishery'. It is a scientific publication delivered from various assessments and researches, containing 3 aspects of Lessons, i.e.: Fishery Resources, Socio-economic and Governance related to tuna fisheries. Those have been discussed in this proceeding.

The scientific knowledge is crucial for understanding fish stocks, their population dynamics, and the impacts of fishing activities. Robust data collection, monitoring, and research are essential to support management decisions accurately. The proceeding considers applying effective implementation for Ecosystem Approach of Fisheries Management, based on the appropriate data analysis combined with management, especially in developing Harvest Strategy.

A lesson of using citizen science for fish data collection, then give back to information to the data providers will give awareness on the resources condition. While Crowd Data Crawling manuscript, may is a future practice for data collection and management and business intelligence. Big data and AI have the potential to revolutionize the fisheries sector by providing more comprehensive, real-time, and accurate data that can inform better decision-making and management practices.

In the aspect of Socio-economic, the fisheries management and management of conservation areas should lead to an impact on socio-economic conditions, especially related to the resilience of fishermen. In this case, a Fisheries Sustainability Model (Sustainable Livelihood Assessment – SLA) needs to be developed to measure the resilience of fishing communities and at the same time measure the impact of the Harvest Strategy Implementation.

To sustain tuna fishing future, it is necessary to improve capacities of governments and stakeholders to develop and strengthen regulatory and policy frameworks for the successful implementation of Tuna Harvest Strategy.

The issues that is still apparent in Indonesia is the lack of governance structure in place for tuna fisheries labor and worker governance. Therefore, improvement of governance and regulation for fishery worker need to be strengthened. The studies explore the social structures and power relations resulting in the gender differentiated access to, and control over, livelihood assets. This has important implications that affect the ability of men and women to participate in governance and policy, achieve social-ecological resilience to change in global processes and the environment and livelihood sustainability.

Illegal, unreported, and unregulated (IUU) fishing is a transnational organized crime in fisheries, has significantly affects Indonesia's national losses of fisheries resources and socio-economic problems. There is an opportunity to combat IUU fishing. How to battle against IUU Fishing in Tuna and Governance regulation Initiatives. The important traceability, Fair Trade, MSC certification is how we can increase prosperity of fishers and investing self-reliance fishers in the future without any subsidies and incentive.

I hope that we can continue to work together in the future to sustain our tuna! Enjoy Reading.

Jakarta, March 28th, 2024.

Dr. Budy Wiryawan
Chair of Tuna Talks and Advisor of Tuna Consortium
Professor in Department Fishery Resources Utilization
Faculty of Fisheries and Marine Sciences, IPB University.

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ACKNOWLEDGEMENTS

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Funding for the workshops was provided by a grant from Walton Family Foundation (Leo Pradela) through Resonance Global (Tim Moore, Stephanie Ng, Thilma Komaling and Barokatun Nisya) and contribution from Tuna Consortium members (Yayasan Konservasi Alam Nusantara/YKAN, Yayasan IPNLF Indonesia/YII, Marine Change, Yayasan Masyarakat Dan Perikanan Indonesia/MDPI and Fair Trade USA).

The program for the Tuna Talks was developed in consultation with the committee (Dr. Toni Ruchimat, Prof. Dr. Ir. Luky Adrianto, Prof. Dr. Ir. Indra Jaya, Hari Christianto, MSc, Prof. Tri Wiji Nurani).

The Proceedings from the Tuna Talks would not have been possible without the enthusiastic participation of all participants from difference institutions during Event and the commitment of the authors to completing their sections of the Proceedings. The participants come from a diverse range of organisations and the Tuna Talks have highlighted the value of a collaborative approach between government, universities and nongovernment organisations for facing the many challenges of the implementation of Tuna Harvest Strategy and Fisheries Management in Indonesia.

ABBREVIATIONS

ACE	: Annual Catch Entitlement
AI	: Artificial Intelligence
BET	: Bigeye Tuna
BKIPM	: Fish Quarantine and Inspection Agency
BLM	: Black Marlin
CDC	: Crowd Data Crawling
CODRS	: Crew-Operated Data Recording System
CPUE	: Catch per Unit Effort
DGMSM	: Directorate General of Marine Spatial Management
DOL	: Dolphinfish
FAD	: Fish Aggregating Device
FIP	: Fisheries Improvement Project
FMA / WPPNRI	: Fisheries Management Area
HS	: Harvest Strategy
IAW	: Indonesian Archipelagic Waters
IKAN	: Initiative of Fisheries Data Collaboration
ILO	: International Labor Organization
IOP	: Indonesian Ocean Policy
IOTC	: Indian Ocean Tuna Commission
IUU	: Illegal, Unreported, and Unregulated
MDPI	: Indonesian Fisheries and Society Foundation Indonesia
MMAF/KKP	: Ministry of Marine Affairs and Fisheries
MPA	: Marine Protected Areas
MSA	: Sustainability Analysis
MSC	: Monitoring Control and Surveillance
NGO	: Non-Governmental Organization
RFMO	: Regional Fisheries Management Organizations
SEEA	: System of Environmental and Economic Accounting
SKJ	: Skipjack Tuna
SST	: Sea Surface Temperature
SWO	: Sword Fish
TAC	: Total Allowable Catch
TCT	: Tuna, Skipjack, and Mackerel
USAID	: United States Agency for International Development
VMS	: Vessel Monitoring System
WCPFC	: Western and Central Pacific Fisheries Commission
YFT	: Yellowfin Tuna

TUNA TALKS AGENDA

Activity/Topic	Detail	Speakers / Moderators
Opening	Welcoming	Thilma Komaling, M.Sc Lead of Indonesia Tuna Consortium
	Opening Remarks	Dr. Ridwan Mulyana Direktor of FRM MMAF (PSDI KKP)
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	2) A method to Involve Fishers in Voluntary Data Collection for Management of Tuna Fisheries in Indonesia	Dr. Peter Mous – YKAN
	3) Population Parameters Analysis of Skipjack Tuna (*Katsuwonus pelamis*) Landed on Kendari Oceanic Fishing Port	Dr. Naslina Alimina / UHO - Kendari
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	7) Gender Equity in Tuna Fisheries Indonesia	Dr. Ria Fitriana – Freelance Consultant

Activity/Topic	Detail	Speakers / Moderators
Opening	Welcoming	Thilma Komaling, M.Sc Lead of Indonesia Tuna Consortium
	Opening Remarks	Dr. Ridwan Mulyana Direktor of FRM MMAF (PSDI KKP)
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	13) Decades of FADs Regulation in Tuna Fisheries: Moving Forward or Going Nowhere?	M. Natsir, Ph.D - BRIN
	14) Transnational Organised Crime in Fisheries Threaten the Sustainability of Future Tuna Commodities in Indonesia	Dr. Alexander Khan / UNPAD
	15) Indonesia Archipelagic Tuna Industry Rapid Assessment	Roderic Hodges / Marine Change
	16) Traceability & Certification	Mr. Sven Blankenhorn / Fair Trade

Activity/Topic	Detail	Speakers / Moderators
Opening	Welcoming	Thilma Komaling, M.Sc Lead of Indonesia Tuna Consortium
	Opening Remarks	Dr. Ridwan Mulyana Direktor of FRM MMAF (PSDI KKP)
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OPENING WELCOMING

Thilma Komaling, SE, MPP (Strategic Lead of Indonesia Tuna Consortium Phase 2)

Selamat Pagi!

Just yesterday, and today in a different part of the world, nations are celebrating the UN Biodiversity Day – on the 22nd May 2023 It is not by coincidence that we are having this talk responding to the theme for this year, "From Agreement to Action: Build Back Biodiversity." As conjunction to the International Tuna Conference tomorrow, the Indonesia Tuna Consortium is fully committed to deliver one single objective: "By 2024, supporting the Indonesian government in finalizing and initiating the implementation of Harvest Strategy for tuna fisheries in the Indonesian Archipelagic Waters (WPP 713, 714,715) based on sound science with effective co-management and coordination mechanisms in place, while strengthening adaptive fisheries management and community livelihoods."

Every single detail of elements in this objective are happening today, tomorrow and the day after tomorrow. Today in Tuna Talks, we will discuss the 'sound science' as the foundation of fishery management; right next door – the co-management and coordination is in place led by one of the Tuna Consortium members.

Tomorrow, we will witness the commitment of the government of Indonesia in the highly anticipated launching of the Tuna Harvest Strategy, which historically emerged as the premise of national sovereignty based on the national mandate of The 1945 Constitution of The Republic of Indonesia Article 33 Section 3: The land and waters and the natural wealth contained in it shall be controlled by the state and utilized for the optimal welfare of the people.

The day after tomorrow, the dialogue of sustainable business practices and responsibilities will be detailed in the business forums – as the realization of policy and commitments made based in accordance to scientific developments.

It is about sustainable consumption methods; we can all have a real impact on our ecosystems through our consumption practices and choices. So, from nature to table, let us rethink the relationship between our food and the sea, reconnecting human to the ocean.

With great honor, I welcome you researchers, academia and policy makers to the very first Tuna Talks: Interfacing Science and Management for Sustainable and Regenerative Tuna Fisheries.

We need a whole-of-government, whole-of society approach.

Everyone must be engaged. Everyone must be involve

OPENING

Opening Remarks

Dr. Ridwan Mulyana (Director of Fisheries Resources Management, MMAF)

Guests of honor, members of the Indonesian Tuna Consortium from the Yayasan Konservasi Alam Nusantara, MDPI, ladies and gentlemen who were selected as speakers and all the participants whose names I may not be able to name.

Assalamualaikum.wr.wb

Om swastiastu

Salam budaya

Salam kebajikan

Good morning to all of you,

First of all, let all of us express our gratitude to Allah and our mighty creator for giving us the opportunity together in person in this comfortable room as well as virtually to join me in increasing our system and knowledge in understanding tuna fisheries in "tuna talk". For this blessing, allow me to congratulate participants who submitted their scientific writings and or will directly present the ideas within the tuna talk agenda.

Guests of honor, ladies and gentlemen, I am very aware of the importance of some scientific knowledge in supporting decision-making, and that is why, within the invitation that we extend to you, I confide that. Excellent scientific information background is an important part of the effort and process to achieve the sustainability of tuna resources. Therefore, as rationally as it is called, sufficient scientific knowledge will lead to a better direction following their conditions. Management of tuna fisheries in the current information aim has its challenges, including the variety of information that must be available and the speed at which this information is provided to solve various problems in tuna management. In this field, tuna talk can be an excellent start to re-establish a more robust network of research experts spread throughout Indonesia and overseas, especially in channeling and forwarding scientific information to support fisheries management.

Ladies and gentleman, The formation that looks above is becoming increasingly important because the management of tuna fisheries will enter a new phase with the presence of the harvest strategy of fish utilization strategy. With this strategy, a framework has been determined that includes management action for tropical tuna fisheries in RFMO 713, 714, and 715 needed to achieve management objectives as consequences of the results monitoring and best simulation that has been carried out. Insha Allah, the minister of marine affairs and fisheries will launch the strategic framework for tropical tuna in Indonesia's Archipelagic Waters tomorrow.

Guests of honor, Ladies and gentleman

The tuna talk confided the preferred time of connecting science and management for sustainable and regenerative tuna fisheries. I believe that the result of the tuna talk will contribute to the achievement of tuna fisheries, such as Indonesia's effort to achieve sustainable development goal number 14 to conserve and use oceans, seas, and marine resources sustainably for sustainable development. And to the success of the quota and zone-based fishing policy on which implementation is being initiated

my deep appreciation for the team collaboration from the director of fish resources and the Indonesia tuna consortium initiatives members for their action appreciation and hard work. Finally, I hope you have a productive discussion and be helpful to our Indonesian Fisheries.

Thank you

INTRODUCTION TO TUNA TALKS

Science on Tuna Fishery as basis of Sustainability: Research Locally, Negotiate Globally

Prof. Dr. Budy Wiryawan (Chair of Tuna Talks, Advisor of Tuna Consortium)

Assalamualaikum warahmatullahi wa barakatuh.

Good morning

Ladies and gentlemen, I am honored to become a host and speaker of this important event, and I welcome you all to this tuna talk on the topic of science on tuna fisheries as a basis of sustainability research locally and globally. As we know, tuna is also a leading fisheries product for Indonesia. Tuna fisheries have generated economic activity in this fisheries sector and also generated the well-being of fishers, the coastal community, and the industry. Talking fisheries management, we come to the mandate of the Code of Conduct of Responsibility Fisheries 1995, which is a set of principles and international standards of behavior for responsible practice concerning the ecosystem, biodiversity recognition, the network nutritional economy, social environment, and cultural important of fisheries and interest of all those continental fisheries sectors.

Indonesia's tuna fisheries are amongst the most important, diverse, and complex fisheries in the world. More than 130,000 vessels from 3 m in length to more than 100 m are operated with a total catch of more than 1 million tons of tuna per year. Tuna is one of the most valuable species in Indonesia, with an export value of US$677.9 million in 2017, increase to be US$ 865.7 in 2022. Hence, tuna is an important generator of wealth across all fleets, making it the most important seafood category for the country. The species of tuna caught in Indonesian waters mostly yellowfin (*Thunnus albacares*) and Skipjack (Katsuwonus pelamis).

Tuna fishing has grown significantly in the waters of the Indonesian archipelago so that in 2016, Indonesia was the top country globally for tuna landings. In the last 10 years, Indonesia has become involved in several regional fisheries management organizations.

The Government of Indonesia has shown its commitment to sustainable tuna fisheries by issuing a Tuna Fisheries Management Plan in 2015. One of the most important components of this plan is the collection of data to improve decision support systems for tuna fisheries management.

From a researcher's perspective, the policy-making and management environments may seem distant or daunting. The fisheries and resource management decision interface is extremely complex and multifaceted, and organizational structures and cultures have been identified as hurdles for implementing new information and approaches to management. Often, scientific evidence only occupies **a small part** of the "decision space" of managers or policy makers, and other factors including values, judgment, pragmatics, competing interests, and path dependency also influence decision-making

We do respect to cultural Divide. In the science-policy literature, issues related to the paradoxical relationship between science and politics as well as the influence of governance structures are additional challenges to using science in decision-making. These factors widen the gap between knowledge and action, which undermines the effective flow of information across knowledge and practice.

Sometimes, uptake of new knowledge into fisheries management can be influenced by government models, political regimes, the geographic region, the organizational culture on information management, and personal and institutional interests and values of different stakeholders. The decision-making process in fisheries management is also complex and must often consider multiple objectives, disciplines, perspectives, and constituencies and respect economic and political realities

Fisheries management is a complex process aimed at maintaining sustainable fish populations while balancing the economic, social, and environmental aspects of fishing. Here are some general considerations for effective fisheries management:

1. Scientific Data and Research on Resource consideration: Sound scientific knowledge is crucial for understanding fish stocks, their population dynamics, and the impacts of fishing activities. Robust data collection, monitoring, and research are essential to inform management decisions accurately.
2. Sustainable Harvest: Fisheries management should aim to maintain fish populations at levels that can support sustainable harvests. Setting appropriate catch limits, such as total allowable catches (TACs) or quotas, based on scientific advice and stock assessments, helps prevent overfishing and depletion of fish stocks.
3. Biodiversity & Ecological. Ecosystem-Based Approach: Fisheries management should consider the broader ecosystem dynamics and interactions. It's important to account for the relationships between target species, their predators, prey, and habitat, as well as the impacts of fishing gear on the ecosystem.
4. Stakeholder Engagement: Inclusive and participatory processes involving fishermen, fishing communities, scientists, NGOs, policymakers, and other relevant stakeholders lead to better decision-making. Engaging stakeholders in the management process helps promote transparency, legitimacy, and ownership of the measures implemented.
5. Institutional function on Compliance and Enforcement: Effective fisheries management requires strong monitoring, control, and surveillance systems to ensure compliance with regulations. Monitoring fishing activities, enforcing regulations, and addressing illegal, unreported, and unregulated (IUU) fishing practices are crucial for sustainable fisheries management.
6. Adaptive Management for fleet capacity: Recognizing the dynamic nature of fisheries, adaptive management approaches allow for flexibility and adjustments based on new information or changing circumstances. Regular review and evaluation of management measures enable iterative improvements over time.
7. Protection of Habitat and Biodiversity: Preserving critical habitats, such as coral reefs, seagrass beds, and spawning grounds, is vital for the long-term sustainability of fish populations. Implementing measures to minimize habitat degradation, protect vulnerable species, and reduce bycatch are essential components of fisheries management.
8. Integrated Fisheries Management: Recognizing that fisheries are just one aspect of broader marine resource management, it is important to integrate fisheries management with other sectors such as coastal zone management, marine spatial planning, and marine conservation initiatives.

9. Robust & Precautionary Principle: The precautionary approach involves taking preventive measures when scientific knowledge is uncertain or incomplete. It suggests that if there are concerns about the health or sustainability of fish populations, conservative management actions should be implemented to avoid irreversible damage.

By considering these factors, fisheries management can work towards sustainable fishing practices, protect marine ecosystems, and ensure the long-term viability of fish populations for both current and future generations.

The fisheries management process is an iterative and ongoing cycle, where feedback and lessons learned inform future management actions. It aims to balance the ecological, economic, and social aspects of fisheries to ensure the long-term sustainability of fish populations and the well-being of fishing communities.

Make sure we have fish in the sea so we do Stock Assessment: The process begins with the assessment of fish stocks to determine their status, abundance, and health. This involves data collection through surveys, sampling, and scientific research to estimate population size, age structure, reproductive potential, and other relevant factors.

During the HS process from 2014-2023, we do science matchmaking event series through Workshops! Thank you very much for MMAF and TC Members. Science is only one input into policy making process. Many other factor such as economic, budgetarybtradeoffs, and public opinion must and will factored into final policy decision; science is not policy – prescriptive; policy maters need to be inform scientifically; Respect each other Science and Policy-making process.

Example of Implementation of Tuna Management Plan: Information of TCT, Integrated data, reduce destructive fishing, no by catch, catch effort information, HS formulation, implementation of HCR, TAC and Catch Limit (Measurable fisheries)

Conclusion and Management Recommendation

There is a need to strengthen the science-policy interface in support Tuna Harvest Strategy implementation, so that policy reform can lead to increased integration of sustainable resource management with social and economic development. To sustain tuna fishing future, it is necessary to improve capacities of governments and stakeholders to develop and strengthen regulatory and policy frameworks for the success implementation of Tuna Harvest Strategy. Evidence has shown that results of scientific research may not always be in a format that is accessible or directly applicable to the needs of decision makers or resource managers due to timing, methods and uncertainty issues. Improved data and knowledge can support implementation of the SSF Guidelines for Tuna Fisheries Business in Indonesia.

I hope you all have a productive discussion and be benefiting to our Indonesian Tuna Fisheries.

Thank you

Assalamualaikum wahmatullahi wa barakatuh.

THEMATIC PRESENTATION

The Role and Position of the IAW Tuna Fisheries in RFMO (IOTC &WCFC)

Putu Suadela, MESM (Directorate of Fisheries Resources Management, MMAF)

First of all, I would like to say thank you having this great events. This is the first time we have this tuna talks. I think that a lot topics are going to discuss present today's. and the first time at the station is about the role and positions of the indonesian archipelagics waters tuna fisheries RFMO for an IOTC and the WCFC. So, this first thematic presentations for me is will be in regional level and what is the role and positions of our archipelagic waters is involves or needed.

Illegals bussiness is ofcourse from the indonesians Nations Convention on the Law of the Sea and also the Nations Fish Stocks Agreement. But where is arctic water is mention?

First and if you see on part 4 on the UNCLOS arctic water is on the mentions about uses of terms, the baselines, etc. and there's no mentions about how we utilize the fish resources. There is no fish resources involved in that part. For highly migrations species which is tuna and the next species it is mentions at the part 5 inclusive economic zones. That the coastal state and other states is national peace and regions, shall cooperate directly or through appropriate for the national decisions and so on. That if you do take a look on UNFSA the second paragraft in the exercise of severn rights for the purpose of exploring and exploiting the serving and managing spreading to stock and highly migrated. Stock within areas under national jurisdictions the courses that shell apply without this within this the general principle in route in article 5. So, there's a basis where we practically need to manage our archipetic waters which is compatible with the regulation operations in regional basis

If you take a look on the IOTC agreement and if you see on the area competance in this is a little bit in the be discussions which is the applications of that agreement it sis said because the area competence of IOTC is FAO statical area 51 and 57 it doesn't mean since it is exclude there at international waters is not exclude arctic waters so it states all of those areas for this IOTC. On that basis in the resolutions adopted IOTC it always said IOTC area competance with no any further conditions. IOTC already have conservation major measure and this is some for of what we already adapted, but there are many other things. So we have the catch lmit to rebuilding the govern fish stock, we just adopted the catch limit for big eye tuna. we have this management flow for drifting paths and also anchor paths. We have this harvest strategy also is we already have this medium procedures status for the bigeye tuna and the rest will be conducted. WCFC and the second conventions is has this explicit provisions in its conventions that article 8 is says that compatibility of conservations and many measures where we are the CMM (Conservation and management measures) established for the high seas and those adopted for areas under national jurisdiction shall be compatible so that is the key is compatibility.

This is our archic waters for the IOTC we know that we have this area here what I have this yellow little round circles laut sawu and mentawai that is included in the area IOTC 57 and we have this area WPP 713, 715 included statistical area of the WCFC. The Big eye is actually the production of our archivic waters WPP 713, 714, 715 it consists of 59% from the total and this only for tuna catch. So a lot of productions came from arctic waters and you can see the tuna compositions most of its is from handlines and purse seine. This data we submit it to the RFMO through our National Report or Annual Report to IOTC end of WCFC. We are report the annual catch estimates and we also report the operational data. So what's important for the stock assessment is those both exercise frequency also. Those data is going to be used to assess the stock assessment and the harvest strategy

The result from our data that is submit to RFMO. We have the status green, red and yellow based on the stock assessments.

In the arctic water we conducted 11 I line to improve our tuna data monitoring and reporting of course from logbook from sampling observer and also not just by the government but also already support by assosiations and we are willing to have full support from the academics university and also from the bussines compenies are very welcome. The highlight for our body waters fish menagement is the harvest strategy. The condition of tuna fisheries in the quarters because IOTC they already developing the harvest strategy and since there are a basis to have the compatibility of those provisions including strategy

This is compatibility base on what we have in the CCMM (compatibility of conservations and management measure) so they have Bigeye, skipjack, yellowfin but its not estabilished yet up until now because they have this timeline or work plas are connected right now but we already have this strategy in place that was initiated in 2024. Interim framework harvest strategy is launch 2018. However, to the focus is not easy. We need a time series data or operational data, CPUE index, we nees data from the size distribution dan size frecuency. So, the technical team can incorporate those data into operating models. So its not about one year data ot two year data but it should be time series with the standardize data, so this is what we are trying to have collaborate with others data providers not just the government, not just logbook, but also data from associations or something data from NGOs assosiation and we combine. When we realise that we need more data integrate into operating models

Hopelly we/you can give a little bit hence what we need from the arctic waters and to be incorporated and how we mannage the fisheries arctic water. Data is important that not just the statistic data but operational data and the size data is very important, oceanography information also important because this is not just for us but also its for the whole regional aspect in the whole management fisheries.

That is from me

Thank you very much

Wassalamualaikum.wr.wb

TUNA TALKS SESSION I – TUNA RESOURCES

1. Genetic Connectivity Between Fish Larva and Adult Fish Caught Inside and Outside of MPAs

Elle Wibisono[1], Victor Nikijuluw[2]

[1,2] *Konservasi Indonesia*

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In April- June 2022, Konservasi Indonesia and Universitas Pattimura conducted a joint research expedition using DNA metabarcoding and DNA barcoding to measure genetic connectivity between fish larvae and adult fish caught inside and outside of MPAs. We also used hydrodynamic modelling and particle backtracking to model the dispersal of larvae from MPAs to the surrounding areas. This study was conducted in WPPNRI 714 and 715 across eight species, comprised of 5 demersal species: *Cephalopholis sexmaculata, Variola albimarginata, Cephaopholis urodeta, Cephalopolis argus,* and *Lutjanus gibbus* and three pelagic species: *Decapterus macerellus, Selar crumenopthalus*, and *Elagatis bipinnulata*. In this study, we found that samples for all species inside and outside of MPAs are connected, even across WPPNRIs. Larva identification and modelling also illustrated that hydrodynamic systems in the Banda Sea disperses causes the larvae to circulate within the Banda Sea (Figure 1) and that larva produced in the Raja Ampat Region would be dispersed to areas around Buru Island (Figure 2).

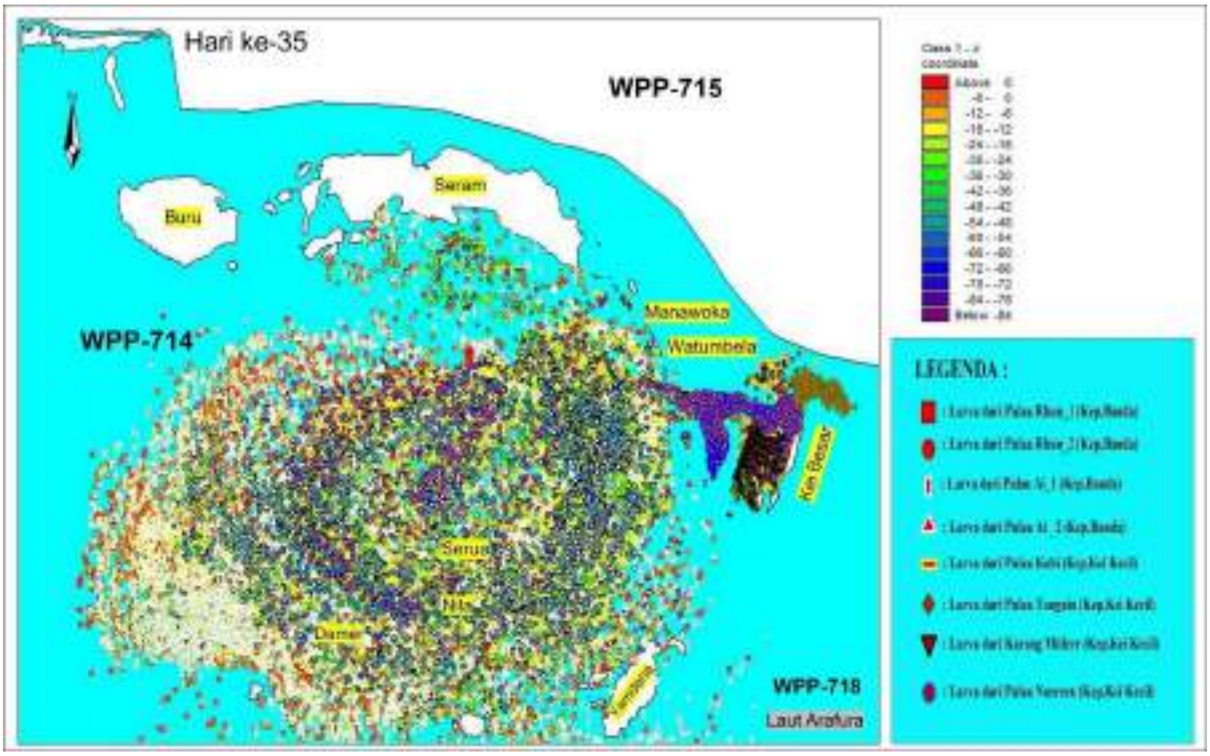

Figure 1. Modelling output of day-35 of larva dispersal from Banda Islands and Kei Kecil Islands in WPPNRI 714. Modelling was done using hydrodynamic modelling and particle tracking.

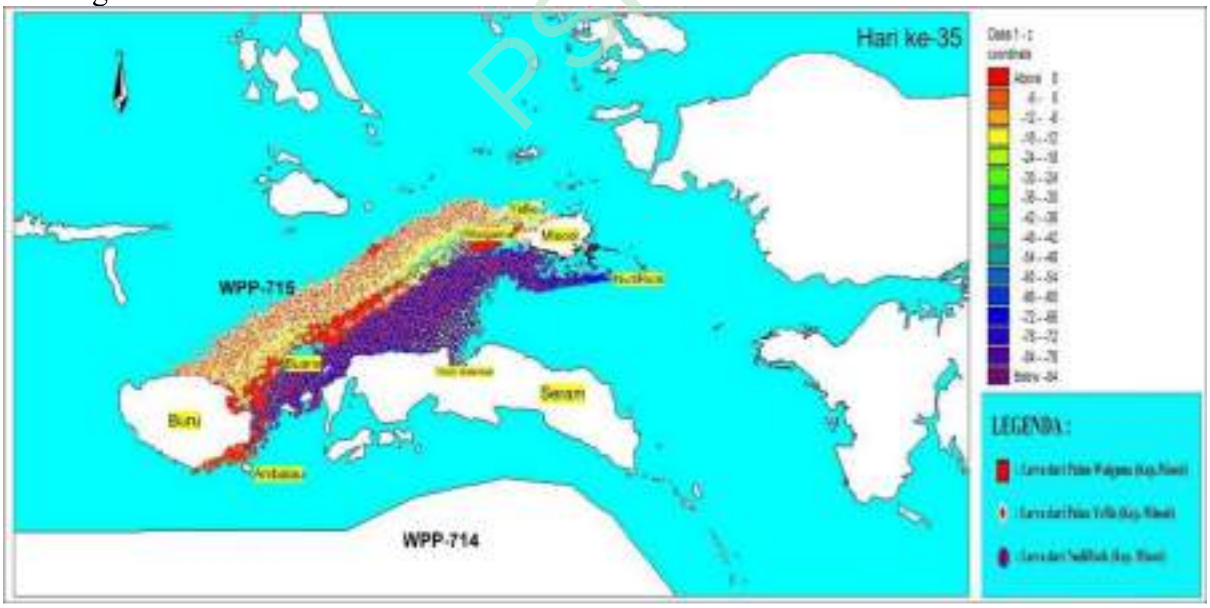

Figure 2. Modelling output for day 35 of larva dispersal from Raja Ampat (Misool Islands) in WPPNRI 715. Modelling was done using hydrodynamic modelling and particle tracking.

Relevance to tuna management in WPPNRI 714 and 715:

As a fishery management tool, MPAs can benefit fisheries by promoting adult fish spillover from reserves to fishing grounds or seeding larvae to surrounding fishing grounds with suitable habitats (Di Lorenzo, Claudet and Guidetti, 2016). While the benefits of area-based protection are more pronounced on demersal species or other species with smaller habitat ranges (Stobart et al., 2009; Sackett et al., 2017), studies show potential benefits for pelagic species. Blue water (areas from continental shelves to the high seas) MPAs could be a solution to manage tuna and tuna-like species (Hilborn et al., 2022). For example, the Galapagos Marine Reserves caused increased purse seine tuna catches outside of the reserves; fishers also fished the line indicating a strong spillover benefit from the reserves (Boerder et al., 2017). In 2022, studies indicated spillover of yellowfin and big-eye tuna from the Papahānaumokuākea Marine National Monument (Medoff, Lynham, and Raynor, 2022).

In Indonesia, since 2015, the Ministry of Marine Affairs and Fisheries has designated a portion of the Banda Sea for temporal closure to protect yellowfin tuna spawning grounds. However, for fishery benefits to be realized, MPAs need to be designed and located in strategic areas (e.g., have optimized spacing, location, size, and configuration) (Gaines et al., 2010). To improve and ensure benefits from this closure to Indonesian yellowfin tuna fisheries, we need more monitoring and analysis of this closure (Romdon et al., 2019; Satrioadjie, Suyadi, and Wouthuyzen, 2018).

While our research focused on non-tuna species, future collaborative research combining larva sampling, DNA metabarcoding, and particle tracking could improve the accuracy of future tuna larva research in the area. We would like to engage the tuna consortium to discuss potential future research collaboration (e.g., refine research questions, joint-fundraising efforts, etc.).

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2. A method to Involve Fishers in Voluntary Data Collection for Management of Tuna Fisheries in Indonesia

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The use of digital technology has enhanced the capture and transmission of information in fishery-dependent monitoring. This type of monitoring depends on fishers to gather data at sea and provide qualitative and/or quantitative information to scientists (Maynou and Sardà 2001; Hind 2015). This study contributes to provide a combination between a fishery-dependent monitoring that features high dependency of fisher's willingness and ability to share data on their practices and catch composition. We designed the Crew-Operated Data Recording System (CODRS) for snapper (Dimarchopoulou et al. 2021; Wibisono et al. 2022) and tropical tuna fisheries that was developed similar to Indonesia fishing-logbook system. Some adjustments were made from (Dimarchopoulou et al. 2021; Wibisono et al. 2022) in order to enhance tropical tuna monitoring, particularly for bulky fisheries (purse seine and pole-and-line), where the catch rates are too high to capture images of individual fish. We also requested fishers to take pictures of gears and bait to capture the diversity of gears in tuna small scale by fishing events, as well as pictures of their fishing association. These changes were necessary to improve accuracy and comprehensiveness of our monitoring efforts for tuna fisheries in the IAW.

The adapted CODRS comprised four parts data captures: 1) position and movement of the vessels; 2) catch volume, species and size composition of the catch and gear used; 3) operational data; and 4) situational data. We used a Spot Trace to record position and movement of fishing operation. We combined time stamp of images, locations and movement data from the tracker to estimate where each fish was caught. We provided participating fishers with a compact camera, spare SD cards (16Gb), and acrylic measuring boards (for handline, trolling line and longline fishers) or ten cm-wide marking sticks (for purse seine and pole-and-line). Fishers utilized the tools to provide pictures of each fish on the measuring boards with gears they use (handline and trolling line) or pictures of unsorted fish spread out on the deck or fish hold (purse seine and pole-and-line). Catch images from handline, trolling line, or longline gears were sufficient to estimate catch volume (Fig 1.). For purse seiners and pole-and-liners, however, only a sample of the catch was photographed (Fig 2.). As the raising factor of the pictures samples is unknown, we could not directly estimate catch volume for these gears. Therefore, we asked fishers to also include an image of the sales slip (Fig 3.). We asked fishers to take an image of the a FAD, birds, dolphins, etc. that they were associating in fishing operation (Fig 4.). These images provide additional clues on fishing conditions. For longliners, we asked fishers to provide image their setting activity. Together with the tracking data, the time stamp of these images provides information on the setting position, including position of the FADs.

Technicians in the field were tasked with responsibility of recruiting and training fishers in the application of CODRS, maintaining relation with participating fishers, and analyzing the images handed over by the fishers. We applied rating on CODRS data as follows: 1) *Lacking*, if images appeared to cover less than 30% of the catch reported on the sales slip. We rejected landings with lacking status; 2) *Incomplete*, if images appeared to comprise between 30% and 90% of the catch reported on the sales slip; 3) *Complete*, if images appeared to comprise more than 90% of the catch reported on the sales slip. For purse seiners and pole-and-liners, it was not possible to cross reference data from the images with information from the sales slips, so we rated all landings from these gears as *No Status*.

Figure 1. "Conventional" CODRS image with a measuring board in the background, used for tuna handliners.

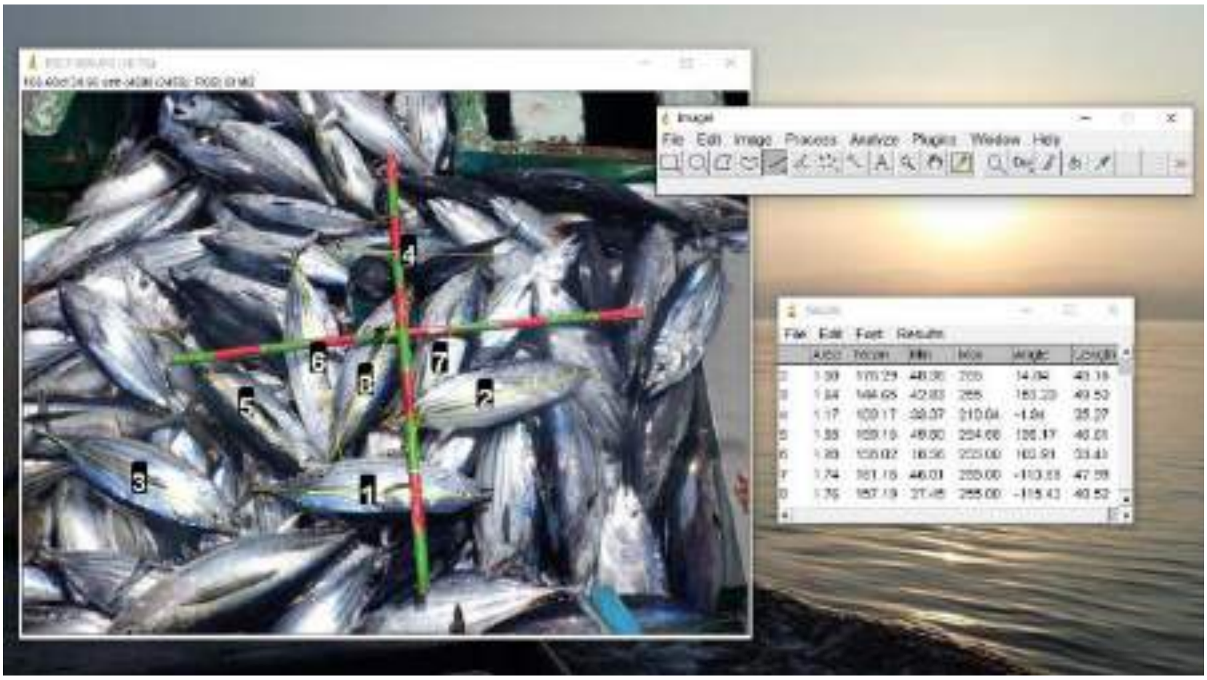

Figure 2. CODRS length measurements on fish from a pole-and-line catch. Technicians use the software program ImageJ to measure length of fish on screen, using the green-and-red sticks for size reference.

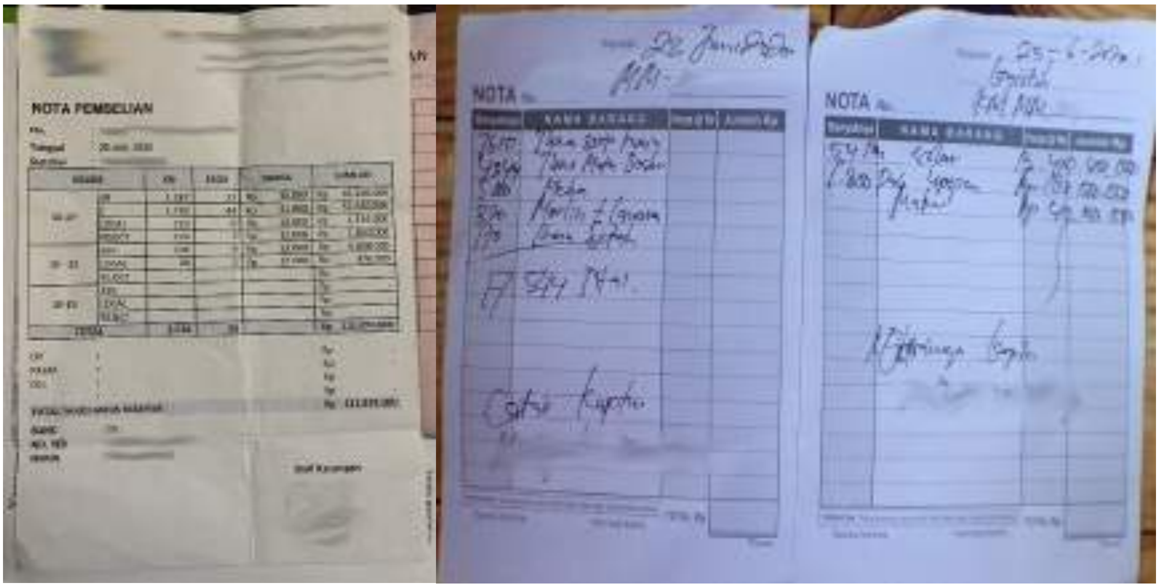

Figure 3. Examples of sales slips (left and center) and a receipt for purchase of fuel and bait (right), as submitted by fishers participating in the CODRS program.

Figure 4. Examples of images of an aFAD (left), dolphins (center), and sea birds (right), taken by fishers participating in the CODRS program.

We compensated the fishers through a payment-for-services contract on a monthly-basis, depends on the vessels size. The amount are IDR 1,500,000 (US$107), IDR 2,500,000 (US$ 178) and IDR 3,500,000 (US$ 250) for small vessels <30 GT, between 30 GT and 60 GT, and >60GT respectively. Crews were only paid if they submitted images, and generally the vessels were inactive for about three months per year.

In 2020, we deployed CODRS on 110 vessels, with the note that some of the vessels participated for only part of the year (Table 1). The program resulted in a total of 310,130 images in the year 2020 (Table 2). Using CODRS, we assessed 3,244 landings (Table 3). Of the 2,926 landings for which we could rate quality by reconciling the data from the images with the sales slip: 76% were "Complete" (i.e., over 90% of the catch imaged), and 3% were "Lacking" (i.e., less than 30% of the catch imaged). Disengagement was mostly due to technical reasons, for example to reduce over-representation of CODRS in some of the fleet segments, or because the vessels left the fishery. Disengagement due to low performance of the crew was rare: we discontinued collaboration with 10 vessels over the period 2018-2020 (4% per year). Low performance was due to difficulties to integrate the CODRS process in the work flow, loss of the crew member responsible for implementation of CODRS, or loss of enthusiasm for the activity.

Table 1. Deployment of CODRS (number of vessels) representing each of the 15 fleet segments of the IAW tuna fisheries. "NA" = Not Available, meaning that the fleet segment does not exist, "0" means that the fleet segment does exist, but the program failed to deploy CODRS.

Vessel size	Pole-and-line	Purse Seine	Handline	Trolling Line	Longline	Total
< 5 GT	NA	NA	38	15	NA	53
5 - 10 GT	NA	0	7	5	NA	12
10 - 30 GT	3	8	14	6	2	33
> 30 GT	6	4	0	0	2	12
Total	9	12	59	26	4	110

Table 2. Number of images resulting from deployment of CODRS representing each of the 15 fleet segments of the IAW tuna fisheries.

Vessel size	Pole-and-line	Purse Seine	Handline	Trolling Line	Longline	Total
< 5 GT	NA	NA	40736	39505	NA	80,241
5 - 10 GT	NA	0	38464	24975	NA	62,439
10 - 30 GT	1883	51062	19857	31132	989	104,923
> 30 GT	52384	8409	0	NA	734	61,527
Total	54267	59471	99057	95612	1723	310,130

Table 3. Number of landings in 2020 assessed with CODRS, by vessel size category and data quality rating.

Vessel size	Complete	Incomplete	Lacking	No Status	Total
< 5 GT	2020	507	58	3	2588
5 - 10 GT	95	44	35	0	174
10 - 30 GT	90	51	6	190	337
> 30 GT	10	10	0	125	145
Total	2215	612	99	318	3244

For handline and trolling line, CODRS provided a complete description of catch, gear, and situation, even if fishers changed gear, or if they changed from fishing around aFADs to fishing on free-swimming tuna. For pole-and-line and purse seine, however, it was not always possible to determine whether they fished around aFADs or not, since the protocol did not require fishers to take images of all of the catch.

We provide comparison between CODRS and three main conventional data collection methods in Indonesia (logbooks, observer, and port-sampling). A comparison between methods is challenging, because there is always a trade-off between accuracy, detail, coverage, and cost. Ultimately, it depends on the research question or the purpose of the data collection program whether a method is suitable or not. Hence, we assessed each of the methods qualitatively in respect to 12 attributes (Tabel 4).

Table 4. Attributes of the main data collection methods used in Indonesia for management of marine capture fisheries.

	Logbooks	**Observers**	**Port Sampling**	**CODRS**
1. Verifiability of data	*Low*	*High*	*Medium*	*High*
2. Data quality – species	*Low*	*Medium*	*Medium*	*High*
3. Data quality – spatial	*Medium*	*High*	*Low*	*High*
4. Data quality – length composition	*Low*	*High*	*High*	*High*
5. Data quality – catch volume	*Medium*	*High*	*Medium*	*Medium-High*
6. Compliance monitoring	*Low*	*Medium*	*Medium*	*Low-Medium*
7. Suitability for small vessels	*Medium*	*Low*	*Medium*	*High*
8. Dependency on fishers	*High*	*Medium*	*Low*	*High*
9. Need for training of fishers	*Medium*	*Low*	*Low*	*Medium*
10. Need for support personnel	*Medium*	*Medium*	*Medium*	*High*
11. Logistical challenges	*Low*	*High*	*Medium*	*Medium*
12. Cost per trip monitored	*Low*	*High*	*Medium*	*Medium*

Similar with logbooks, CODRS is a self-reporting mechanism, and therefore we articulated the differences and similarities for these two methods. We focus the comparison on small-scale fisheries, highlight a number of challenges (human capacity, physical assets, resource issues, and social issues) in respect to implementation of a logbook program for monitoring of catch and fishing effort in Indonesia's small-scale fisheries. The CODRS system addresses most, though not all, of these (Table 6).

Table 6. Challenges for implementation of a logbook program in small-scale fisheries, and the way CODRS addresses these challenges

Challenges identified by (Sari et al., 2021)	**CODRS**
Some fishers are illiterate	CODRS is fully image-based, so it does not require the fisher to do any reading or writing
Fishers require training to fill in certain fields of the logbook form	CODRS does require some training, but the skills needed are practical, not administrative.
Fishers too tired or too busy to fill in the logbook	CODRS also requires some work, just like logbooks, but fishers can integrate this work in their workflow (for example, taking pictures as fish are moved to the hull).
Fishers do not have a GPS receiver, and it is difficult to fill in coordinates	Deployment of a low-cost tracking device (Spot Trace) is integral to the CODRS approach, so fishers do not need to read or record positions. Just like for a logbook, fishers retain full ownership over data recording, and fishers can decide to switch off the tracking device. This is a feature,

Challenges identified by (Sari et al., 2021)	CODRS
	not a bug.
Most SSF are multi-species, and fishers lack identification skills	CODRS is based on images, and fishers do not need to identify fish. Technicians can use the images to compare notes or to call in the help of taxonomists.
Infrastructure to receive and process logbook forms is often lacking	Just like logbooks, CODRS requires infrastructure to pick up and process the images. Whereas it may be possible to upload the images, the high data volume often makes uploading impractical.
Fishers are concerned about privacy, especially in relation to location of fishing grounds and catch volume	Just like in logbooks, fishers retain full ownership of the data recording process, and therefore the CODRS system is similar to logbooks in this respect.
Fishers may have concerns about sharing data if the fisher works for a fishing company or trader	See above

In addition to the challenges listed in (Sari et al. 2021), it is important to add that pen-and-paper logbook data have low verifiability when it comes to species identification. By contrast, the images generated by CODRS system provide higher level of verifiability, not only through the images themselves, but also through the time stamp and other meta-data that are contained in the image file. However, the CODRS system cannot verify whether all fish were photographed, so in this respect performance of CODRS and logbooks is similar

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3. Population Parameters Analysis of Skipjack Tuna (*Katsuwonus pelamis*) Landed on Kendari Oceanic Fishing Port

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Skipjack tuna demand has a positive meaning for fisheries development especially from an economic perspective, mainly for an archipelagic country like Indonesia which has a high potential of capture fisheries such as in FMAs 714. However, these resource faces by the exploitation pressure of fish resources which is also intensively increased. If it is not managed wisely, this situation will promote decline and user conflict in fish resources utilization. Fisheries management requires data and information from research on stock status, especially population parameters and exploitation levels.

Fish stock analysis is based on an understanding of fish populations. According to Welcomme (2001), the information are important because it can be useful input for decisions making in fisheries management. The purpose of this study was to analyze several population parameters including size structure, length-weight relationships, and growth rate of skipjack tuna in the study area.

Data collection was carried out for 12 months from October 2020 to September 2021. Data were collected including the length and weight of skipjack tuna caught at FMAs 714 by purse seine and pole and line gears. Data were tabulated and then analyzed quantitatively by means of length frequency distribution, length-weight relationships, and growth parameters equations.

Length frequency distribution

The number of skipjack tuna samples during the study amounted to 1259 individuals. Fork length of the fish samples ranges from 150-770 mm, whereas weight ranges from 40-10,820 g. Length frequency distribution consisted of 11 classes with an interval of 57 for each class. The smallest size was 150 mm with body weight of 40 g, while the largest was 770 mm with the body weight of 10,820 g. Based on class interval, skipjack tuna catch was dominated by 378 – 434 mm length size range, whereas the least was 150 – 206 mm size range (Figure 1).

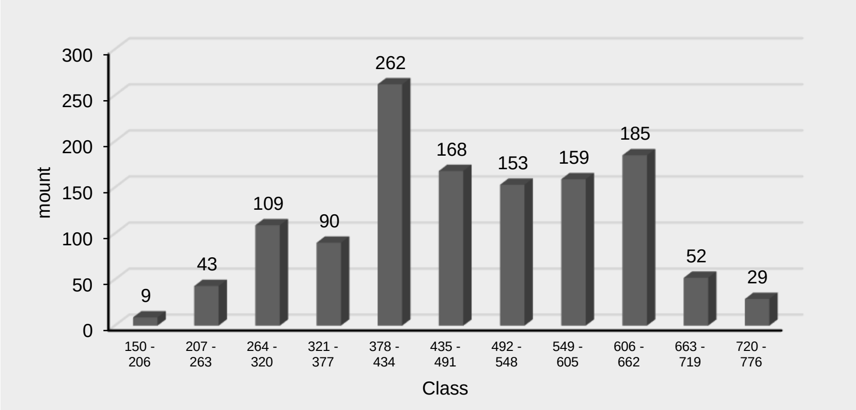

Figure 1. Length frequency distribution of the skipjack tuna

According to several studies, the length at first maturity (L_m) of skipjack tuna is 44.7 cmFL (Hartaty and Arnenda, 2019); 42 cmFL (Stequert and Ramcharrum, 1996); and 43.5 cmFL (Grande *et al*., 2014). In addition, Sumadhiharga and Hukom (1989) found that L_m of skipjack tuna in the Banda Sea was 420 mm (males) and 418 mm (females). These result shows that approximately 63.07% of skipjack tuna catches were above 42 cm and 36.93% were below 42 cmFL. This indicated that most of skipjack tuna caught in FMAs 714 waters are above their L_m.

Length-Weight Relationship

Based on length-weight relationship analysis, the equation value that obtained was $W = 0.000002L^{3.3998}$, where *a* is 0.000002, *b* is 3.3998, and R^2 is 98.33%. t-test analysis shows that t value was in the critical area, where t count was smaller than -t table (-37.6301 < -1.9619), that is indicated that skipjack tuna showed a positive allometric growth. The length-weight relationship of skipjack tuna is shown in Figure 2.

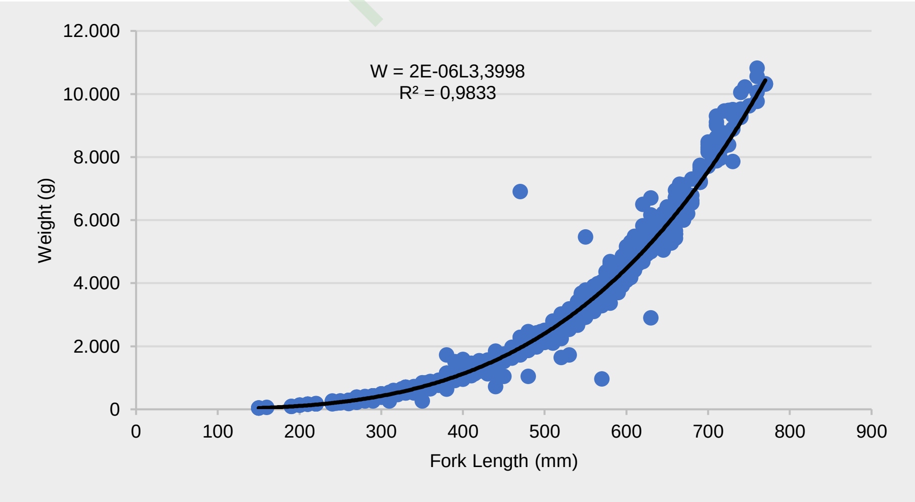

Figure 2. Length and weight relationships of the skipjack tuna

Length and weight relationship shows that skipjack tuna caught in the FMAs 714 waters has a relatively faster weight growth compared to its length. However, length and weight relationship has a temporal fluctuation (Table 2). The results, also showed that temporal value of *b* is relatively the same (above 3). This also shows that skipjack tuna caught in FMAs 714 waters has a faster weight growth compared to its length or the growth patterns of skipjack tuna were all positive allometric.

Table 1. Temporal length-weight relationships of skipjack tuna

No.	Month	Relationships	R^2
1	October 2020	$W = 0{,}000001L^{3{,}4488}$	$R^2 = 0{,}9718$
2	November 2020	$W = 0{,}0000004L^{3{,}6252}$	$R^2 = 0{,}9727$
3	Desember 2020	$W = 0{,}000001L^{3{,}4509}$	$R^2 = 0{,}9317$
4	January 2021	$W = 0{,}000002L^{3{,}3974}$	$R^2 = 0{,}9675$
5	February 2021	$W = 0{,}000002L^{3{,}4037}$	$R^2 = 0{,}9867$
6	March 2021	$W = 0{,}000002L^{3{,}3544}$	$R^2 = 0{,}8306$
7	April 2021	$W = 0{,}000003L^{3{,}3168}$	$R^2 = 0{,}9600$
8	May 2021	$W = 0{,}000003L^{3{,}2725}$	$R^2 = 0{,}9773$
9	June 2021	$W = 0{,}000003L^{3{,}3099}$	$R^2 = 0{,}9919$
10	July 2021	$W = 0{,}000006L^{3{,}1584}$	$R^2 = 0{,}9967$
11	August 2021	$W = 0{,}0000002L^{3{,}7747}$	$R^2 = 0{,}9710$
12	September 2021	$W = 0{,}000003L^{3{,}3032}$	$R^2 = 0{,}9780$

Growth Parameters

The results of the growth parameters estimation of skipjack tuna in FMAs 714 waters are shown in Table 2. Skipjack tuna will reach its asymptotic length when it is 838.80 mm in length. At that size, skipjack tuna will not grow in length anymore. Energy from metabolism is no longer used for growth, but for reproduction and repair of damaged cells. The asymptotic length occurs with a growth coefficient of 0.68 year-1.

Table 2. Growth parameters of skipjack tuna

$L\infty$ (mm)	K (year^{-1})	t_0	Growth Equation
838,80	0,68	-0,095	$L_t = 838{,}80\ (1–e^{-0{,}68(t+0{,}095)})$

Based on growth parameters, skipjack tuna growth in the waters of FMAs 714 is presented in Figure 3.

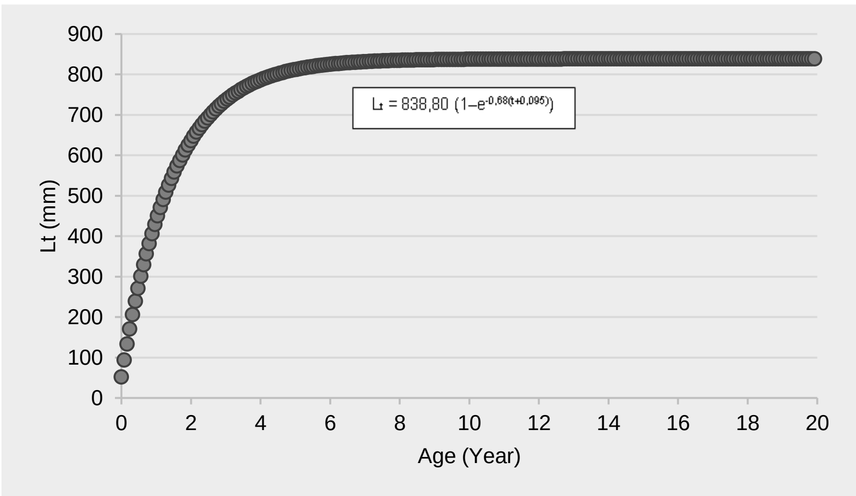

Figure 3. Skipjack Tuna Growth

The growth coefficient (K) of skipjack tuna (0.68/year) is a parameter that describes how quickly skipjack tuna reaches its maximum length. Saputra (2009) assumes that the growth curvature parameter (K) is related to the age of the fish and K shows how long it takes to reach L∞, and longevity is related to mortality. Fish with high K values usually have high mortality (M), while species with low K values usually have low mortality. If there are high mortality, fish with slow growth (K) will quickly become extinct. Furthermore, according to Djamali and Harahap (2005), fish with a high growth rate coefficient (K) grow quickly and usually reach their maximum length in a short time, while fish with a low growth rate coefficient need a long time to grow and reach their maximum length. The parameter values for skipjack tuna growth at several locations are shown in Table 3 below.

Table 3. Growth Parameters of Skipjack Tuna at Several Locations

Resources	Location	L∞ (mm)	(K) per Year	t_0
Gaertner *et al.* (2008)	Eastern Atlantic	893,8	0,40	-0,1705
Mayangsoka (2010)	Western Indian Osean (Western of Sumatera)	591,2	0,40	-1,0749
Fadhilah (2010)	Palabuhanratu and adjacent	662,0	0,20	-0,6909
Jamal (2011)	Bone Bay Area	759,8	0,19	-0,3600
Koya *et al.* (2012)	Indian Osean	920,0	0,50	-0,0012
Satria (2015)	Indian Osean	992,6	0,30	-0,2195
This research (2021)	FMAS 714 waters	838,8	0,68	-0,0950

Conclusion

Fork length ranged from 150 to 770 mm formed 11 classes dominated by 378 – 434 mm of 262 ind. It also reveal that 63.07% skipjack caught at size above 42 cm and 36.93% under 45 cm with length at first maturity 42 cmFL. Length-weight relationship analysis indicated that skipjack tuna growth categorized as positive allometric. The growth parameters analysis showed that infinitive length (L∞) is 838.80 mm, growth rate (K) is 0.68 per year, and t0 is -0.095.

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4. The Biological Characteristics of Yellowfin Tuna (*Thunnus albacares*) in The Indian Ocean the South of Nusa Tenggara (WPP 573), Indonesia

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The Yellowfin tuna (*Thunnus albacares*) is a fish that migrates long distances. This tuna migration route covers almost all waters in the world, especially in the Indian and Pacific oceans. Until now, yellowfin tuna (YFT) has been hunted relentlessly. Thus, its stock is vulnerable to collapse. YFT is the second main fishing target in the world after skipjack (*Katsuwonis pelamis*) (Vincent et al., 2020). The Indian Ocean Tuna Commission (IOTC) has determined that the Indian Ocean has experienced overfishing (IOTC, 2022). Hence all countries that are members of the IOTC carry out management in a more massive and coordinated manner to sustain the life of this species in the future.

As one of the countries involved in the IOTC, Indonesia contributes 16% to the world's production of tuna, skipjack, and mackerel (TCT) and 20% to the national fishery (FAO & SOFIA, 2018). One of the provinces in Indonesia, the Province of West Nusa Tenggara (NTB), located in the Indonesian fisheries management area (WPP 573), has quite a significant contribution to the production of TCT, especially YFT. The Indian Ocean in the south of West Nusa Tenggara is a tuna fishing ground for fishermen both from NTB and from other provinces such as Bali and East Nusa Tenggara. Based on the statistics data of West Nusa Tenggara Province Capture Fisheries, YFT production in West Nusa Tenggara from 2011 to 2016 fluctuated and tended to increase from 3,534.6 tons to 4,330.2 tons. Afterward, in 2021, West Nusa Tenggara Provincial Marine and Fisheries Service published that YFT's production in the Province of NTB reached 7,062.04 tons. It shows that YFT's production in NTB Province has increased. Following up on this, the Ministry of Marine Affairs and Fisheries and the local government carry out supervision and management together by encouraging researchers to conduct research related to species to become one of the government's references that will be used in making policies at the local, national, and regional scope. It also can even become recommendations internationally.

In the southern waters of Nusa Tenggara, researches on YFT fisheries have not been carried out consistently and continuously. Therefore the basic profile of the policy cannot be highly accurate yet to be determined at this location. The essential data that must be obtained are the biological characteristics of YFT in order to be able to explain the population structure of the school of YFT in the southern waters of NTB. Knowing changes in population structure will make it easier to understand the issues of population decrease due to habitat destruction, predation, or fishing pressure (Kaymaram et al., 2014). The illustration of these biological characteristics is then used to determine the strategy to be formulated. Research has been conducted for WPP 573 in the Indian Ocean comprehensively, but this has never been done specifically for the southern waters of West Nusa Tenggara. Ghofar (2021) researched population dynamics in the 2013 to 2017 observation year covered all of WPP 573 but partial research per area is also essential because the profile of tuna fisheries is not even, so the strategy formulated will vary between regions to be more on target. Therefore, research on the biological characteristics of YFT in the southern waters of West Nusa Tenggara needs to be done. The biological characteristics referred to include: a) the relationship between the length and weight of YFT; b) the YFT size distribution; c) the YFT growth parameters; d) the length of first captured of YFT; and e) the mortality and exploitation rates of YFT.

Data collection in this study was carried out for five years, from January 2017 to December 2021. at the Labuhan Lombok Fishing Port, East Lombok Regency, West Nusa Tenggara, Indonesia. Figure 1 shows the YFT landing site at the Labuhan Lombok Fishing Port and fishing ground area of YFT.

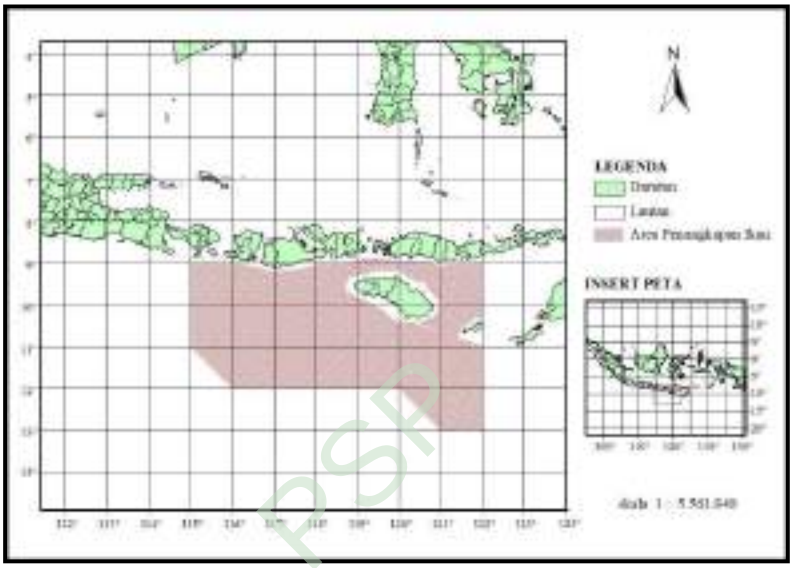

Figure 1. Fishing ground area of YFT landed at Labuhan Lombok Fishing Port

In this research, stratified sampling was carried out on the size of the tuna fishing vessels; those are vessels < 3 GT and vessels sized 3 – 30 GT. Systematic sampling was carried out on the size of YFT landed, YFT < 10 kg. Efforts were made daily to collect at least 20% of the total fish landing activity sampled in this research (WCPFC, 2003; WCPFC, 2008). The number of samples is considered a representative sample of all fishing vessel landings and the number that is feasible to be recorded. Sampling on fishing vessels sized 3 – 30 GT with large catch volumes will be implemented with a subsampling system. For YFT sized ≥ 10 kg, a separate measurement will be carried out, where all fish landed on the sampled vessel will be measured for length and weight. Whereas for YFT sized < 10 kg, systematic sampling will be carried out on the baskets that are landed.

The analysis of the relationship between the length and the weight of YFT was conducted using the equation $W = aL^b$. The length at first caught (L_c) is calculated through the value of the frequency distribution of fish lengths. The value of this distribution is then analyzed by using the Spearman-Karber standard logistic equation approach, where the length class with the highest forking length value is the length at first capture (L_c). The parameters of fish growth analyzed in this study consisted of the growth coefficient (K), maximum body length (L_∞), theoretical age of fish at 0 cm (t_0), and maximum age of fish (t_{max}). The estimation to determine the value of K and L_∞ uses ELEFAN I analysis contained in FISAT II software. The total mortality rate (Z) was estimated using a length-converted catch curve (Sparre & Venema, 1998; Gayanilo & Pauly, 2001). Meanwhile, the natural mortality rate (M) is estimated using the empirical equation of Pauly (1983).

YFT landed in Labuhan Lombok Fishing Port was caught by fishermen using a hand line. The size of hooks used by these fishermen to catch YFT sized ≥ 10 kg is numbers 3 and 4. Meanwhile, YFT sized < 10 kg were caught by the fishermen using hooks size numbers 9 and 10. In performing the fishing activities, tuna fishermen at the Labuhan Lombok Fishing Port use fishing vessels sized 8-12 meters. Tthe YFT fishing area utilized by fishermen at the Lombok Labuhan Fishing Port is at 9º - 13º South Latitude and 115º - 122º East Longitude (Figure 1). The fishing area has a depth of 1,000 meters. However, YFT is generally caught by fishermen in the fishing area in the range of depth of 1-60 meters.

During the year of this study, the value of R^2 was close to one, which was equal to 0.99, which means that YFT's weight increased as its length increased (Nugraha et al., 2020). The analysis of the relationship between length and weight produced a value of b<3 indicating that YFT is in a negative allometric, which is commonly found in YFT lives in the Indian Ocean (Hartaty & Sulistyaningsih 2014; Triharyuni & Iskandar 2018; Perera & Weerasiri, 2020; Yosua *et al*., 2018). Two size groups of catchs were assumed to have come from old and new recruitment have been obtained with significantly different numbers. More than 80% of the shoal of YFT at the study sites is dominated by small sizes (Figure 2). The high fishing of small tuna will trigger growth and recruitment overfishing, where small fish do not have enough time to reach maturity or if they do reach maturity their numbers will be less (Ben-Hasan *et al*., 2021). Assessing the profile per year of observation, there was a tendency for the proportion increase of large YFTs in 2020 and 2021. This was allegedly due to a decrease in effort related to the Covid-19 pandemic which also indirectly affected fish production and consumption in NTB (Partelow, 2023). Therefore, the tuna had time to reach larger sizes. However, the increase in the number of large YFTs has not been profoundly noticeable.

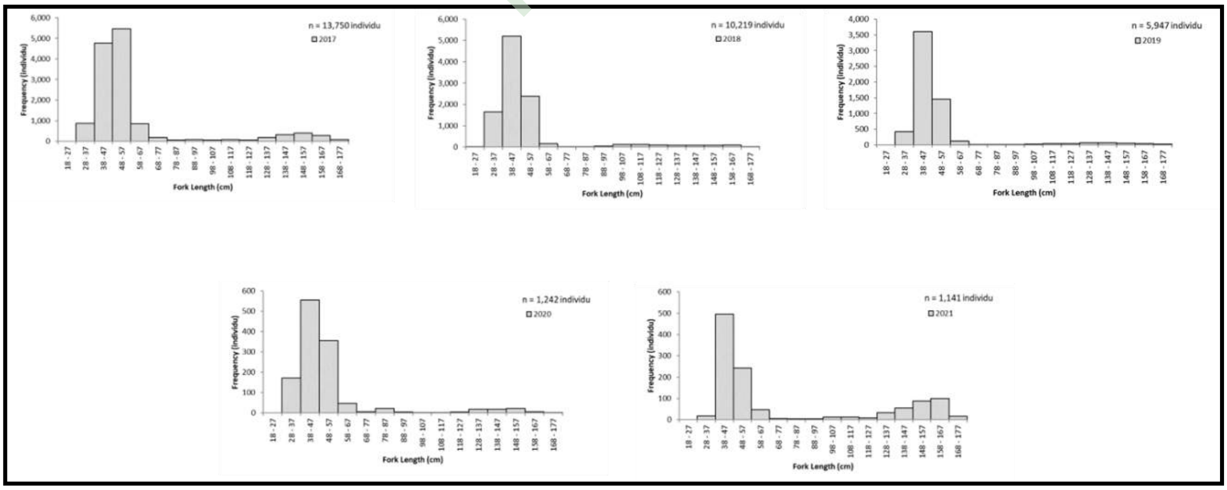

Figure 2. Fork length-frequency distribution of YFT in the south of Nusa Tenggara waters, Indian Ocean 2017 – 2021

Based on the data analysis, it is found that the growth rate (k) of YFT caught in the southern waters of Nusa Tenggara is very low at 0.28 $year^{-1}$. The slow growth is indicated by a K value of less than 1 (Gulland, 1983). This growth value is in line with research from Amaliani et al. (2021) in 2020, where the K value at WPP 573 was 0.2 $year^{-1}$ with L_∞171.5 cm. Hartaty

& Sulistyaningsih (2014) noted that the value of K in WPP 573 once reached 0.59 year^{-1} with L_∞ 185.85 cm in 2011. Ghofar (2021) stated that during the 2013-2017 study at WPP 573 the K value was 0.51 year^{-1} with L_∞ 194.25 cm. This explains that there has been a decrease in the value of k and L_∞ in the last five years in the southern waters of Nusa Tenggara (WPP 573). The K value is influenced by several factors, including the availability of food sources, fish internal factors, and aquatic environmental conditions (Nurdin et al., 2016). The lower the value of K, the longer it takes to reach L_∞ (Sparre & Venema, 1998). In reaching L_∞ 176.4 cm, YFT in this study takes up to 10.35 years.

Based on the data, it can be seen that the catch is dominated by YFT with sizes below the proper size to be caught, so this reflects the L_c value obtained, namely 65.7 cm. It is known that the value of L_m of YFT in the Indian Ocean is in the range of 100-110 cm (Lehodey & Leroy, 1999; FAO, 2010). Different Lm values can be caused by stressors from the environment and internal fish species themselves (Arula, 2017). This indicates that there is a tendency for fishermen in the research location and its surroundings to use fishing gear that is not selective for YFT.

There are four sizes of hooks used by YFT fishermen in the southern waters of Nusa Tenggara, namely hooks number 3 and 4 for large YFT and 9 and 10 for small YFT. Likewise in the research of Maspeke et al. (2019), at research locations in the Celebes Sea, Halmahera Sea, and around Tomini Bay using fishing line number 2-3 produced YFT with very small sizes, namely in the size range of 35-40 cm at most. Therefore, choosing a larger hook size is expected to improve the selectivity performance of the fishing gear used. Fishing exploitation should be selective to the size of the fish, it’s intended to avoid the occurrence of recruitment overfishing and growth overfishing (Saranga et al., 2018).

Based on the current research data, it is known that fishing is carried out on the day and the night at a depth of 1-60 m. This area is included in the depth range of the small-sized YFT swarm. Barata *et al*. (2011) argued that 88% of YFTs size >100 cm are caught in a depth range of 100-200 m, while 77% of YFTs <100 cm are caught in a depth range of 0-100 m. However, Soepriyono (2009) explained that large tuna at night will be on the surface. Thus, both of these pieces of information need to be considered in order to be able to accurately target YFT above their proper size. The depth is one of the main factors in the size distribution of tuna because it is related to the temperature preferences required in each tuna age group. The thermocline or deep water zone is favored by YFT (Collette & Naeun, 1983).

YFT's natural mortality in the Indian Ocean the south of Nusa Tenggara is higher than mortality due to fishing. This shows that there is low fishing pressure on YFT in the Indian Ocean the south of Nusa Tenggara. The results of the analysis on mortality are in line with the results of the analysis on the level of exploitation in this study, where the E value is below (0.28), which means that the utilization of YFT in the Indian Ocean the south of Nusa Tenggara in the year range 2017 - 2021 is not optimal with the E value being 0.28. The results of this study are in line with several similar studies in Palabuhanratu port, East Cost of India, and the Eastern & Central Pacific Ocean (Nurdin et al., 2016; Rohit et al., 2012; Zhu et al., 2011). However, similar research in the Oman Sea and the Banda Sea shows that the utilization of YFT has indications of being over-exploited (Kaymaram *et al*., 2014; Damora & Baihaqi, 2013). The difference in the value of E in each seawater is determined by the effort in carrying out fishing activities, where the greater the effort, the greater the level of exploitation, causing a decrease in fish biomass in the waters (Tickler et al., 2018; Costello et al., 2016; Watson et al., 2013).

The data on the status of tuna fishing issued by the IOTC (2022) shows that YFT in the Indian Ocean has been over-exploited since 2018-2021. This is different from the results of this study. The difference in the results of this study is because this research was conducted in a small part of the Indian Ocean which only sampled 2-5 companies that act in tuna fishing, so there are data which not fully recorded for YFT status conditions in the Indian Ocean the south of Nusa Tenggara. Effort and production in this study decreased along with the reduced number of fishing companies in the sample. Therefore, there is a need for thorough research to be able to produce a more comprehensive utilization status of YFT's fishing activities in the Indian Ocean the south of Nusa Tenggara.

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5. Fishing Ground and The Composition of Large Pelagic Fish Catching Using Tuna Handlines in The FAD Area of FMA 713 and 714

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Tuna (*Thunnus sp*) itself is a fish species that has high protein, high demand and widely consumed by various groups of world communities, including people in Indonesia. The fish is one of the flagship export commodities from Indonesia (Widodo et al., 2020). With the potential possessed by this tuna, and it is not surprising that various efforts to catch by fishers are increasing in order to pursue the economic level and also the necessities of life. South Sulawesi itself in 2022 until early 2023 is the largest producer of tuna in Indonesia, where the increase index is above 30%. As the description that in 2022 the achievements of tuna, skipjack and tuna (TCT) nationally were 359,132 tons, where the achievement of South Sulawesi TCT production was 79,534.3 tons (DKP. Prov Sulsel, 2023).

One of the main types of fishing gear used to catch tuna is a hand line (HL), generally the increase in the production of tuna fish catches is inseparable from the Fish aggregating device (FAD) aids. FAD itself is one of the fishing aids, and several studies related to FADs revealed that the FAD is very epective and efficiently used to collect fish species including tuna in a waters, so it is easy to find and easy to catch (Rumpa et al., 2022a). This is inseparable from the FAD function as a shelter from predatory fish (Sinopoli et al., 2015), reference points of navigation (Capello et al., 2012) and supporting food source for carnivore fish (Lopez et al., 2017).

Some issues of problems in fishers emerge after the FADE developed rapidly both in number and its distribution, among others, because FADs are also a "ecological trap" that causes many small tuna fish (juvenile) caught, there is competition in the location of the fishing ground between fishermen purse seine and handlines. On one side economically, due to the number of small tuna fish caught and experienced a decrease in larger tuna fish catches and the presence of competition that caused a shift in fishing ground to be a serious problem at this time. Even, Ministry of Maritime Affairs and Fisheries Indonesian, reporting several YFT stock (*Yellowfin Tuna*) at Fisheries Management Areas (FMAs) 713 has been exploited excessively, while in the Banda Sea in FMAs 714, the tuna population has crossed the optimal limit so that management and caution are needed. So that in this study it is more focused on understanding the performance and fishing ground handline tuna, the dynamics of the catch in the FAD area and the sustainable solutions of tuna fisheries in the FAD area.

The data used is the result of observations using nine ships based in PPI Lonrae-Bone Regency. Data collection of 185 trips for 3 years in a row (2020-2022), where the handline fishermen fishing around WPP 713 and 714 (Figure 1). This data collection procedure refers to the "Sampling Protocol for Artisanal Indonesia Tuna Fishing" developed by USAID IMACS project, and Fishing and Living Program. Fishing ground data using a vessel tracking device handline installed on boat, tuna sample size based on recommendations by Simonds & Robinson (2016) namely juvenile size (20 - 99 cm), adults (≥100 cm) and skipjack fish based on the length at first gonad maturity is about 40 cm. Composition and number of catches are expressed in percent, length frequency distribution is presented in the form of the next graph compared to the length at first maturity (Lm).

Based on the results of the handline tracking device vessel installed on the ship to monitor the location of the fishing ground for three years, as presented in Figure 2.

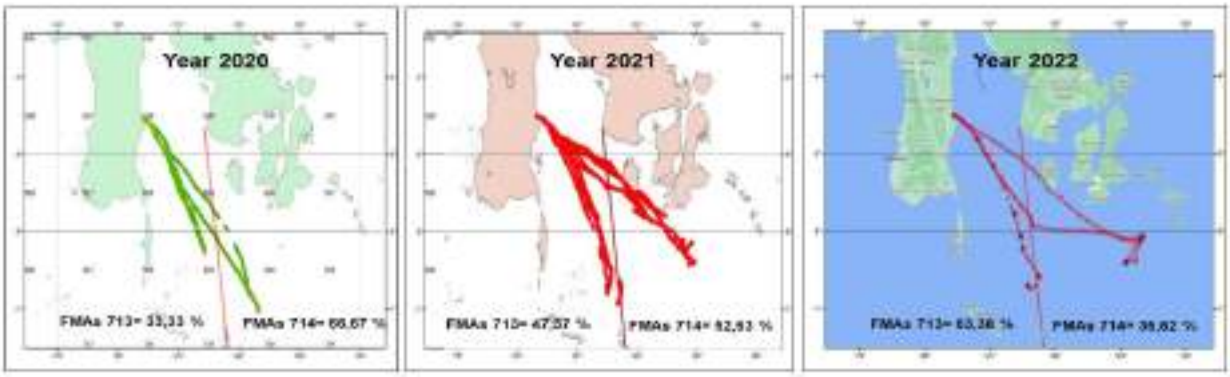

Figure 1. Tuna handline fishing in Fisheries Management Areas (FMAs) 713 and 714

One approach taken by fishers to overcome the decrease in catches is to expand the fishing ground. Vessel Tracking Device Handline results, namely there is a tendency for the last 3 years that there is awareness of fishers starting to reduce or shift the capture area from FMAs 714 where in 2020 the percentage of 66.67%, in 2021 decreased to 52.63% and in 2022 only 36.62%. This is the possibility of awareness or understanding related to (Ministry of Marine and Fisheries Regulation Number 4/PERMEN KP/2015) concerning Prohibition of Fishing in FMAs 714.

Indonesia itself, especially the productivity of capture fisheries, benefit from the FAD, but in terms of environmentally friendly criteria, tuna handline fisheries have not met the environmentally friendly criteria because there are still many small tuna fish caught that can cause over fishing. Even the latest statement (Widodo et al., 2023) revealed that the size of fish species catching is one of the best indicators whether fishermen use FADs, where most of the SKJ (~ 76%) and all YFT -bet caught in FADs are teenagers.

The capture of tuna and skipjack is small and unfit for catching in the FAD area is true, where our findings for 3 years in a row (2020-2022), especially in FMAs 713 and 714. Based on the composition of the main catch itself, in general is dominated by spesies of Yellowfin Tuna (YFT), then Bigeye Tuna (BET) and followed by species Skipjack Tuna (SKJ). While the measurement of the percentage of dominant fish sizes is worthy of capture and unfit for catching fish and side fish species can be seen in Figure 2,3,4 and 5.

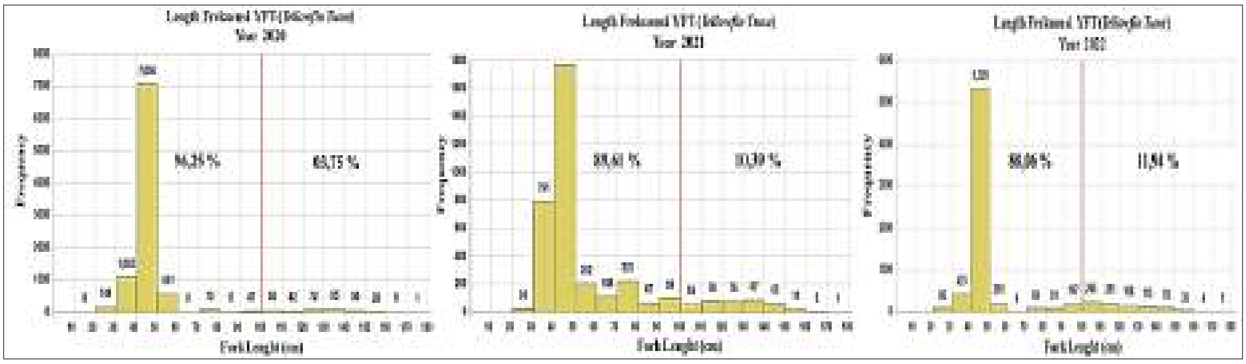

Figure 2. Percentage of Yellowfin Tuna sizes worthy of capture and unfit to catch

Figure 2 shows that a total of 20,313 fish samples were measured, the results of the analysis show that the size of the madidihang tuna was only around 7.89% higher than Lm, and dominated by fish juvenile of 92.11%, the most caught size was in class 41- 50 cm length.

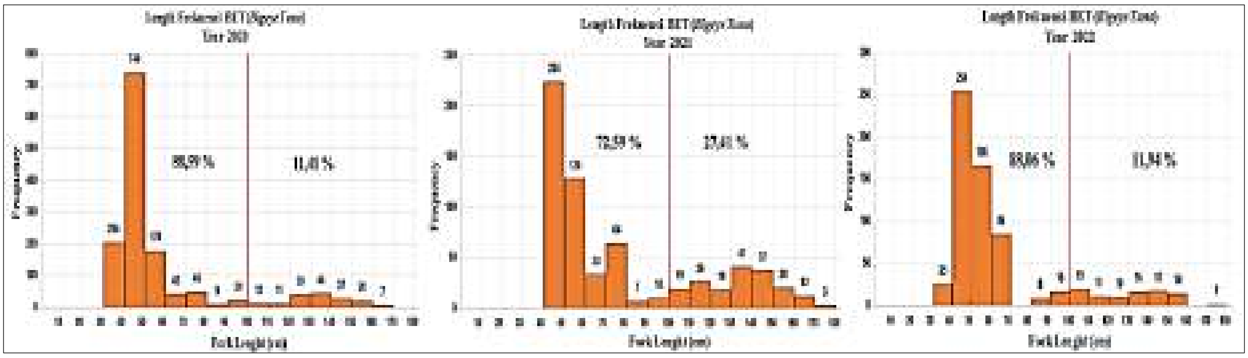

Figure 3. Percentage of Bigeye Tuna sizes worthy of capture and unfit to catch

Figure 3, overall with a total sample of a large eye tuna that was measured as many as 2,685 tails, showing that fish that are worthy of catching only around 15.79% and not worthy of catching 84.21%, where the size is most caught in class 41- 50 cm.

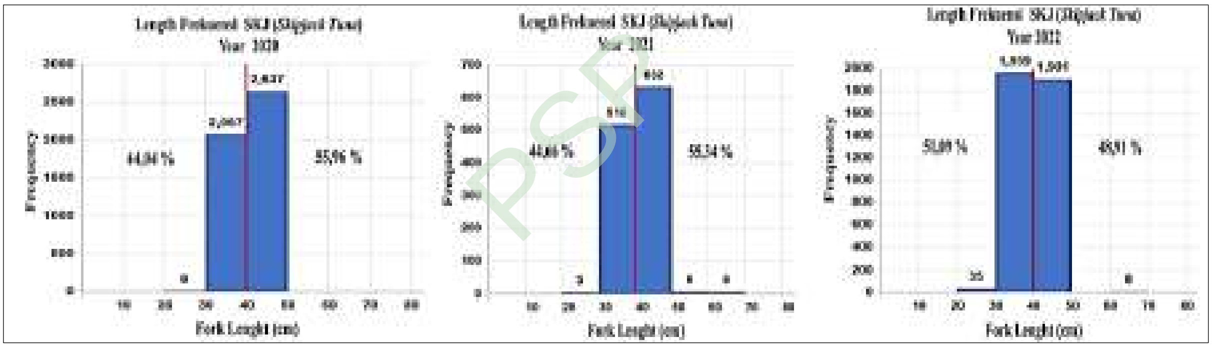

Figure 4. Percentage of Skipjack Tuna sizes worthy of capture and unfit to catch

From Figure 4, overall with a total sample of skipjack fish measured as many as 9,777 tails, the results of the analysis also show that fish that are worthy of catching are only ± 56.07% and are not feasible to catch 46.93%, where the size is most caught in class 31 -50 cm.

In addition to dominant fish caught, many other large pelagic fish species were caught, fishermen call it a side fish (Figure 5)

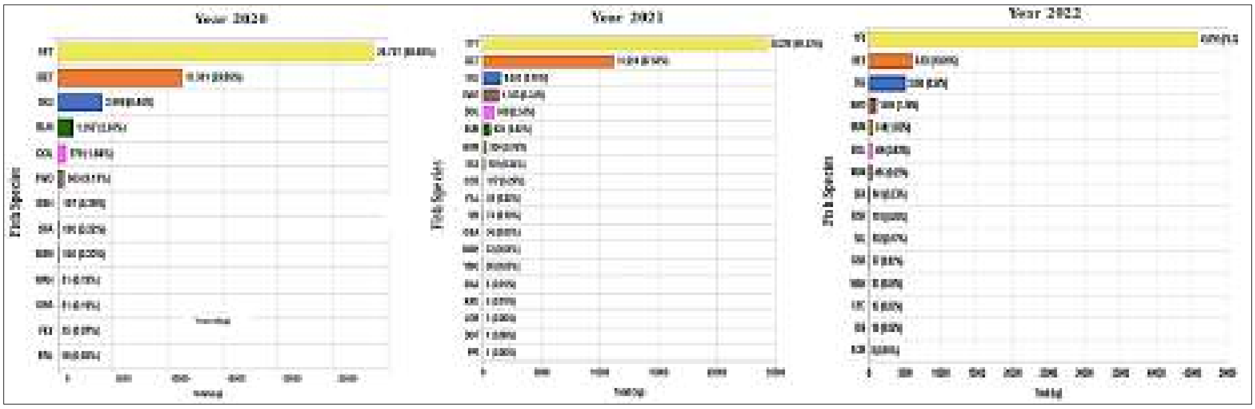

Figure 5. Composition and Percentage of Tuna Hand line catches in FAD

Based on the entire percentage of the composition of the catch with the handline in the FAD area in FMAs 713 and 714 for three years (N: 185), in (Figure 5). Generally dominated by Yellowfin Tuna (*Thunnus albacares*), Bigeye Tuna (*Thunnus obesus*) of 19.14%, Skipjack Tuna (*Katsuwonus Pelamis*) 1.13% and Discard 7.48%.

Whereas based on specifically the composition of the side catchment fish species of Sword Fish (SWO), Black Marlin (BLM) and species Dolphinfish (DOL) are often caught with handline fishing gear (Figure 6)

Figure 6. Percentage of 5 dominant side catchment types caught with handlines in the FAD area

This finding has further clarified a decrease in decent fish, especially tuna and skipjack, where previously the findings of Jalil et al. (2020) that in 2018-2019, the Tuna Madidihang group was caught in the waters of the Bone Bay on FMAs 713 recorded still around 63.2% of unfit to catch sizes followed by 36.9% of fish that were worthy of capture. Likewise, the average length of the average length where our findings are for 3 years (2020-2022) the average size of the tuna species is smaller around 20-170 cm while previous research in the waters of the bone bone (Katun et al., 2016), size The average length of the tuna 40-160 cm, (Jalil et al., 2020) ranges from 20 - 192 cm and the findings of (Haruna et al., 2018) in the Banda Sea in terms of the average length of tuna fish ranges from 20-192 cm.

If the tuna and skipjack species are not yet mature that the gonads are caught in the FAD area, it is estimated that in the next few years it will cause ecological losses but also economic losses because the catch of fish caught is smaller than the conditions that can be achieved optimally. One way to prevent growth overfishing is that in addition to the management of FAD settings as the Mandy of (Ministry of Marine and Fisheries Regulation Number 18/PERMEN-KP/2021), (Ministry of Marine and Fisheries Regulation Number 7/KEPMEN-KP/2022), Technical arrangements for managing targets of catching results for SDI sustainability, especially TCT species as mandated by (Ministry of Marine and Fisheries Regulation Number

121/PERMEN-KP/2021) and (Ministry of Marine and Fisheries Regulation Number 4/PERMEN-KP/2015). In addition there is a need for socialization efforts to handline fishermen related to the technical capture strategy that is ideal for its relationship to the depth of the reduction of fishing gear, the type of bait used and the time of arrest to get a worthy size.

As is known that the tuna handline used in the waters of Bone Bone for tuna has a main rope length of ± 50 m, This is the possibility that causes many immature sizes to be caught in the FAD area. Because of study (Lan et al., 2012) that the juvenile madidihang tuna has a swimming area of 0-50 [m] while the adult is at a depth of 50 - 200 m. For this reason, in the capture strategy, the ditline with handlines needs to adjust the design of fishing gear that adjusts the length of the fishing rope to the swimming area of tuna and it is recommended that the bait decreases should be done at a depth of ≥ 52.5 m with the type of squid bait.

The value of the capture rate was obtained from the recording of the enumerator to the average catch on the handline ship of each ship's trip in a month (January-December). Figure 7

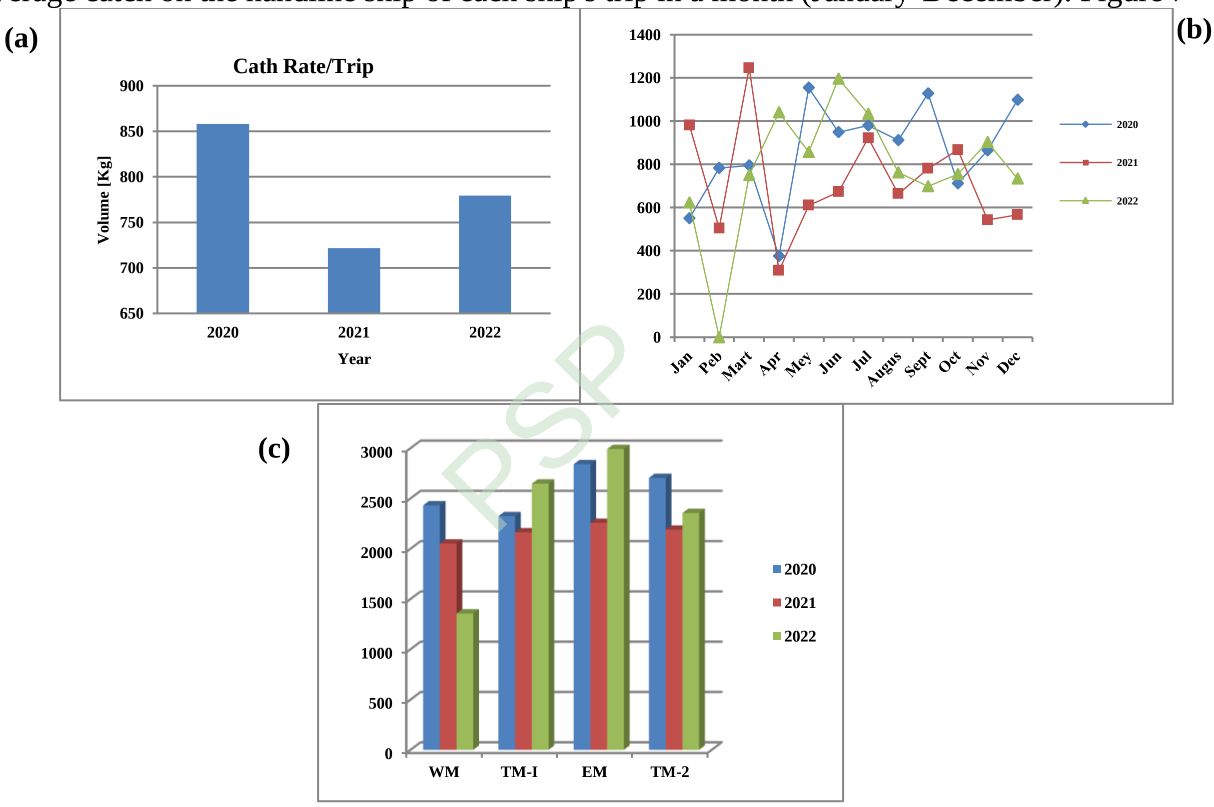

Figure 7. The average value of the capture rate of each ship is based (a). Trip, (b). Moon and (c). Monsoon

From (Figure 7a), shows that in 2020 the average capture rate of the ship/trip was 858.2 kg, then decreased in 2021 which was 721.7 kg and experienced a slight increase in 2022 of 779.2 kg/ship/trip. Overall, the average catching rate in three years is 786.4 kg/trip/ship, with a 7-15 day capture trip length. Based on the average monthly capture rate (Figure 7b) shows every month there is fluctuations in catches, but economically have not been said to be ideal and profitable.

In the optimal handline capture strategy in the FAD area, in addition to the depth of the drop of fishing gear, the type of bait used and the time of arresting is also an important fisherman to understand the potential fishing ground based on the movement of large pelagic fish.

Supervision of regulations related to the placement of FAD aids is also important to continue to be encouraged as an effort to apply legal fisheries and fish resources sustainability.

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TUNA TALKS SESSION II – SOCIAL ECONOMY

6. Fish Resource Account: An Instrument to Support Measurable Fishing Policy in Indonesia (Case Study on Little Eastern Tuna "Tongkol" in Indonesia)

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In Indonesia, the policy orientation for capture fisheries management is based on output control, reflected in the measurable fishing policy. According to Government Regulation of the Republic of Indonesia No. 11 of 2023 (PP No. 11/2023), measured fish capture refers to controlled and proportional fishing conducted in calculated fishing zones based on fish capture quotas to preserve fish resources and their environment as well as to ensure equitable national economic growth. Implementing this policy will be challenging, especially given the current situation, which shows the need for more monitoring of the state or condition of fish resources that have been used (Hilborn et al., 2020; Pilling et al., 2009; Anderson et al., 2015). Also, there needs to be a measurement tool that shows the state and use of fisheries resources in a way that is easier to understand. The goal is for these instruments to be used as guides for monitoring and monitoring fish resources.

Tuna, one of Indonesia's most important fisheries products, needs more accurate information about its use. It could be used better than it is or even more than what is viable. Modern gear for fishing is used by both small-scale and large-scale fishers in Indonesia to catch tuna. In light of these things and problems, fisheries management needs to build fish resource accounting as a control tool. This fish resource accounting is meant to be easy and quick to understand, show the status and use of these resources, and help support laws limiting how many fish are caught. Several studies have shown that strong fish resource accounting systems, like stock assessments and catch monitoring, are essential for developing and implementing effective output control policies (Smith et al., 2010; Sanchirico et al., 2012; Essington et al., 2014).

This study will provide a tool for implementing measured fish capture policies based on the accounting sheet concept. Little Eastern Tuna, also known as "tongkol," was chosen as the species to be evaluated in this case study. The development of fish resource accounting includes physical and economic accounting, according to the System of Environmental and Economic Accounting (SEEA) principles. SEEA is a valuable framework that describes the relationship between the economy and the environment, as well as the changes that occur within it, such as population growth, depletion of natural resources, and unreported fishing. The first step in physical accounting is determining the initial stock. As is well-known, there are various methods for determining fish stocks in the ocean (biological approaches, acoustic methods, sampling, and production surplus). However, based on available statistical data, this study calculates the stock using a surplus production method. It is determined by comparing which of the six surplus production models (Schaefer, Fox, Walter & Hilborn, Gulland, Schnute, and Clarke Yoshimoto Pooley) best fits the data. In order to convert physical accounting to economic accounting, the resource rent aspect must be incorporated (Moro, 2005). The most challenging aspect of the accounting calculation is the creation of economic accounting. The economic accounting is based on the unit rent value of the resources, which is derived from a survey of the Little Eastern Tuna's cost and revenue data.

The study results show that the Clarke Yoshimoto Pooley (CYP) model is the best way to determine how much sustainable production there is. The result is evident when significance values, sign fit, and the higher coefficient of determination are compared. The physical accounting calculation for Little Eastern Tuna fish resources shows that the opening stock in 1992 was 0.49 million tonnes, and the ending in 2015 was 0.08 million tonnes. Figure 1 shows that between 1992 and 2015, the average amount of stock decreased by -3%, or 1.42 million tonnes. The main reason for the change (a decrease) in stock was that actual production was higher than the stock's natural growth in the water (Figure 2). The future of the Little Eastern Tuna in Indonesia is at risk because of this loss trend. In Indonesia, the economic value of the Little Eastern Tuna fish supplies at the beginning of 1992 was 1.05 trillion rupiahs (IDR), and at the end of 2015, it was 1.98 trillion rupiahs (IDR). From the beginning stock to the end stock, the value went up by IDR. 930 billion. Changes affect the economic value of the real account, the consumer price index, and the value of tuna resource rent. Table 1 shows how many Little Eastern Tuna fish there are in Indonesia and how much they are worth.

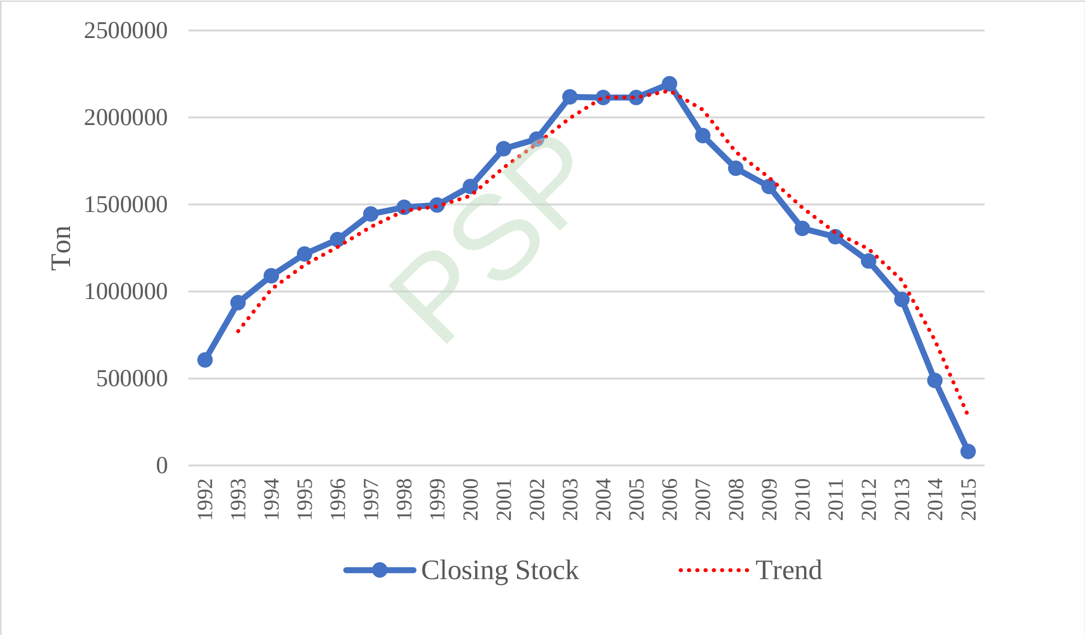

Figure 1. Physical Account: Final Stock Dynamics of the Little Eastern Tuna Resource in Indonesia (1992-2015)

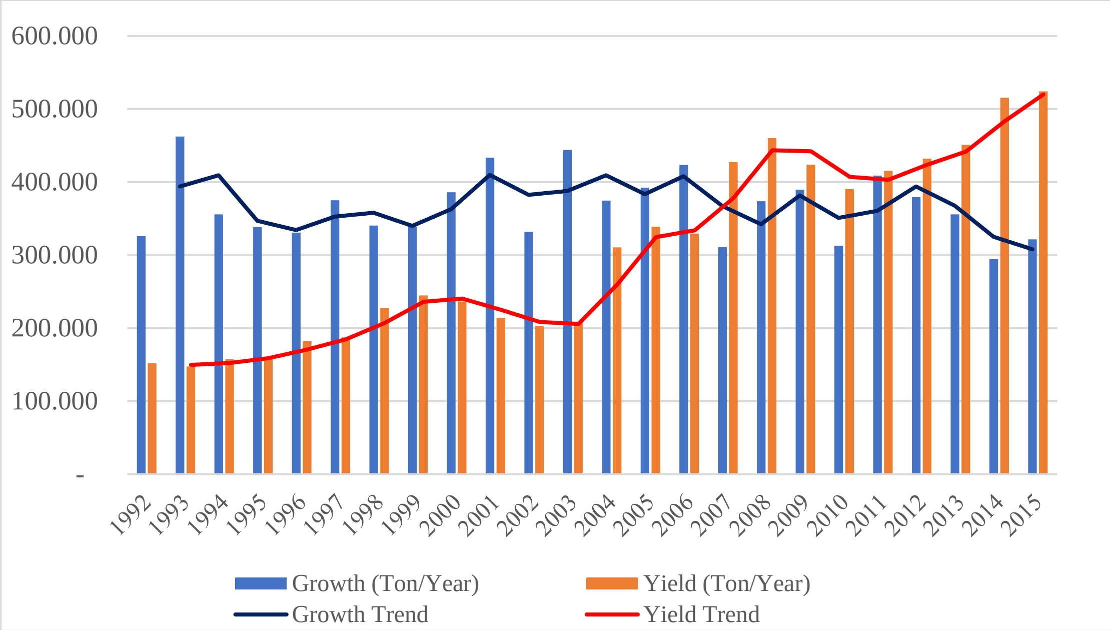

Figure 2. Growth vs Yield of Little Eastern Tuna in Indonesia (1992-2015).

Table 1. Physical and Economic Accounting of Little Eastern Tuna in Indonesia

PHYSICAL ACCOUNT (Million Ton)	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
OPENING STOCK	***0.49***	***0.61***	***0.94***	***1.09***	***1.21***	***1.30***	***1.44***	***1.48***	***1.50***	***1.60***	***1.82***	***1.88***
Growth	0.33	0.46	0.36	0.34	0.33	0.38	0.34	0.34	0.39	0.43	0.33	0.44
Actual Yield (Hact)	0.15	0.15	0.16	0.16	0.18	0.19	0.23	0.24	0.24	0.21	0.20	0.21
IUU Fishing	(0.02)	0.05	(0.00)	(0.01)	(0.02)	0.01	(0.02)	(0.02)	0.02	0.05	(0.02)	0.06
Depletion (Hact - Hsus)	0.04	0.04	0.04	0.04	0.05	0.05	0.06	0.06	0.06	0.05	0.05	0.05
CLOSING STOCK	***0.61***	***0.94***	***1.09***	***1.21***	***1.30***	***1.44***	***1.48***	***1.50***	***1.60***	***1.82***	***1.88***	***2.12***
Cont……	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
OPENING STOCK	***2.12***	***2.11***	***2.11***	***2.19***	***1.90***	***1.71***	***1.60***	***1.36***	***1.31***	***1.17***	***0.95***	***0.49***
Growth	0.37	0.39	0.42	0.31	0.37	0.39	0.31	0.41	0.38	0.36	0.29	0.32
Actual Yield (Hact)	0.31	0.34	0.33	0.43	0.46	0.42	0.39	0.42	0.43	0.45	0.52	0.52
IUU Fishing	0.01	0.03	0.07	(0.07)	0.01	0.04	(0.07)	0.06	0.02	(0.01)	(0.11)	(0.07)
Depletion (Hact - Hsus)	0.08	0.08	0.08	0.11	0.12	0.11	0.10	0.10	0.11	0.11	0.13	0.13
CLOSING STOCK	***2.11***	***2.11***	***2.19***	***1.90***	***1.71***	***1.60***	***1.36***	***1.31***	***1.17***	***0.95***	***0.49***	***0.08***

ECONOMIC ACCOUNT (IDR. Trillion)	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
OPENING STOCK	***1.05***	***1.56***	***2.73***	***3.91***	***4.71***	***5.36***	***9.42***	***11.65***	***12.19***	***14.57***	***18.50***	***20.33***
Growth	0.70	1.19	1.04	1.21	1.28	1.55	2.22	2.66	3.15	3.94	3.37	4.81
Actual Yield (Hact)	0.32	0.38	0.46	0.57	0.71	0.77	1.48	1.92	1.93	1.95	2.06	2.26
IUU Fishing	(0.04)	0.13	(0.01)	(0.05)	(0.08)	0.03	(0.12)	(0.16)	0.14	0.46	(0.22)	0.63
Depletion (Hact - Hsus)	0.08	0.09	0.12	0.14	0.18	0.19	0.37	0.48	0.48	0.49	0.52	0.57
CLOSING STOCK	***1.30***	***2.41***	***3.18***	***4.36***	***5.03***	***5.97***	***9.68***	***11.75***	***13.07***	***16.54***	***19.07***	***22.94***
Cont…..	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
OPENING STOCK	***24.38***	***26.88***	***30.41***	***33.56***	***31.85***	***30.08***	***29.67***	***26.56***	***26.73***	***25.55***	***21.95***	***11.96***
Growth	4.31	4.99	6.09	4.76	6.28	6.86	5.79	7.97	7.72	7.74	6.78	7.87
Actual Yield (Hact)	3.57	4.30	4.74	6.54	7.73	7.46	7.23	8.10	8.79	9.81	11.87	12.84
IUU Fishing	0.12	0.40	0.96	(1.13)	0.23	0.62	(1.21)	1.22	0.43	(0.29)	(2.64)	(1.80)
Depletion (Hact - Hsus)	0.89	1.08	1.18	1.63	1.93	1.87	1.81	2.03	2.20	2.45	2.97	3.21

CLOSING STOCK	***24.34***	***26.89***	***31.53***	***29.01***	***28.70***	***28.22***	***25.21***	***25.63***	***23.88***	***20.74***	***11.25***	***1.98***

Source: Data Processing, 2023

The results of this study show that Indonesia's use of Little Eastern Tuna is getting close to a critical point where it has gone beyond the best level. Based on this study, policy suggestions to support the adoption of measured fish capture policies include limiting the number of fish that can be caught and setting up limited zones. Fleets with high-productivity fishing gear can be limited by quotas, which lets them shift their focus to other big pelagic goods that can still be caught with the same gear. Small-scale fishermen (traditional fishers) with limited fishing grounds can be given more quotas to use the resource for a long time. Accounting for fish resources helps tell fishery managers about the state and use of resources. In order to make the physical account calculation more correct, it will be necessary for future studies to take into account the possible losses caused by illegal, unreported, and unregulated (IUU) fishing. It is necessary because illegal, unreported, and unregulated (IUU) fishing significantly affects Indonesia's national losses. In the future, possible increases in tuna resource rent should be corrected more accurately.

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7. Gender Equity in Tuna Fisheries Indonesia

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The demand for environmentally sound seafood increases in parallel with the growing demand for socially responsible seafood. The recognition of human rights in certified seafood would harness the effort to combat human right violation including abuses and gender discrimination.

Technical perspective dominates how we look at fishery business, which has led to a situation where contributions of female in fisheries are not equally valued or even recognized. It resulted in females being largely excluded from fisheries decision-making processes. The tuna industry is typically perceived as a male's domain, indeed many females are actively involved in the industry with different degrees of engagement throughout the tuna value chain. Not to mention the contribution of male and female in their household livelihoods and local economies is substantial. Being overlooked of female's unique roles and contribution in fishery governance can result in a lack of recognition of female's needs and interests in policies and programs, affecting sustainable development outcomes.

Governing a fishery is about managing people, of all gender. Both male and female are involved in fishing industry, though in different roles and activities (Williams 2008). Male and female have varied roles in tuna fishery in Indonesia (Fitriana 2019). This paper employed gender analysis and gender dimension framework to better understand the roles and relationships. Gender Analysis is a systematic attempt to identify key issues contributing to gender inequalities so that they can be properly addressed. Gender analysis was conducted along all stages in the value chain (Kaplinsky and Morris, 2001). Gender analysis is a powerful tool to understand the actors, the relationship among actors within the society, who owns access, risk and benefit sharing, and identify areas that need improvement. Accordingly, six domains of gender dimension framework help examining every facet of gender issue in tuna fishery (USAID, 2018): Access, Beliefs and Perception, Practices, Time and Space, Rights and Power. In order to achieve this objective, this paper used previous research by the author on the Gender analysis and Gender mainstreaming of BSC and Tuna Fisheries in FIP as part of Global Marine Commodity, UNDP-GEF funded project (Fitriana, 2019). The research was predominantly qualitative, using individual and group interviews, extracting from documents reviews and workshops.

Gender segregated roles in tuna fishery

Gender is a concept that deals with roles and relationships between female and male that are determined by social, political and economic contexts – not by biology. Several roles were performed by male and female in domestic, productive and public sphere (Razavi and Miller, 1997). These varied roles lead to varied interests and needs. These variations depend on ideas, customs, cultures and practices within society. The roles are segregated, indeed, they are complemented each other.

Following gender segregated roles by actors along the tuna value chain. The actors (Fitriana, 2019) covered the key actors who participate directly; actors who participate indirectly as well as actors in the supporting system who do not engage along the value chain either direct or indirect but affect how the market works (Figure 1). However, number of actors by gender-disaggregated data is difficult to find and patchy. The key actors start from input providers, fishers at production, traders, processing and whole sellers. At the input stage, female involved in providing logistic for small scale fishery (AP2HI, 2019), while for larger scale fishing, crews who were male normally prepared for logistics (AP2HI 2019). Male dominates at the production stage (UNSRAT, 2018; AP2HI, 2019; Duggan, 2017), although few cases of females do fishing occurred. Percentage of male act as fishers are 92.65% with females accounting for 7.35% of total fishers (UNSRAT 2018). Several females owned fishing vessels in Bitung (UNSRAT, 2018). At the post production stage, females play a significant role in processing goods and trade. What is more at industrial level, females are an important labour force. At the wholesalers or trading stage, around 45.51% of total actors are male and female made up 53.49% of total actors. Activities related to fish transportation, receiving and storage are dominated by male (AP2HI, 2019). These roles are segregated but they are complemented.

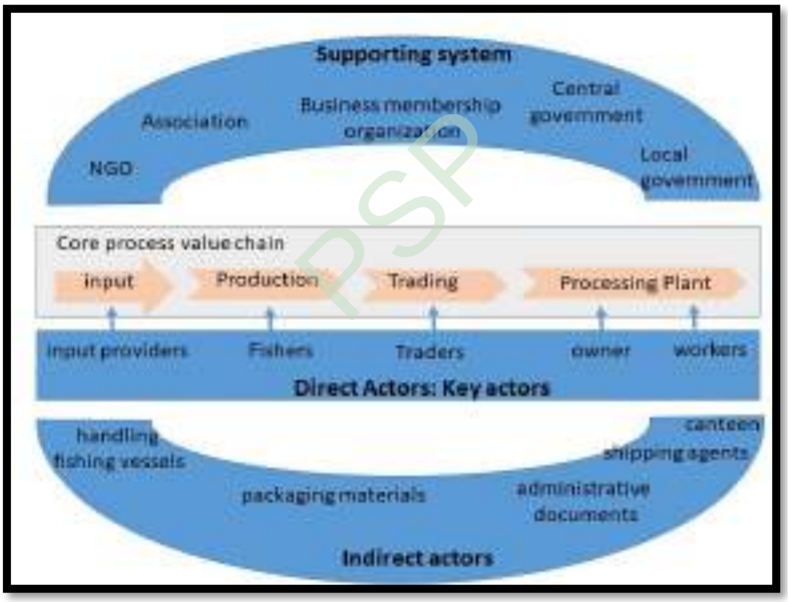

Figure 1. Actors along the value chain (Source: Fitriana, R. (2019). Gender Analysis & Gender Mainstreaming in FIP of Blue Swimming Crab & Tuna Fisheries, Global Sustainable Supply Chains for Marine Commodities Project (GMC) project. UNDP.)

Perceived beliefs and practices in tuna fisheries was assessed by employing the six gender domains framework following all stages in value chain Access, Beliefs and Perception, Practices, Time and Space, Rights and Power (USAID, 2018). Male and female have varied levels in accessing assets and resources. All males were knowledgeable on the information about the resources while female were less knowledgeable (AP2HI, 2019). No discrimination that restricted female's involvement in capture fisheries (UNSRAT, 2018) but females did not normally engage in capture fisheries because common local culture believed that females did not fit to work as fishers in the sea, sailing longer distances away from home, as well as domestic roles that inhibit females working far from home as social expectations and perception. Contrary, on land, more females involve in the pre-production and post-production (e.g. trading and processing) than male.

Only few females were participating in tuna organization, despite the fact that several females had power in tuna industry (such as owning a company and fishing vessels). Fishing organization engaged males in its membership. Female involved in post-harvest organization: Processing and Marketing Group. What is more, female enjoys less formal gathering such as *arisan*. Females were less involved in public domain, in which policy and regulation were sometimes discussed. This made female was left with updated policy and regulation. The time of meeting about policy and regulation does not allow female counterpart to take part due to domestic roles or being inferior in attending public discussion or not invited. Management and governance need to include actors in the fishing industry.

Final words

This paper revealed that male and female are both key actors. Therefore data and information regarding the actors should include gender segregated data. Acknowledging actors by gender along value chain provide lessons on the different roles and challenges in performing the work. Looking beyond the technical issues clarifies who does and who takes responsibility on what. This seems like a simple and technical term but it actually affects the relationship and constructs how the tuna fishing industry works. Considering the segregated roles of females and males along the value chain of tuna, safeguard and reward should ensure female participation and dedication to the industry provide benefits and receive no negative impact of a certain intervention. This paper advocates for equitable treatment of males and females, according to their respective needs, interests and equality of outcomes. Attention to decent work or better working conditions for all actors along the value chain from input providers, production stage, post-harvest, processing and whole sellers will ensure the tuna has been supplied from socially responsible sources. What is more important, more females should be promoted to participate in the decision making level of tuna governance at all levels wherever possible.

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8. Small Scale Handline Tuna Fishery in Buru Island, Maluku Province, Indonesia, During the Covid-19 Pandemic

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Small-scale handline tuna fishery is a major economic activity of the communities spread across coastal villages on Buru Island (Duggan & Kochen, 2016), as a provider of employment opportunities and as a source of income and food for fishermen and their families. This activity is also important for the regional economy and on a national scale, and even in the international trade of seafood (Bailey et al., 2016a). There is a need to better understand the socioeconomic conditions of this small-scale tuna fisheries (The World Bank, 2012; Schuhbauer & Sumaila, 2016), in order to integrate them into sustainable management programs (Bailey et al., 2016b; Duggan & Kochen, 2016; Neitzel et al., 2017; Satria & Sadiyah 2018; Borland & Bailey 2019), by paying attention to socio-economic indicators (Unal dan Franquesa, 2010). Socio-economic data is a major component of the scientific advice needed for evidence-based fisheries management, in order to improve the fisheries' planning and monitoring, and their responsible management (FAO, 1999; Graaf et al., 2011; Pinello et al., 2017). However, information on the socio-economic conditions of handline tuna fisheries on Buru Island is still limited. This situation is increasingly complex, due to the Covid-19 pandemic which has an impact on people's livelihoods. The Covid-19 pandemic presents a difficult challenge for the global small-scale fisheries sector, providing broad socio-economic impacts (Bennet et al., 2020). This study aimed to assess the socio-economic conditions of tuna handline fisheries on Buru Island, which include: revenues, gross profits and fishermen's income during the Covid-19 pandemic compared to the previous condition in year 2019. The results of this study are expected to provide information that can improve the understanding and support for small-scale tuna handline fisheries on Buru Island towards its socio-economic sustainability.

This study was conducted in Buru Island, which includes Buru and South Buru Regency's, Maluku Province, Indonesia. This study uses primary and secondary data. Primary data concern the number of fleets and fishermen who are directly involved in handline tuna fishing activities (Pinello et al., 2017), the price of catch products based on species, the costs (FAO, 1999; Sparre, 2000; Stamatopoulus, 2002), the fishing activity and the actual data at the landing site. The considered costs concern the fuel, the supplies per trip and the ice per trip (Pinello et al., 2017). Data collection was carried out by means of field observations and interviews with fishermen and collector traders, processing companies and village or local government officials, in order to capture information related to this research. Secondary data in the form of tuna handline landing data were obtained from the Maluku Tuna Fisheries Co-Management Committee, formed by the Maluku Provincial Fisheries and Maritime Affairs Agency and the MDPI Foundation. This secondary data consist of 2019 records of tuna handline landing based on samples, at least 20% of the daily landings at the sampling time (MDPI, 2019) from the villages of Buru and South Buru regency taken. The data used in this study are the landings records for the villages of Waplau, Wailihang, Wamlana, Waipure and Bara in Buru Regency, and Pasir Putih village in South Buru Regency. To assess the socioeconomic conditions in this study, the data were analyzed based on the socioeconomic indicators suggested by FAO (1999), Stamatopoulos (2002) and Pinello et al. (2017). The revenue, is the value of the sold landed production.The Gross Profit is the Revenue deducted by the Operating Costs: Energy cost (fuel consumption*fuel price), Ice cost (Ice consumption*Ice Price), Supply and food cost (number of persons per vessel*cost per person). The Income per fisher is the Gross profit per number of persons and per vessel. All analyzes use actual prices obtained during observations, for both 2019 and 2020. In order to describe the actual socioeconomic situation at the study location, the 2019 secondary landing data were analyzed and compared to the 2020 actual data from the field survey.

Based on the field survey in the two districts, there are approximately more than 1,082 tuna handline fleets and more than 1,600 fishermen who work directly in fishing activities, which does not include support workers. The tuna handline fishing unit on Buru Island operates using vessels of an average size of 8.25 m. Boats are made of fiber glass materials, the average engine power is of 16.23 HP, and they are operated by 1 to 4 fishers for each vessel (average 2 fishers) (Table 1), using handline fishing gear. According to Halim et al. (2018), these characteristics confirm that the tuna handline fishery on Buru Island is a small scale fishery. The fishing area for handline tuna fishermen on Buru Island is still within the Indonesian archipelagic waters (Satria and Sadiyah, 2018), around the Banda Sea and Seram Sea. The fishing is operated in a one-day fishing system: usually fishermen leave early in the morning and return in the afternoon to evening or at night, on the same day, the duration of the fishing trip is generally 11.91 hours (the average fishing trip lasts less than 24 hours). The main catch target is adult sized tuna. The catch was dominated by adult yellowfin tuna *Thunnus alabacares* (87.2%), juvenile tuna (9.7%) and bycatch (3.1%). The tuna caught is processed directly on the boat, the landed tuna is usually in the form of loin, 1 tuna consists of 4 loin parts, 2 dorsal parts and two stomach parts. The average catch of adult tuna per boat per day is 60.53 kg (gross weight) or 1.69 indv. Loins measure about 67% of the adult tuna catch weight (Table 2).

Table 1. Average vessel length, engine power, person per vessel, trip duration, fuel and ice consumption per trip of handline unit, on Buru Island

Location	*Vessel length (m)*	*Engine power (hp)*	*Person/ Vessel*	*Trip duration (hour)*
Waplau	8	15	1	11
Wailihang	8.57	15	1.95	12.7
Wamlana	8.26	15.51	1.8	12.51
Waipure	8.1	16.46	1.45	12.11
Bara	8.11	16.28	1.65	12.76
Pasir Putih	8.46	19.14	1.69	10.38
Average	8.25	16.23	1.59	11.91

Table 2. Average CPUE and composition of the tuna catch by handline on Buru Island

Location	***CPUE (kg boat^{-1} trip^{-1})***	***Adult tuna (ind)***	***Adult tuna (kg)***	***Loin weight (kg)***	***Small tuna (kg)***	***By catch (kg)***
Waplau	48.79	1.33	37.67	22.47	9.05	2.07
Wailihang	68.66	1.82	58	40.73	9.09	1.57
Wamlana	54.77	1.74	50.07	34.45	3.69	1.01
Waipure	63.48	1.83	54.19	30.7	5.04	4.25
Bara	65.1	1.55	55.45	37.78	8.41	1.24
Pasir Putih	62.36	1.92	61.24	46.03	0	1.12
Average	60.53	1.69	52.77	35.36	5.88	1.87
% of avg CPUE			87.2	67.0	9.7	3.1

Operating costs include energy, ice, food and supplies costs. The average cost of energy used in one trip of a handline tuna fishing operation on Buru Island ranges from USD 19.63 to 24.63 (an average of USD 23.07) which is derived from a fuel consumption ranging from 28.52 to 35.79 L trip^{-1}, at a cost per liter between USD 0.62 and 0.83 (the price of fuel has not changed during 2019-2020). The average need for ice per trip ranges from 9.86 kg to 28.89 kg (average 14.01 kg), with ice costs ranging from USD 2.04 to 5.96 (average USD 2.89), at the average price per kg of USD 0.21. The average cost of food and supplies per trip was USD 3.44 to 6.73 (average USD 5.48). Thus, the operational costs range from USD 29.11 to 34.15 (an average of USD 31.45).

Table 3. Average operational costs per tuna fishing trip on Buru Island

Location	*Fuel (L)*	*Energy cost (USD)*	*Ice (kg)*	*Ice cost (USD)*	*Food and supply cost (USD)*	*Total operational cost (USD)*
Waplau	35	24.09	11.67	2.41	3.44	29.94
Wailihang	28.52	19.63	13.33	2.75	6.73	29.11
Wamlana	35.21	24.23	9.9	2.04	6.20	32.48
Waipure	34.15	23.50	9.86	2.04	5.00	30.54
Bara	35.79	24.63	10.43	2.15	5.68	32.47
Pasir Putih	29.54	22.36	28.89	5.96	5.82	34.15
Average	33.04	23.07	14.01	2.89	5.48	31.45

Table 4. Revenue, gross profit and fisher income of handline tuna before and during the Covid-19 pandemic, in several locations on Buru Island (in USD)

Location	*2019*			*2020*		
	Revenue	*Gross profit*	*Fisher income*	*Revenue*	*Gross profit*	*Fisher income*
Waplau	75.28	45.34	45.34	46.01	16.07	16.07
Wailihang	99.63	70.51	42.42	51.92	22.80	14.04
Wamlana	77.85	45.37	24.69	38.68	13.68	12.05
Waipure	60.76	30.22	22.37	43.73	12.01	8.28
Bara	46.20	58.92	40.63	33.35	13.74	9.95
Pasir Putih	130.14	91.97	33.91	76.31	38.14	14.18

Average	81.64	57.06	34.89	48.33	19.41	12.43

Table 5. Decrease in revenue, gross profit and income of fishers in 2020 compared to 2019*, in USD and proportion

Location	*Revenue*		*Gross Profit*		*Fisher income*	
	Value	*%*	*Value*	*%*	*Value*	*%*
Waplau	29.27	38.88	29.27	64.55	29.27	64.55
Wailihang	47.71	47.89	47.71	67.66	28.37	66.89
Wamlana	39.17	50.32	39.17	69.84	12.64	51.20
Waipure	17.03	28.03	17.03	60.28	14.09	62.99
Bara	12.85	27.82	12.85	76.69	30.68	75.52
Pasir Putih	53.83	41.36	53.83	58.53	19.72	58.17
Average	33.31	39.05	37.65	66.26	22.46	63.22

**Based on Table 4.*

Revenue is the total sale value of the catch, both adult and juvenile tuna, and bycatch. The biggest revenue comes from the catch of adult tuna which is sold in the form of loins. The average revenue per unit handline per trip from the total handline tuna landings at various locations on Buru Island during 2020 ranged from USD 33.35-76.31 (average USD 48.33), lower than in 2019 which ranged from USD 46.20 -130.14 (average USD 81.64) (Table 4). Revenue in 2020 showed a decrease, ranging from USD 12.85 to 53.83 (average USD 33.31) or around 27.82 - 50.32% (39.05% average), when compared to the revenue that was obtained in 2019 (Table 5). Furthermore, in 2020, the gross profit of handline tuna fleets on Buru Island was around USD 12.01-38.14 (an average of USD 19.41. This gross profit was lower than the Gross profit in 2019 which was around USD 30 ,22 - 91.97 (average USD 57.06) (Table 4).Gross profit in 2020 fell by USD 12.35 to 53.83 (average USD 37.65) or decreased by 58. 53-76.69% (average 66.26%) compared to the previous year's gross profit calculation in 2019 (Table 5). The income of handline tuna fishermen on Buru Island is obtained from a profit-sharing system. The profit-sharing system practiced by fishing communities on Buru Island is an equal distribution between the owner, skipper or crew, depending on the number of fishermen per boat, usually 1 or 2 people per boat (an average of 1.6~2 people per ship). The calculation results show that the average income of each handline tuna fisherman per trip is around USD 9.95 to 16.07 (average USD 12.43), lower than the previous year which ranged from USD 22.37 to 45.34 (Table 4). The decline in fishermen's income ranged from USD 12.64 to 30.68 (average USD 22.46) or between 51.20% to 75.52% or 63.22% on average (Table 5), compared to the previous year. It can be seen that the decrease in income occurred in all locations (Table 5). Interviews also indicated that fishers reported a reduction of more than 50% in their income. Income provides a measure of contribution to the economy (Pinello et al., 2017), which means that the current situation contributes negatively to the economy of handline tuna fishermen on Buru Island, where there is a decrease in income received by fishermen.

The decline occurred because since the beginning of 2020 the price of tuna loin has begun to decline. Prices in 2020, more than half the price in 2019 for the same quality. This low price causes a decrease in revenue from the catch. The price reduction was caused by low demand due to disrupted seafood market conditions due to the Covid-19 pandemic situation. Furthermore, this low gross profit is associated with a low revenue value when compared to normal conditions, while operational costs tend to be constant with stable fuel prices in the study locations. Tuna handline fishermen in the study locations access fuel at prices ranging from USD 0.62-0.83, far above the subsidized price, this price contributes to high operational costs. If operational costs continue to be high and the revenue value gets lower, then there is a potential loss in the handline tuna business. For this reason, reducing operational costs and increasing the value of the catch by maintaining the quality of the fish caught is a must. Observations in the field show that the quality of the catch is the most important thing in increasing the acceptance and profitability of the fleet. There will be a significant price difference if the quality of the tuna sold decreases. Fishermen will get a very low selling price, which in the end will hurt their business. If the revenue and profits of the fleet increase, there will be an increase in fishermen's income, and vice versa if there is a decrease in the value of revenue and profits from the fleet, the income of fishermen will also decrease.

A study of the socio-economic conditions of the handline tuna fishery on Buru Island has shown that this type of fishery is socially very important, because it is a source of livelihood for more than 1,600 fishermen, as well as a source of income for fishermen and their families. and global and local food supply. Facing the current global pandemic situation, the handline tuna fishery on Buru Island is experiencing an economic impact. This is in line with Bennet et al. (2020) and Campbell et al. (2020) who stated that the Covid-19 pandemic had an impact on many small-scale fisheries. The impact on handline tuna fishermen on Buru Island was that in 2020 there was an average decrease in revenue reaching 39.05%, then a decrease in average gross profit of 66.26% and a decrease in fishermen's personal income by an average of 63.22% when compared to the previous year in 2019. This decline occurred following a drop in the price of tuna loin (adult tuna), due to market disturbances. According to Campbell et al. (2020), high-value fisheries that enter export supply chains are more negatively affected. Handline tuna products from Buru Island are marketed in the domestic and export markets. Regarding the export/international market, several handline tuna fishing communities operate through the Fair Trade scheme (Duggan and Kochen, 2016; Doddema et al., 2020; Zheng et al., 2020), and most recently several handline tuna fishing communities on Buru Island achieved MSC certification (MDPI, 2020). As a result, demand forecasts are more optimistic. On the other hand, fishermen face socio-economic impacts that threaten the sustainability of their livelihoods and need support from the public policy side.

Several things that can be recommended from this research are the need for efforts to reduce operational costs in the energy cost component by providing access for fishermen to buy fuel at subsidized prices as appropriate. It is necessary to improve the quality of the catch by handling it properly at sea or at the landing site to get a high selling price, and for fishermen to increase the amount of ice they carry in fishing operations. As well as the need for efforts to improve/enhance the marketing network for the sale of tuna products that can support fleet profits and fishermen's income.

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9. Multiaspect Sustainability Analysis of Small-Scale Tuna Fisheries Management in the Ombai Strait Waters: A Participatory Assessment

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The Ombai Strait is one of the entrance corridors of marine biota originating from the Flores Sea and Banda Sea to the Sawu Sea and the Indian Ocean or vice versa. Gigentika (2017) states that the waters around Nusa Tenggara are waters through which tuna migrate. The Republic of Indonesia and Timor Leste border area is on the route of the tuna fishing route in the sea waters of the Ombai Strait and Sawu Sea which has the consequence that the waters in this area are rich in fish resources, especially tuna and its kind.

Sustainability is an important factor in creating a balance between nature and humans (Fauzi, 2019). It was further explained that the basic essence of sustainability is to continuously carry out strategies for harmonious relations between humans and nature. The important thing related to sustainability is how to measure and assess it. Firmasyah (2022) states that sustainability analysis is an analysis carried out to look at various aspects that have a level of mutual importance to obtain a balance value between all aspects so that it is sustainable into the future.

Studies related to fisheries in the border areas of Indonesia and Timor Leste have been carried out by several previous researchers including small-scale fisheries (Kiuk et al., 2017), mackerel tuna resources (Rehatta and Ninef 2018), cross-border fisheries (Rehatta et al., 2019), pelagic fisheries small (Rehatta et al 2020), flying fish resources (Rehatta et al., 2021) and the bioeconomic of small pelagic fish resources (Rehatta et al., 2022). Studies related to tuna fisheries in the border areas of Indonesia and Timor Leste have never been carried out. To ensure a balance is created between the availability of tuna fish resource stocks and their use by fishermen, it is necessary to have sustainable management of tuna fisheries in the border areas of Indonesia and Timor Leste. In this effort, it is necessary to study several things in depth including .1) the status of sustainability of tuna management; 2) driving factors for sustainable tuna fisheries management; and 3) priority scenarios towards sustainable tuna fisheries management.

This research was conducted in Belu Regency, East Nusa Tenggara in 4 (four) capture fisheries center villages for 3 (three) months. Data collection was carried out using literature study techniques, interviews, observations, and FGDs. The data collected covers ecological, fishing technology, social, economic, and governance aspects related to the management of tuna fisheries. Assessment of the status of tuna fisheries management using a scorecard in a participatory way through FGDs with selected stakeholders. Data analysis was performed using Multiaspect Sustainability Analysis (MSA) with the EXsimpro software.

The catches of tuna, skipjack, and mackerel tuna (TCT) which are landed and marketed in Belu Regency consist of yellowfin tuna (*Thunnus albacares*), skipjack tuna (*Katsuwonus pelamis*), and mackerel tuna (*Euthinnus affinis*). The main target for catching tuna in Belu Regency is yellowfin tuna which is processed into the loin. Loin tuna is the main product of processed tuna which is marketed outside the region, especially in Bali. Tuna production recorded at the DKP NTT Branch Offices of the TTS, TTU, Belu, and Malaka offices in Atambua during the period 2020 – 2022 is presented in Figure 1.

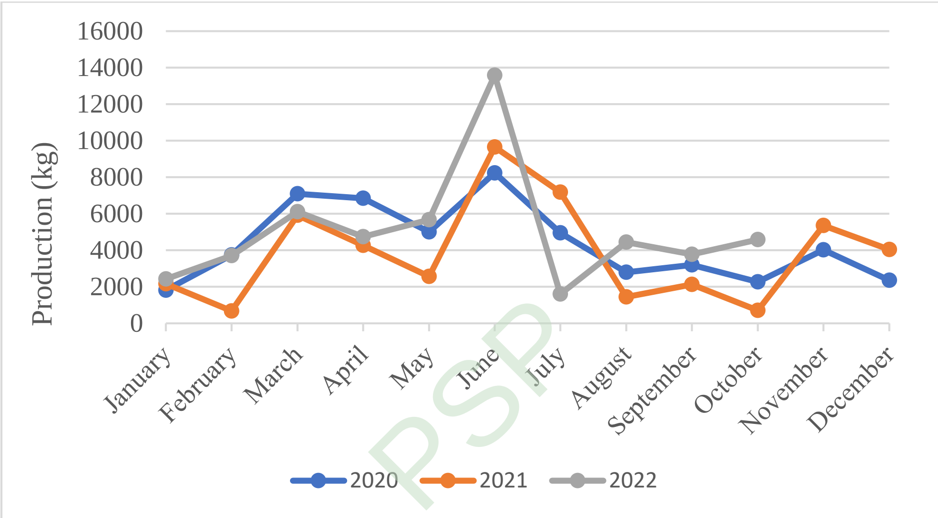

Figure 1. Production trend (kg) of tuna fisheries in Belu Regency from years 2020 - 2022

Figure 1, shows the trend of production which fluctuates every month and tends to experience the highest production in June and March and the lowest production in January-February and August-September. These results also show that the tuna fishing season in Belu District lasts all year round and the peak fishing season on May-June and the lean season occurs in January-February and August-September.

The sampling results for recording the catches of the tuna fishing fleet during the period July – December 2022 show that the success rate on fishing days (%) has an increasing trend from July – December 2022. The highest success rate is achieved in December and the lowest is in July. The success rate of fishing trips (%) shows the same trend during the July – December 2022 period.

Trends in tuna catches per trip during the period July – December 2022 shows that the average number of catches per trip ranges from 0.05 – 0.55 fish/trip, the highest being the trip in December and the lowest in July. The average weight of the catch per trip ranged from 2.08 – 20.28 kg/trip, the highest was in the December trip and the lowest was in the July trip. The average weight of the catch per head ranges from 27.53 – 30.35 kg/head, with the largest average weight caught in July and November and the lowest in September.

The tuna fishing fleet in Belu Regency uses motorized boats made of fiber and wood/board materials and equipped with inboard and outboard engines with sizes ranging from 1 – 2 gross tons (GT). NTT DKP data for 2021 shows that the number of motorboat fleets recorded in 4 (four) coastal villages totaled 303 units, consisting of 62% motorboats measuring 1 GT, 34% measuring 2 GT, and 3% measuring > 2GT. There are 102 units (34%) of the tuna fishing fleet with a capacity of 2 GT in Jenilu Village.

The results of the analysis of the sustainability of tuna fisheries management in Belu Regency are presented in Table 1. The current status of tuna fisheries management in Belu Regency shows an aggregate value of 60.55 and is classified as sustainable. Aspects of governance and ecology show a low value and generally affect the aggregate value, while the economic aspect shows the highest value compared to other aspects. This shows that in the existing conditions, the ecological and governance aspects have not performed well, while the economic aspects have the best performance.

Table 1. Results of the analysis of the sustainability of tuna fisheries management in the Ombai Strait waters

Sustainability Value | Sustainability Graph | Sustainability Criteria | Scenario Priority

Sustainability Value

No.	Aspect	Existing	Scenario 1	Scenario 2
1	Ecology	58.25	68.75	91.79
2	Fishing Technology	62.5	71	91.79
3	Governance	50	62.5	87.5
4	Social	61	88	100
5	Economy	71	82.5	100
	Total Average	60.55	74.55	94.2
	Status Sustainability	Sustainable	Sustainable	Very Sustainable

The leverage factors describe the factors that have the most influence on changes in the status of each aspect as well as the aggregate status. The leverage factor value is taken from the highest value resulting from the sum of the maximum sensitivity value (sensitivity max) added to the actual sensitivity value (Firmasyah, 2022). Maximum sensitive value and sensitivity value for all factors from each aspect of ecology, fishing technology, social, economy, and governance. The highest maximum sensitivity value is 0.5 and the highest sensitivity value is 1, so the highest total sensitivity value is 1.5. The sensitivity value shows the status of each factor in good or bad condition so that it needs improvement and is selected as a leverage factor. A factor with a sensitivity value of 0 indicates that the factor is in good condition and no repair efforts are needed. Conversely, factors with a sensitivity value > 0 – 1 indicate that these factors are not in good condition and improvement efforts are still needed. Based on the sensitivity value, two driving factors are selected from each aspect (5 aspects) that have the highest sensitivity and are a combination of the maximum sensitivity value of the factor plus the sensitivity value. The results of calculating the highest sensitivity value for each factor and determining the selected driving factors for each aspect are presented in Table 2 below.

Table 2. Leverage factors for improving the management of tuna fisheries in the Ombai Strait waters

No	Aspect		Leverage factors	*Sensitivity Max*	*Sensitivity Values*
1	Ecology	1)	CPUE trends	0.33	0.67
		2)	Range collapse of fish resources	0.5	0.5
2	Technology	3)	Fishing capacity	0.33	0.67
		4)	Application of handling technology	0.5	0.5
3	Social	5)	Local wisdom	0.33	0.67
		6)	Fishermen's cooperation	0.5	0.5
4	Economy	7)	Savings ratio	0.5	0.5
		8)	Fishermen's assets	0.33	0.33
5	Governance	9)	Community participation	0.5	0.5
		10)	Management improvement program	0.5	1.0

Source: processed research results (2022)

Table 2 shows that the factors driving the ecological aspects for improving the management of tuna fisheries in Belu Regency are the CPUE trend and the range collapse of fish resources. In general, the CPUE trend for tuna fisheries in Belu District shows a slight downward trend (<25%), and the range collapse of tuna resources is increasingly difficult and the fishing grounds are increasingly far away. Factors driving aspects of fishing technology to improve tuna fisheries management are fishing capacity and the application of fish handling technology. Tuna fishing capacity in Belu Regency has decreased <50% and the application of technology for handling tuna has been carried out but has not been effective in efforts to maintain fish quality and increase value.

Factors driving the social aspect are the utilization of local wisdom in the management of coastal and marine resources and fishermen's cooperation. Indigenous peoples in Belu Regency have local wisdom in managing natural resources but have not utilized it in efforts to manage coastal and marine resources. Fishermen cooperation both formally and informally has been carried out but has not been effective. The ratio of fishermen's savings and assets is a factor driving the economic aspect of improving the management of tuna fisheries in Belu Regency. The fisherman's savings ratio is the value of the difference between the income and expenses of fishing families with their income showing a negative ratio. Ownership of fishermen's productive assets tends to decrease compared to the previous year.

Factors driving aspects of governance to improve tuna fisheries management in Belu Regency are community participation factors and fisheries management improvement programs. Community participation in efforts to manage tuna fisheries in Belu Regency has been carried out but has not been effective. The program plan document for improving the management of tuna fisheries in Belu Regency is not yet available.

The improvement of tuna fisheries management in Belu Regency is designed in two scenarios, namely the moderate scenario (scenario 1) and the optimistic scenario (scenario 2). The moderate scenario is carried out by improving the driving factors in each aspect to raise the status of the assessment indicators to a better level, while the optimistic scenario is carried out by maintaining the status of the indicators and/or increasing the status of the assessment indicators by one level from the moderate scenario. The moderate scenario will increase the performance value of each aspect and increase the aggregate value to 74.55, and the sustainability status is classified as sustainable. The optimistic scenario increases the performance value of each aspect better than the moderate scenario and the aggregate value increases to 94.2 and is classified as very sustainable (Table 1, Figure 2).

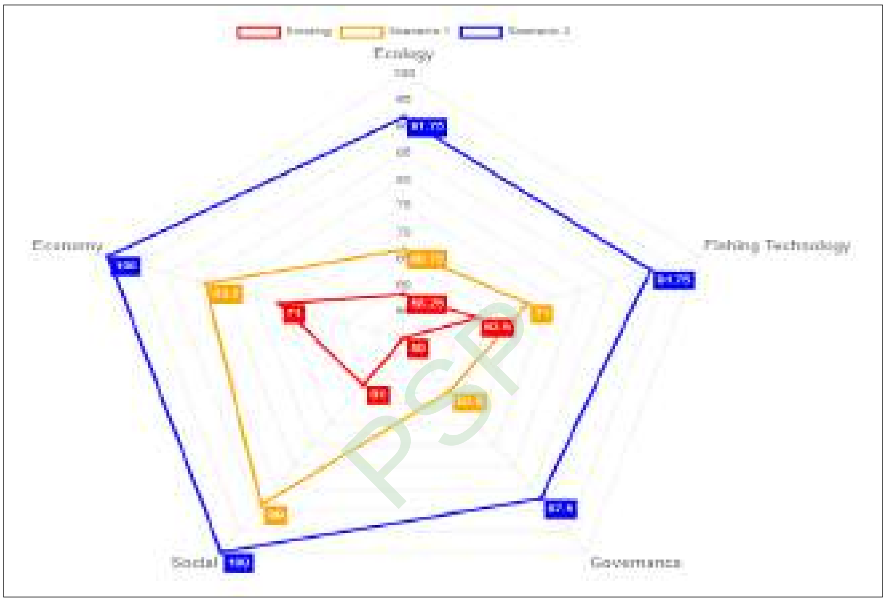

Figure 2. Diagram of the sustainability of tuna fisheries management in the Ombai Strait waters

The results of this study concluded that (1) the status of sustainability of tuna fisheries management in the Ombai Strait waters in the existing conditions is classified as sustainable, (2) the factors driving the improvement of tuna fisheries management consist of CPUE trends, range collapse of fish resources, fishing capacity, fish handling technology, local wisdom, fisherman cooperation, savings ratio, fisherman assets, community participation, and fishery improvement program, and (3) increasing the status of sustainable management of tuna fisheries through moderate scenarios and optimistic scenarios to achieve very sustainable status.

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10. MDPI's Community Development Work

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The fisheries that MDPI engage with are deeply rooted in community well-being, and depend on fishing activities both as a source of income and food security. However, these communities often reside in remote areas of Indonesia, posing challenges for their participation in fisheries management discussions that may directly impact their livelihoods. Since its creation, MDPI has adopted a unique approach by having its staff live and work in the communities of project interventions, recognizing the value of long-term behavior change and adaptive responses. Building upon its experience in community organization for fishers through the implementation of the FairTrade USA Capture Fisheries Standard, the organization chose to expand its scope of work and has enhanced its expertise in community development. This reflects a shift in our five-year strategy towards a more holistic approach to improving fisheries management and coastal community livelihoods, with the objective to build leadership and organizational skills within the communities. In the last few years, we have established multi-stakeholder, democratic structures in coastal communities, acting as forums for fishers and other community members to organize themselves and exchange best practices, while enabling them to effectively communicate their concerns with the district and provincial level fisheries management authorities.

MDPI's focus lies in strengthening the capacity of local champions, both men and women within the communities. The concept of champions in MDPI's work originates from the USAID SEA project, which had a large focus on long lasting behavior change driven by communities. Champions are identified by our field staff as village pioneers who can embody and drive sustainable fishing practices to support coastal communities' livelihoods. Through specific training and coaching, MDPI empowers these individuals to disseminate best practices and transfer their knowledge within their communities. Training curricula cover fisheries concepts and other community-prioritized topics such as Endangered, Threatened and Protected species, bookkeeping, data collection, or waste management. MDPI also fosters the sharing of best practices between champions from different locations, encouraging mutual learning and inspiration.

Additionally, MDPI harnesses the potential of fisher-led cooperatives, aiming for their recognition as representative entities at the provincial level, allowing for a long-lasting impact. Cooperatives, established to foster collaboration and enhance prosperity among fishers, provide a foundation for community members to develop independent business models. MDPI supports the establishment of cooperatives by assisting in meeting the rigorous set of requirements and developing standard operating procedures. To strengthen their capacity, MDPI provides targeted training to improve financial management and organizational effectiveness. Annual members' meetings and the creation of business units based on shared aspirations and needs are also encouraged.

MDPI's work with champions and cooperatives has revealed a pressing need for further support. Challenges faced by small-scale fishers include isolation, limited lending abilities, difficulty in purchasing gear, and restricted access to clients. Establishing cooperatives, which enable community members to join forces and to use the economies of scale, has been an effective solution to overcome these obstacles and create lasting impact within the communities. However, MDPI recognizes the importance of empowering established cooperatives to develop their own sustainable businesses. This economic empowerment approach enhances the sustainability of MDPI's community development work and acts as an essential component of reducing dependency on MDPI over time, thereby strengthening communities and building resilience.

Assessments in MDPI's project sites have demonstrated the organization's positive standing as a trusted partner, having created meaningful impact at the community level. Communities have expressed openness and willingness to learn from and alongside MDPI. Building upon existing processes, MDPI aims to offer more comprehensive value to community development by building financial resilience interventions to help communities withstand fish seasonality. These interventions primarily target fishing activities, such as byproducts or gear, and focus on building household capacity to operate businesses intended at diversifying income during low fishing season through accessing local markets. Empowering fishers' wives to manage these businesses and providing financial knowledge is expected to significantly impact household economic stability.

By employing a bottom-up methodology, MDPI ensures that interventions are locally relevant, tailored to community needs, and undergo pre-assessments, feedback gathering, and piloting phases to address potential barriers and challenges. One of MDPI's key strengths lie in its deep immersion and ongoing commitment to remote communities across Eastern Indonesia.

Note : The full manuscript is not available in this proceeding.

11. Socio-economic in Small Scale Tuna Fishermen in Kawa, West Seram, Maluku

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Small-scale fisheries elicit a variety of social and economic benefits that are most often associated with coastal communities in developing countries, underpinning local livelihoods, employment, and food security (IPNLF, 2022). Environmental, economic, and social objectives have been central to fisheries policy and regulatory frameworks around the world for many years (Brundtland 1990, Voyer et al. 2017). In fact, the collection and dissemination of socio-economic data is highlighted in Indonesia's Ministry of Marine Affairs and Fisheries (MMAF) Tuna Management Action Plan based on Ministerial Decree 121 under several targets; an example of socio-economic activities includes carrying out studies related to socio-economic aspects of Tuna and Skipjack Tuna fishers among others (MMAF, 2021).

Kawa is one of the villages in West Seram that has abundant fisheries resources. So that almost all of its residents depend on fishing in the sea for their livelihood. With such great fisheries potential, it should be balanced with a good level of welfare. The low level of human resources and equipment used by fishers affects the way of catching fish, limited understanding of technology, making the quality and quantity of catches not improved. Various efforts have been made by the fishing community in Kawa Village to improve their welfare conditions.

One of the efforts that can be made to increase the income of fishers is by increasing the production of their catch. For example, these fishermen are not only limited to fishing, but they also take other marine biota such as octopus, squid, clams and so on. The catch is also very limited, and sometimes the catch is not entirely sold, but for their own consumption because they have dependents in the family.

Another thing that contributes to worsening the level of fishers welfare is the habit or lifestyle. It is inappropriate to call fishers lazy, because if we look at the life cycle of fishers who always work hard. However, the obstacle is the consumptive lifestyle, where when there is a lot of income, it is not saved for preparation for bad seasons, but is used as an opportunity to buy secondary needs. Fishes poverty is a multidimensional problem, so to solve it, a comprehensive solution is needed, and not a partial solution (Kusnadi, 2015).

This research was conducted in March 2023 in Kawa Village, West Seram, Maluku Province. Informants in this study were grouped into two, namely people from the harvest node (fishers) and people from the post-harvest node (fish collectors).

The fishers respondents were determined by using purposive method which amounted to 44 fishers and fish collectors respondents were determined by census.

Data collection techniques carried out during the research were carried out in several ways, namely:

1. Observation
   Observation in this study was carried out through direct observation of activities at the research location related to respondents or fishers and other information needed in this study.

2. Interview
   The interview used in this research is focused interview, which is an interview whose discussion leads according to the research objectives.
3. Documentation
   Documentation in this study was carried out every time data was collected at the research location.

Data collected in the form of production data or catches, selling prices, average income in good months and bad months, household fish consumption, and satisfaction with the level of income obtained.

Data analysis used in this research is qualitative descriptive analysis. According to Winaratha (2006), the qualitative descriptive analysis method is carried out by describing, summarizing various conditions, situations from various data collected in the form of interview results or observations regarding the problem under research.

A total of 44 fishers were interviewed, all were male and worked on one-man fishing vessels. The ages ranged from 27 to 58 years old, with the average age being 39 years. The majority of fishers (63.6 %) had only 6 years of formal education, this was the lowest number of years in school whilst the longest amount of formal education was 16 years.

A total of 14 fish collectors were interviewed at the Kawa site, 11 were male and 3 were female. Ages ranged from 32 to 50 years and 50 % had up to 6 years of formal education.

1. Volume of fish sold as a proportion of fish landed and average prices

Only two species of tuna are reportedly landed in Kawa, Yellowfin (YFT) and Skipjack (SKJ). The fishers also reported landing juvenile YFT which was not large enough to be processed for loins. All fishers reported selling 100 % of the mature and juvenile YFT, all reported the same rate of IDR 60,000 per Kg of mature YFT and IDR 14,000 per Kg of juvenile YFT. Only four of the fishers reported not being able to sell to whomever they wished. The amount of SKJ as a proportion of SKJ landed ranged from 40 % to 100 % with the average being 72.5 % and the mode being 66.7 %. The fishers reported a consistent rate of IDR 12,000 per Kg of SKJ.

2. Average income during good and bad months

Income during a “good” month ranged from a class of IDR 8 million- 10 million (n=1) to a class of IDR 40 million – 45 million (n=2) (Figure 1). The majority of fishers (n=18) reported earning IDR 15 million – 20 million during a good month. Income during a “bad” month ranged from a class of IDR 0 – 300,000 (n=1) to a class of IDR 0 million – 5 million (n=2). Thirteen fishers reported earning IDR 0 – 1 million during a “bad” month, whilst 12 fishers reported earning IDR 0 – 2 million.

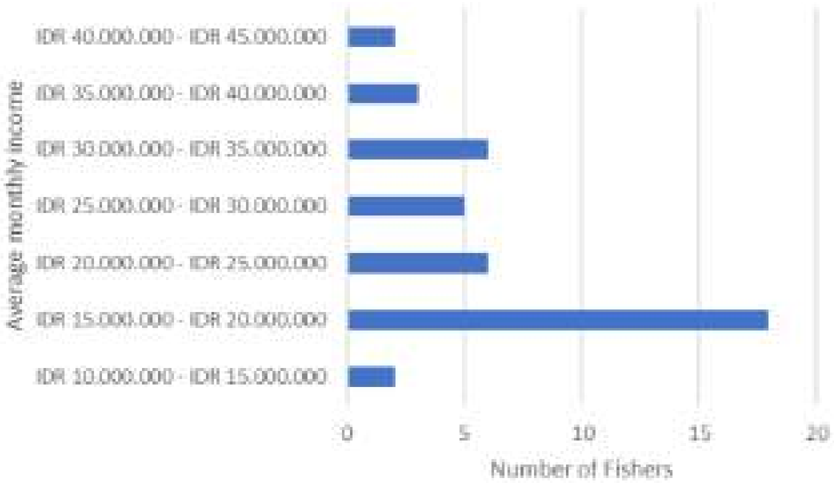

Figure 1. Average income (IDR) reported by fishers

3. Household fish consumption

All respondents stated they consume fish everyday with 90 % of the tuna coming from their own activities. All YFT loins are sold and so the fishers reported consuming any remaining parts of the juvenile tuna and SKJ which is not sold. The amount of tuna consumed ranges from 1-6 Kg per week, with the most common mount being estimated at 2 Kg per week.

For the remaining 10 % of fish consumed is either bought from other fishers at a discounted price (all fishers stated this) and/or supplemented by catching other species, such as reef fish whilst at sea (stated by 91 % of the respondents).

4. Income satisfaction and livelihood pride

The majority of fishers (67 %) reported that they are very satisfied with their income from fishing. Reasons for this satisfaction included that fishing was also their hobby (n=1) and that it provides a greater income than agriculture (n= 5), other respondents stated that it was due to "greater income" however they did not state what this was relative to. The remaining 33 % of fishers stated that they felt neutral about the income earned from fishing. All reasons were related to the seasonality of the livelihood affecting their incomes.

When asked if they would continue fishing only one respondent said they would not if an alternative opportunity arose. Reasons for staying in the livelihood included:

a. the fact that it is the primary source of income for the household (n = 13);
b. fishing is a good job (n= 8)
c. it is a flexible livelihood (n = 11);
d. it is a hobby (n = 3);
e. it provides a good income (n= 2);
f. there are no other option (n = 9).

Please note some fisher gave more than one answer. Finally, all fishers reported that they were very proud of fishing as a livelihood.

There is a high reliance on small scale fishing in Kawa as a contribution to income, food security, and identity. Changes to management approaches at a national, provincial, and local level have the potential to have significant impacts on individuals working in small scale fisheries throughout Indonesia.

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THEMATIC PRESENTATION

Crowd Data Crawling As an Alternative Source For Tuna Fishery Data: How Big Data Supports Fisheries Business Intelligence and Policy Recommendation

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The application of big data and artificial intelligence (AI) in various sectors is rapidly increasing (see Allam and Dhunny, 2019; Bhat and Huang, 2021). Nevertheless, the application of them in fisheries is still limited and now emerged (Probst, 2020). The data are often collected by manual or semi-manual methods (hereafter called conventional method), including in tuna fishery. Fishery data collection using conventional methods, which can be time-consuming, costly, and prone to limitations. The conventional data collection methods in fisheries typically involve manual data gathering through on-site surveys, logbook records, and catch reports (KKP, 2019). These methods may provide valuable information, but they often have scale, timeliness, and accuracy limitations. Additionally, the data collected through conventional methods may not be sufficient to effectively address the challenges faced by the fisheries industry, such as overfishing, ecosystem impacts, and climate change.

Big data and AI have the potential to revolutionize the fisheries sector by providing more comprehensive, real-time, and accurate data that can inform better decision-making and management practices. Here are some potential applications of big data and AI in fisheries (see Probst, 2020; Gladju et al., 2022):

1. Data Integration: Big data can aggregate and integrate various sources, including satellite imagery, oceanographic data, weather patterns, and fishing vessel tracking data. This integrated data can provide a holistic view of the fisheries ecosystem and help identify patterns, trends, and relationships between different variables.
2. Stock Assessment: AI algorithms can analyze large volume of data to estimate fish stocks and predict their dynamics. By incorporating factors such as fishing effort, environmental conditions, and species interactions, AI models can provide more accurate and timely assessments of fish populations.
3. Fisheries Management: Big data and AI can support adaptive and proactive management strategies. Real-time data on fishing activities, catch rates, and environmental conditions can enable dynamic adjustments in fishing quotas, fishing seasons, and spatial management measures to ensure sustainable practices.

4. Illegal, Unreported, and Unregulated (IUU) Fishing: AI technologies, such as machine learning algorithms, can help identify and track suspicious fishing activities, including IUU fishing practices. By analyzing vessel movement patterns, data anomalies, and historical records, AI can assist in detecting and preventing illegal fishing activities.
5. Ecosystem Monitoring: Big data and AI can contribute to monitoring and understanding the impacts of fishing on marine ecosystems. By analyzing diverse data sources, including species distribution, habitat mapping, and environmental parameters, AI models can provide insights into the health of ecosystems and support ecosystem-based fisheries management approaches.

While the application of big data and AI in fisheries is still limited, ongoing efforts are being made to harness the potential of these technologies. Advancements in data collection methods, collaboration between stakeholders, and the development of AI algorithms tailored to fisheries-specific challenges can facilitate the integration of big data and AI into fisheries management.

Several approaches can be employed to overcome the limitations of fisheries data, including more effective and efficient data collection through the use of modern technology and the participation of local communities. Citizen science-based data collection is an example of an approach that can be developed in the future. The development of citizen science for fisheries assessment can provide various benefits (see Bonney et al., 2021; Fulton et al., 2019), including:

1. A more adaptive and flexible management approach, where fisheries management takes into account data limitations and conducts regular monitoring and evaluation
2. The development of models and algorithms to estimate fish populations, as well as the influence of the environment and climate on fisheries
3. Enhanced collaboration and coordination among various stakeholders, including the government, local communities, academia, and non-governmental organizations, to strengthen fisheries management efforts in conservation areas

The Department of Fisheries Resource Utilization of IPB University, in collaboration with the Fisheries Resources Center of Indonesia of Rekam Nusantara Foundation, has been developing a citizen science-based data collection initiative called IKAN (*Inisiatif Kolaborasi Pendataan Perikanan* – Initiative of Fisheries Data Collaboration). This initiative has been implemented through piloting in several fishing ports along the northern coast of Java (Tegal, Rembang, Pati, and Lamongan) since 2019. IKAN is an Android-based, open-access data collection application designed to be used by various stakeholders such as fishermen, fish collectors, students, academics, communities, and the general public. The purpose of IKAN is to engage stakeholders in collecting fisheries data and information in Indonesia by gathering, storing, and processing fisheries data according to scientific protocols and needs.

The IKAN application has been registered with patent number 000439998. By being part of IKAN, users can easily access and obtain information from the collected data. Another advantage is that users can be aware of the condition of fish resources in their respective areas, which allows for optimizing fishing operations.

Table 1. Data recap from IKAN Database.

Items	Quantity
Number of Trips	: 601
Number of Boats Recorded	: 130
Number of Samples Recorded (Individual)	: 203
Total Landing (Kg)	: 182494
Last Update	: 2022-02-09

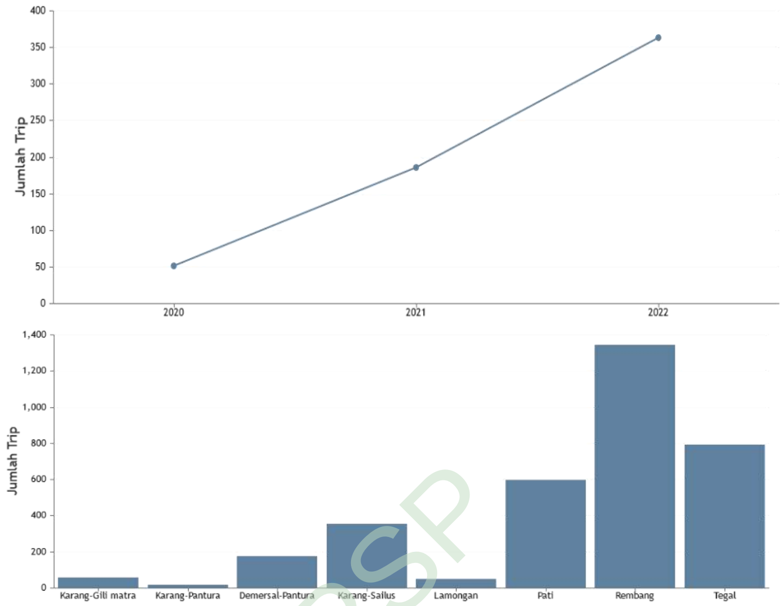

Figure 1. Data summary from various landing sites in 2000 – 2022

Further, the collaboration has also developed a data collection system using AI using *Phyton* (Van Rossum and Drake 1995) and *AutoGPT* (Radford et al. 2020) called Crowd Data Crawling (CDC) as other data sources. CDC monitors and records the fisheries data from the internet with pre-defined keywords and data types. The data can then be tabulated and analysed to contribute to the decision support system. The CDC can automatically collect and index data from various documents unlimitedly and enables the data collection process from available fisheries information online on various websites (such as social media, wholesale markets, marketplaces, e-commerce, and others available on the internet). Manual data collection from various sources carries a higher risk of data manipulation. This capability enables CDC to provide comprehensive and real-time information on fisheries product without limits through the internet. With such high levels of data variation, extremely high speed, and large volume, it offers numerous new opportunities for businesses, governments, or researchers to conduct various studies and considerations for making business decisions or government policies. Therefore, the CDC application is proposed as an innovation to facilitate fast and accurate data collection from various sources. The scheme for independent data collection through the CDC mechanism is presented in Figure 2.

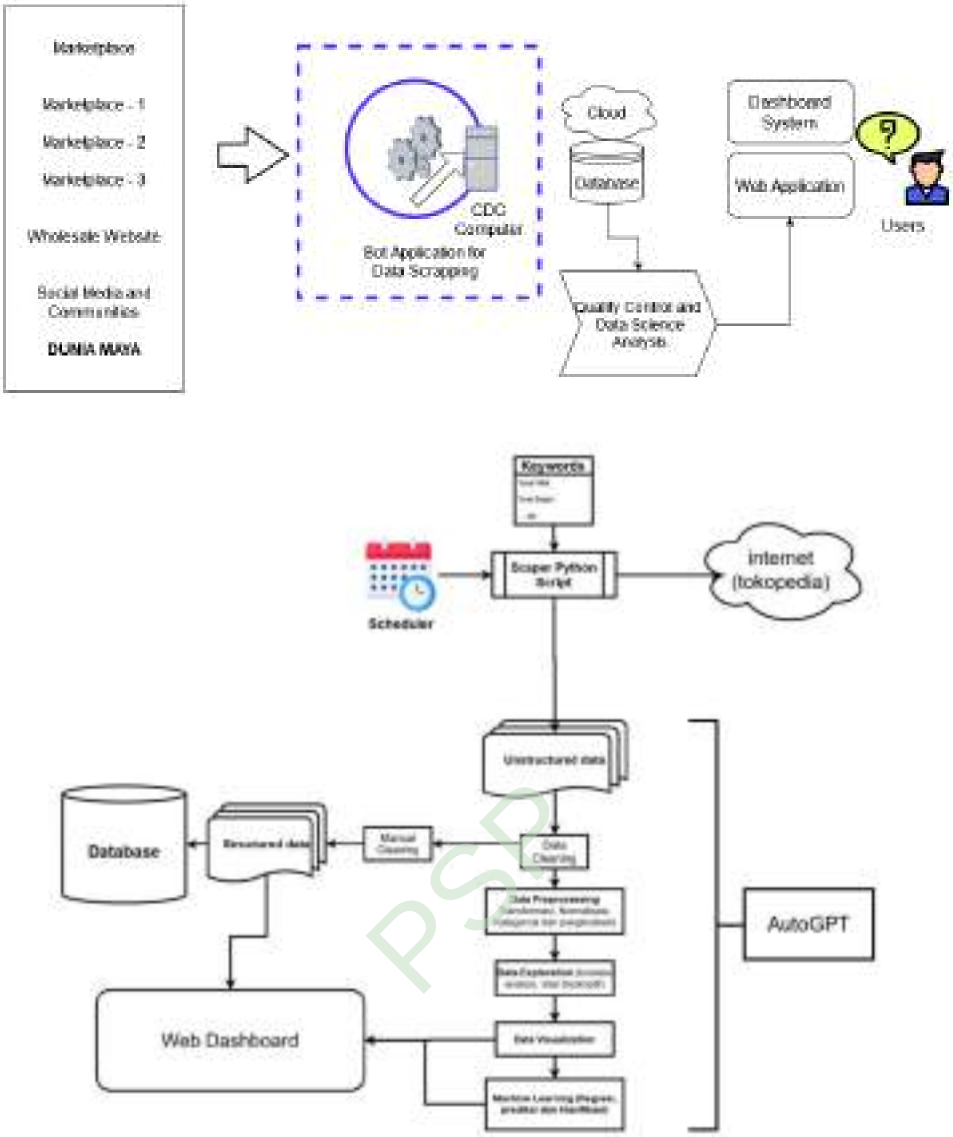

Figure 2. System of crowd data crawling (CDC) and the flow of data collection

This study presents the preliminary results of CDC development as an alternative source for tuna fishery data. We run this application to explore the trade of tuna in selected marketplaces. The price of each tuna product resulting from this CDC application can be found in Figure 3. We also explore the time series data collection. This application can also provide helpful information (Figure 4). The support of AI in analyzing the big data generated by CDC in fisheries has great potential in decision support system for fisheries management. By utilizing natural language processing algorithms (such as AutoGPT) and automated data collection techniques like CDC, AI can assist in classifying, indexing, and processing diverse fisheries data, including fish catch reports, weather data, and geospatial information. With this capability, AI enables faster and more accurate data compilation, providing deeper insights into the current state of fisheries. Furthermore, AI can also be employed for trend analysis and prediction of future fish stocks. By analyzing big fisheries data, AI can identify patterns and relationships among various factors such as seasons, water temperature, fishing effort, and other environmental factors.

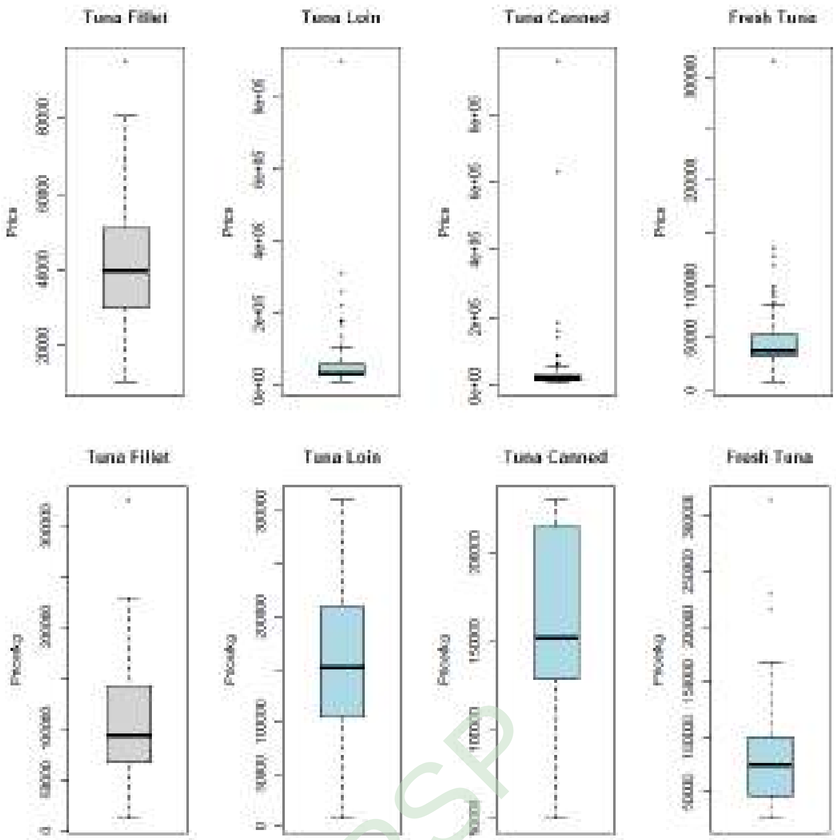

Figure 3. The price of each tuna product type resulted from the CDC application; raw data (above) and adjusted data (below)

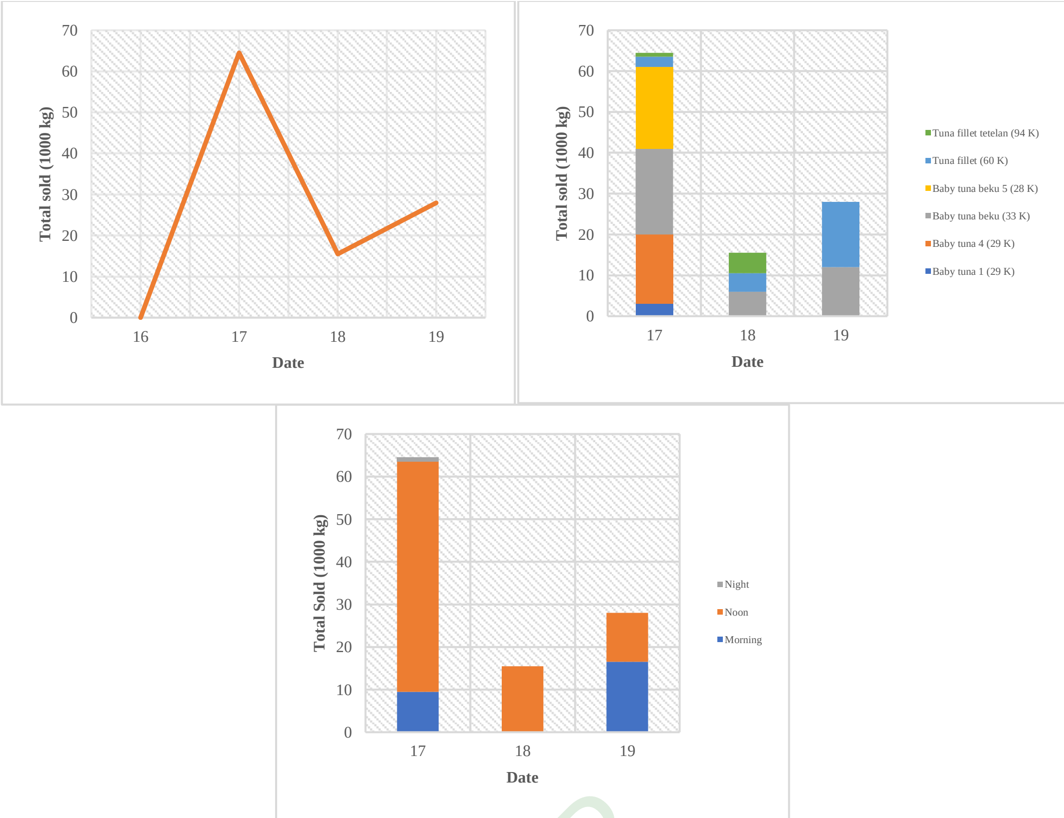

Figure 4. Time series monitoring results of tuna trade from selected stores in marketplaces

Data collection and analysis can be effectively and efficiently established by harnessing the support of all stakeholders, including infrastructure, human resources, and funding. By moving together in collaborative action, we can work towards ensuring the sustainability of fish resources and the sustainability of the fishery business. It is crucial to involve all relevant stakeholders, such as government agencies, research institutions, fishing communities, and industry representatives. Each stakeholder can contribute unique perspectives, resources, and expertise towards the common goal of sustainable fisheries. Adequate infrastructure enables the collection of accurate and real-time data on various aspects of fisheries, including stock assessment, fishing effort, and environmental conditions.

Human resources are essential for the effective implementation of data collection and analysis. Trained personnel, including scientists, statisticians, and data analysts, are required to conduct surveys, research, and process collected data. Collaborative efforts can involve sharing knowledge and expertise among stakeholders, promoting capacity-building initiatives, and fostering interdisciplinary collaboration.

Funding is a critical component in supporting data collection and analysis activities. Adequate financial resources should be allocated to ensure the continuity of research projects, data collection surveys, and necessary equipment maintenance. To secure sustainable funding sources, public-private partnerships, grants, and international funding mechanisms can be explored. By embracing a collaborative approach and leveraging the combined efforts and resources of all stakeholders, we can enhance the accuracy and reliability of fisheries data. These, in turn, allow for informed decision-making and the development of effective management strategies. Striving towards the sustainability of fish resources and the fishery business, we can ensure the long-term viability and well-being of our oceans and coastal communities.

One of the efforts to sustain the data collection program is the submission of a Kreasi Reka scheme, which is implemented in collaboration with partners and with matching funds from Kedaireka, Directorate General of Higher Education, Ministry of Education and Culture in 2023. This opportunity allows us to scale up the data collection for fisheries with a common goal; sustainable fisheries. Data collection is a "*never ending*" story. It must be addressed through a collaborative action involving all stakeholders (government, local government, academia, researcher, NGOs, private sectors, associations, community groups, and fishers). Data collection and analysis could be established using all the supports (infrastructures, human resources, and funding) from all stakeholders and moving together as a collaborative action towards the sustainability of fish recourses and fishery business.

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TUNA TALKS SESSION III – GOVERNANCE

12. Understanding the Intricacies of Governance in Fishing Vessel Crews and Seafood Workers in Indonesia: An exploratory study

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The fishery industry plays a significant role in Indonesia's economy, contributes 16% to the world's fishery production, ranked second among the countries in the world total production from capture fisheries, and contributes to employment and foreign exchange earnings (SEAFDEC, 2022; Firdaus, 2019). However, the welfare of fishers and seafood workers in Indonesia has been overlooked, and the human aspect of the fishery industry is vulnerable to high-risk working conditions without health and work guarantees (DFW, 2022). Nakamura et al. (2018) argue that Indonesia is one of the hub countries wherein seafood is made with a significant incidence of forced labour, child labour, or forced child labour in the seafood supply chain.

While currently, labour issues and human rights violations have become the subject of rising concern in fisheries and seafood production in international buyers and consumers (Lozano et al., 2022; Sparks et al., 2022; Nakamura et al., 2018). Recent research has mainly focused on severe violations such as forced labour, particularly in 'hotspot' geographies, often relying on indicators and risk-based approaches given the paucity of data and challenges of monitoring working conditions. Nakamura (2018) argues that sixty-five per cent to 70% of seafood for export markets is produced in developing countries where labour costs are relatively low, and the monitoring data of the hands pulling fish from the sea disappear.

The lack of governance structures and weak regulation implementations have resulted in poor recruitment processes, unstructured competency training and certification, low wages, and non-transparent management. The study paper proposes that systematic governance can contribute to assessing and improving a range of labour governance issues in Indonesian management fisheries. The paper elaborates on some critical considerations for studying labour governance structures and promoting welfare for seafood workers in Indonesia.

Growing Concern of International Buyers

Indonesia's fishery products exhibit a significant degree of competitiveness on the global stage (Suhana et al., 2016). These products are being marketed across major international markets such as Europe, the United States, Japan, China, Thailand, and Australia. Given the expansive reach of this global market, an increasing number of buyers and consumers are concerned about the well-being of all individuals engaged in the upstream and downstream sectors of the fisheries industry to prevent labour exploitation or enslavement (Sparks et al., 2022). Currently, the government of Indonesia have explored the impact of international agreements and trade policies on the seafood industry. For example, third-party certifications, such as MSC, Fair Trade, Fisheries Improvement Project (FIP) and Dolphin Safe, provide an assurance to international buyers and consumers that the fish they are buying was caught in the socially responsible way they are purporting aside from environmental concern. However, the fulfilment of social standards are not able to provide an assurance to social issues, while the government and industry just trying to reach market demand.

Labour Standard made by ILO and Indonesian Government

The Indonesian fisheries industry is not only crucial for economic growth but also for social development. As such, the social aspects of this industry have attracted considerable attention (Lozano et al., 2022; Sparks et al., 2022; Nakamura et al., 2018). Some have focused on the social impacts of fisheries management policies, including the diSSTacement of fishing communities, the loss of traditional livelihoods, food insecurity and poverty (Béné et al., 2007). The International Labor Organization (ILO) has been at the forefront of efforts to promote and protect labour rights in the fisheries industry. The organization has developed several international labour standards to improve working conditions and ensure that workers in the industry are treated fairly. Some key areas covered by these standards include wages, working hours, occupational safety and health, and social security (ILO, 2017). According to the ILO, workers in the fisheries industry are vulnerable to exploitation, including forced labour, child labour, and human trafficking. The ILO has developed several international labour standards and guidelines to protect workers' rights in the fisheries industry. However, the implementation of these standards remains a challenge, particularly in developing countries (ILO, 2018).

At the national level, the Indonesian government made Government Regulation No 27/2021 concerning Marine Affairs and Fisheries and Minister of Marine Affairs and Fisheries Regulation 33/2021 to make a standard for fishery governance. By establishing standards for fishery governance, they aim to promote sustainable fishing practices, protect marine ecosystems, and ensure the social and economic well-being of coastal communities involved in the fishing industry. This study tries to understand the governance structure to unravel the fisheries Industry's workforce in Indonesia, particularly in the four hotspots of the largest seafood producers and exporters.

Methodology

The study was conducted in four fishery hotspots in Indonesia: Benoa in Bali, Dobo in Maluku, Bitung in Sulawesi Utara, and Muara Baru in Jakarta. This study employed a mix-method approach, with quantitative data collected through online questionnaires and qualitative data collected through semi-structured interviews and observations. Three hundred eighteen respondents' answers were analyzed, and study locations were observed. Out of the total respondents, fishers (69%), factory workers (19%), head of vessel technicians (4%), and technicians (4%). In order to analyze the governance structure of labour conditions in four different locations, we feature triangulation data with 18 interviews of an organization, government authority, and fishers for a progressively looking into the detail of Recruitment, the process to the vessel or industry, working conditions, and after the working process.

Results

Indonesia is one of the largest fisheries producers in the world, and the industry plays a crucial role in the country's economy. The total number of fishers and seafood workers in Indonesia in 2021 was 2,925,818 million people (Marine and Fisheries Ministry Statistics, 2022). Specifically, in Bali Province, there were 64,249 people; in Maluku Province, there were 193,756 people; in North Sulawesi Province, there were 79,295 people; and in DKI Jakarta, there were 75,604 people. To unravel the governance structure in Industry's workforce in Indonesia, the discussion of the results divided to four stages: recruitment process, process before work, working conditions, and after work period ends.

a. Recruitment Process

The recruitment process for fishers is as follows: 28% of the Recruitment comes from middlemen, and friends and relatives invite 35% (figure 1). On the other hand, almost all workers in the processing unit apply directly to the company and go through the company's recruitment process. The problem with recruitment through middlemen or referrals is the need for more knowledge about the job of fishers and fishing. "On average, middlemen target unemployed individuals, street children who have no job. They are enticed with high salaries and the opportunity to work abroad. They do not understand the working conditions and risks involved in sea-based work," one of the observers confirms the existence of middleman and how they recruit workers.

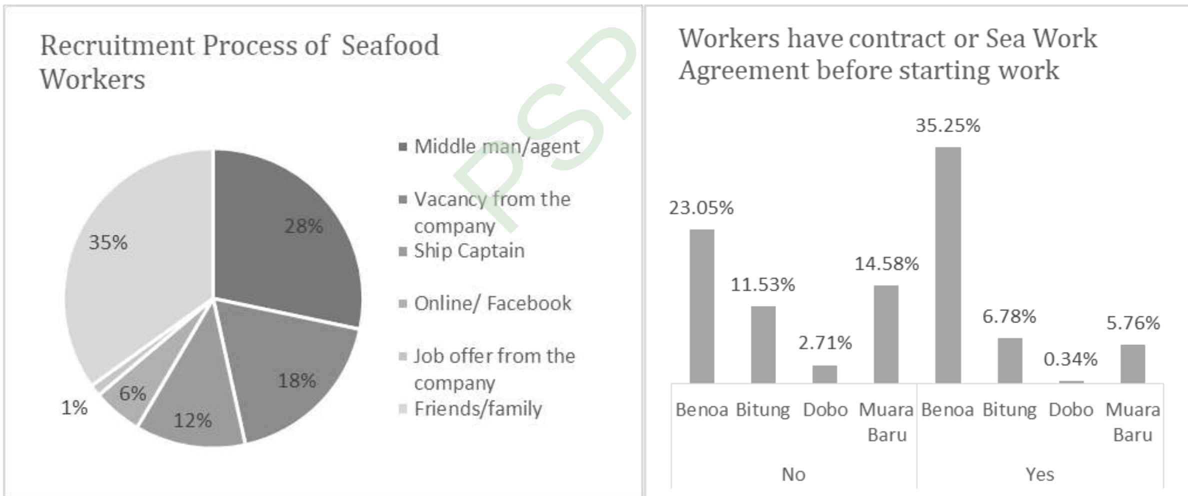

Figure 1. Recruitment Process and Ownership of Contract/Sea Work Agreement

One of the port authorities says, "Recruitment is the entry point for workers to board the ship, so all problems start with their skills and knowledge. Without skills and knowledge, their jobs are unsustainable and tend to be mismatched with their expectations." The statement shows that the current recruitment governance system has been going on for a long time and has yet to consider the background and skills of prospective workers.

b. Process before work

The issues continue with the preparation process before working on the ship after recruitment process. Workers state that senior fishers or vessel captains directly train them without any formal training process or documentation, such as Basic Safety Training (BST) or Seaman Book. Based on interviews with fishers at the port, some undergo a one-month training process to obtain the Seaman Book. Some stated that they only underwent a three-day training process before working on a tuna vessel for 10 months or on another ship during a 2-week sea voyage.

Less than 35.25% respondents in four location stated they are aware of the importance of Sea Work Agreement. More than 50% do not know the content of Sea Work Agreement of do not know at all. Fishers confirmed that the process of signing the Sea Work Agreement is very quick. "During the signing process of the Sea Work Agreement, we are told to sign quickly because the ship is about to depart. I was trying to find out what's in it... but I couldn't. Mine has held by the management," one of the fishers shared about the process before working on the ship. From the interview, it was found that the Sea Work Agreements for the fishers are just vessel requirements to sail. For example, in Benoa, one of the fishers explained, "At Syahbandar, we only sign papers... because it's for sailing approval requirements." Syahbandar is a government authority under the Ministry of Transportation that grants sailing permits.

c. Workers are feeling about working conditions.

Regarding working condition, there is a significant difference between fishers and seafood workers in the industry. "On tuna boats, fishers work 12 hours a day. There are a rolling system for 18 people. One rolling consists of 9 people," explained one of the fishers. In the case of squid boats, the situation is more extreme. "The working hours for fishers on squid boats are extremely harsh. We start at 4 am to fish for squid until 6 in the morning, then we break to eat. We clean up the equipment until 10 am then we have time to sleep until 4 pm. And it goes on like that." The demanding nature of the work and the high targets set by the boat captains are not supported by adequate basic facilities. In addition, fishers acknowledge that the food supply on the boat is only sometimes sufficient for all fishers, resulting in them having only two limited meals per day.

These statements are also reflected in the survey results (Figure 3), which indicate that the workers strongly disagree that their working conditions are good. In Muara Baru, 34% of workers disagree, while in Dobo, the percentage is 41%. Furthermore, 42% of workers feel that their working conditions could be better, with Bitung having the lowest percentage of workers who feel that way, less than 10%.

The survey also reveals that besides the strenuous nature of the work, pressure and intimidation are present. The highest percentage of workers feeling intimidated at work is in Dobo (79%), followed by Muara Baru (58%), Bitung (52%), and Benoa (39%). From these statistics, there is still a lack of comfort in the workplace for fishers

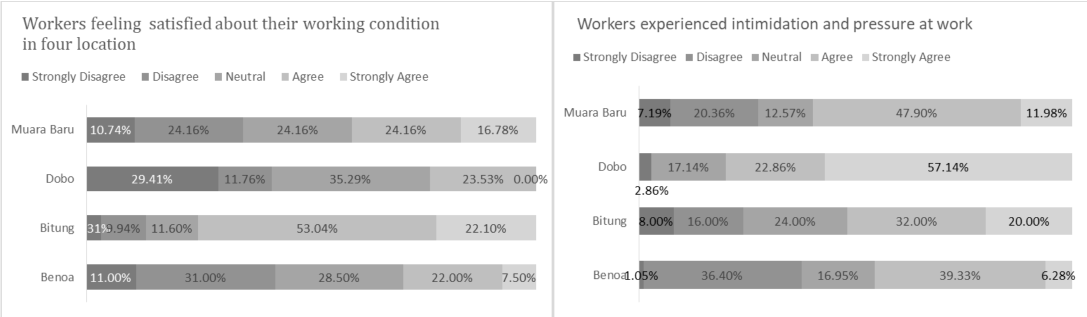

Figure 2 Workers feeling about working condition

d. After the work period ends

Upon completing their contracts or fishing periods, whether for 10 months or 2 weeks, the wages or benefits received by fishers often need to align with what was promised. Fishers have two income schemes: a fixed wage and a profit-sharing scheme based on the weight of their catch. This scheme is based Minister of Marine Affairs and Fisheries Regulation 33/2021.

One fishers from a squid boat stated, "The daily wage is 30,000 rupiahs, and for profit-sharing, squid is valued at 10,000 rupiahs per kilogram." When calculated monthly, they only receive 900,000 rupiahs as wages, while the minimum wage ranges from 2,500,000 to 5,000,000 rupiahs (Regulation of the Minister of Labor 18/2022). However, with the inclusion of bonuses, their earnings can exceed the regional minimum wage if the workers are in good condition and the squid season is prosperous. Conversely, if they are sick or unable to fish, fishers do not receive any compensation.

In contrast to the workers in the company, one seafood worker narrated, "The working conditions for industry workers are more prosperous. They receive the regional minimum wage (UMR), bonuses, and health insurance coverage from BPJS and the company. … have been working for 7 years. Every year, there is a salary increment. The working hours are from 7:30 am to 4:30 pm every day. The workload and working days are appropriate." The process diagram, encompassing Recruitment, pre-employment procedures, working conditions, and post-employment aspects, can be observed in Figure 4.

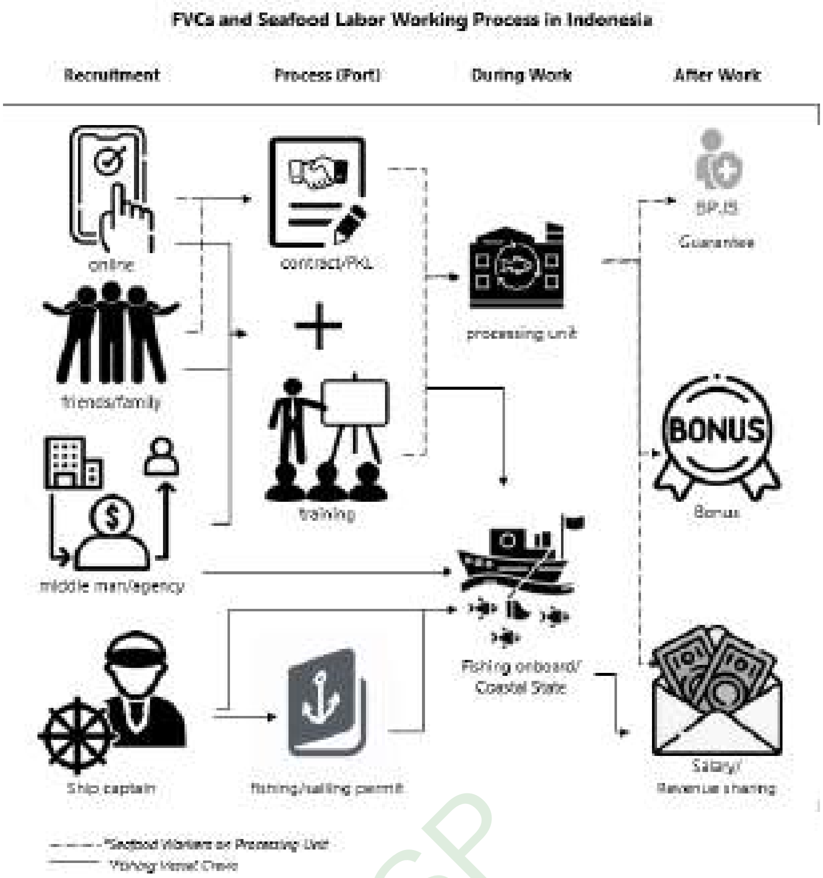

Figure 3. Fishers and seafood workers are working process in Indonesia

Discussion and Conclusion

The study found that the governance of seafood workers from recruitment, pre-employment processes, working conditions, and employee benefits in the fishing industry are far from standard made by ILO or Indonesian government in Minister of Marine Affairs and Fisheries 33/21. Recruitment heavily relies on middleman, lack of education or training for the workers, poor wages transparency, and lack proper communication with workers about Sea Work Agreement. Consequently, welfare of fishers and seafood workers is overlooked.

The regulations made by the Ministry of Marine Affairs and Fisheries and Ministry of Labor have not been implemented optimally. The study revealed that there is still a gap in worker welfare, upstream workers are not with a fishing background, have an uneven understanding of Sea Working Agreements, unstructured training systems and supervision from the provincial or regional level that has not adequate. Even though there are regulations at the national level, they only partially regulate the mechanism for monitoring fishing vessel crews. Meanwhile, at the provincial level, supervision of crew members has been carried out by North Sulawesi through the Labor Office through inspections with fishing vessel crews. Therefore, build and strengthen rules and mechanisms for monitoring fishers and other seafood workers that apply at the central and provincial governments are crucial. Furthermore, there are unintegrated regulation that can also be seen in the difference in the payroll system between the Labor Office and monthly recitation system (minimum wages) and the Minister of Marine Affairs and Fisheries, which acknowledges profit sharing. There has yet to be an actual application of profit-sharing standards in the field. There should be an agreement between the Department of Labour and the Department of Maritime Affairs and Fisheries regarding the payroll system or revise Ministry Marine Affairs and Fisheries Regulation 33/2021.

The study suggests a network involving government, industries, workers, and practitioners should be developed to enhance collaboration, knowledge sharing, and the grievance mechanism for more effective fisheries governance. As H. Setyawan et al. (2020) argue, the Indonesian government should prioritize the development of a comprehensive and coordinated fisheries governance framework. Governance challenges have plagued the industry, including overfishing, illegal fishing, undetected forced labour, and weak enforcement of regulations (Kusumawati, R., & Rosyid, D. M, 2018). The various governance frameworks are full of intricacies in Indonesia, including the role of government agencies, civil society organizations, private sector actors, and the workers themselves. Workers also should be empowered to voice their concerns and participate in decision-making processes related to decent work through fishing unions

The Indonesian government should prioritize comprehensive and coordinated fisheries governance. The concept of decent work by the International Labor Organization (ILO) can help address labour issues in the sector. It emphasizes a comprehensive human rights approach to decent work. Understanding political-economic systems and historical factors influencing seafood production is crucial Lozano et al. (2021). Governance structures should be established to safeguard workers' rights and well-being, and a comprehensive network involving stakeholders is recommended. Human capacity development and management transparency in the Indonesian fishery industry are essential. Workers should be empowered to voice their concerns and participate in decision-making processes related to decent work. By implementing these recommendations, the fisheries sector can uphold the principles of decent work and ensure the well-being of fishers and seafood workers.

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13. Decades of FADs Regulation in Tuna Fisheries: Moving Forward or Going Nowhere?

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The tuna fishery is the most important and predominant in Indonesia. Artisanal fish aggregating devices (FADs) in tuna fishery are the main contributor to tuna catches in Indonesian tuna industries. Most of the tuna fishery associated with FADs in Indonesia is categorized as artisanal, in which more than 75% of the tuna fishing fleet is under 10 GT size (ACIAR, 2019). It plays as the primary source of tuna for industry input and consumed fish. The use of fish aggregating devices (FADs) for tuna fishing has been established since the early 1980s. Ever since, it has had critical roles for the significant tuna fishing fleet, namely pole and line, handline, troll line, small pelagic mini purse seine, small pelagic purse seine and large pelagic purse seiner (Figure 1).

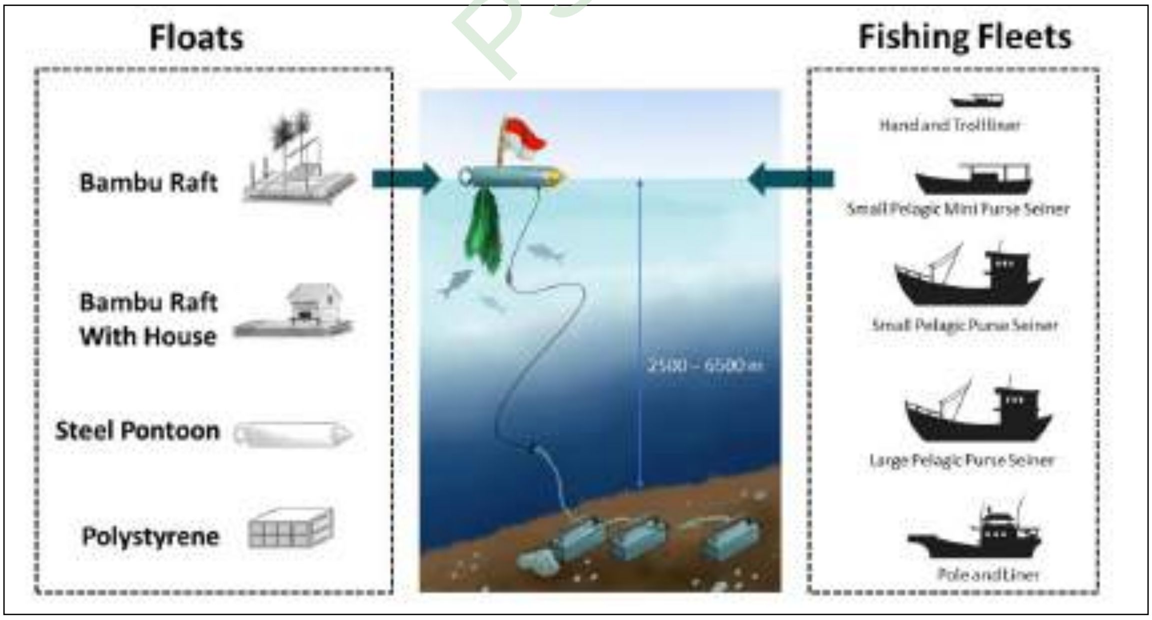

Figure 1. Anchored FAD Characteristics (Sources of pictures: Agavia – FRCI, 2023)

FAD-associated fishing fleet vary in size and engine power, both between fleet segments and within each vessel group. Hand line and troll line vessels are usually the smallest in size, while the pole and line vessels are the largest. Number of crew differs for each fishing fleet and it influences income shares. Yield and profit from each fishing trip is SSTit between crews and FAD owners according to fixed rules and arrangement. The captain gets the highest share of the crew followed by engineer and ordinary deck crew.

Since the FADs in tuna fisheries still offer benefit/profit, this encourages the FAD fishers to invest more in the FADs. Studies in Kendari and Palabuhan Ratu show an ongoing over-investment in Tuna fisheries, such as an increase in new FADs deployments. One of the factors was the traditional culture among fishers. They try to compete with one another in terms of the number of the boat and the number of FADs owners to show the success level of their achievement. Common FADs tuna fisheries are the extensive investment and the uncontrolled increasing number of FADs, increase the fishing pressure, bycatch issues, the juvenile catch, conflict for space competition (for FADs placement), lack of knowledge about FADs licensing procedures, robust data, and information to formulate FADs management (science-based policy) (ACIAR, 2019). Better management of FADs will prevent over-investment in FADs in the tuna fishery. That will help minimize the negative impact of too many FADs in tuna fishery, such as low fish densities in every FAD, longer time to catch fish, and higher fuel costs due to the empty FAD.

The government of Indonesia initiated FADs management in 1997 through the Ministry of Agricultural Republic of Indonesia Regulation Number 51/KPTS/IK.250/1/1997 concerning the installation and utilization of fish aggregating devices (FADs) (MA-RI, 1997); the regulation then being revised in 2004 based on the Ministry of Marine Affairs and Fisheries Republic of Indonesia Regulation No. 30/2004 concerning FADs Installation and Utilization (MMAF-RI, 2004). The revision of FADs regulation in 2011 was conducted based on the Ministry of Marine Affairs and Fisheries Republic of Indonesia Regulation No. 08/2011 concerning fishing zone and placement of the fishing gear and supporting fishing device operation in Indonesia's fisheries management areas (FMA's) (MMAF-RI, 2011).

Ministry of Marine Affairs and Fisheries Republic of Indonesia Regulation No. 26/2014 concerning FADs were enacted to update the FAD regulation (MMAF-RI, 2014). The most recent regulations concerning FADs are Ministry of Marine Affairs and Fisheries Republic of Indonesia Regulation No. 18/2021 concerning placement of fishing gear and fishing support equipment in Indonesia's fisheries management area (FMA's) and open seas, as well as the arrangement of *andon* (temporary migrate) fishing fleet (MMAF-RI, 2021), Ministry of Marine Affairs and Fisheries Republic of Indonesia Regulation No. 10/2021 concerning standards for business activities and products in risk-based licensing implementation in the marine and fisheries sector (MMAF-RI, 2021b). Based on these latest regulations, more requirements are required to install the FADs in the sea. A new additional requirement before obtaining a FADs installation license is approval on the suitability of marine spatial utilization activities granted by the Directorate General of Marine Spatial Management (DGMSM) – MMAF. A detailed matrix regarding FAD regulations is presented in Table 1. In general, all regulations require periodic reporting of FAD utilization.

Table 1. The summary of regulations concerning FADs installation license

No	Aspect	1997	2014	2021
1.	Document Needed	Photocopy of Fishing Business License (IUP) Schedule and the coordinates for FAD installation. Construction design drawings	Photocopy of Fishing License. Copy of identity card General plan layout drawing of the (FADs) and technical specifications of the FADs FADs Utilization Plan.	Fishing Vessel book Business License for the Fisheries Capture Subsector Approval of the Suitability of Marine Spatial Utilization Activities FAD Utilization Plan.
2.	FADs Placement	Installation is not disturbing marine shipping/transportation routes The minimum distance between FADs must be more than ten nautical miles Not to be placed in the marine organism migration lane Not to be placed in shallow waters (less than 200 m). Not to be placed in waters with less than 12 distance. The installation must not be in a zig-zag configuration to prevent a barrier effect.	Placed in the fishing ground as mentioned in SIPI Not to be placed in the shipping lane Not to be placed in ALKI (Indonesian Archipelago Sea Lane) The minimum distance between FADs must be more than ten nautical miles. The installation must not be in a zig-zag configuration to prevent a barrier effect. Avoid unwanted bycatch by not using the net as attractor material.	The minimum distance between FADs must be more than ten nautical miles Placed in the fishing ground Not to be placed in MPA Not to be placed in ALKI (Indonesian Archipelago Sea Lane) Not to be placed in marine organism migration lane. Not to be placed in the shipping lane.
3.	FADs Limitation	No FAD limitation	The ownership of the FADs is also regulated; the maximum number of FADs for one boat/owner is three	The maximum number of FADs for one boat/owner is three for the vessel operated in FMA waters

No	Aspect	1997	2014	2021
				15 FADs for the fishing fleets operating on high seas 5 FADs for the fisher's groups or cooperatives for a minimum of 10 vessels
4.	FAD Specification	No detail specification	FADs are accompanied by technical specifications that include at least each component's material, size, and quantity FAD must be equipped with an identification mark (includes a. owner's name; b. SIPI number and name of the authorized vessel; and c. coordinates (latitude and longitude) of the FADs installation location and radar reflector.	FADs are accompanied by technical specifications that include at least the material, size, and quantity of each component FAD must be equipped with an identification mark (includes a. owner's name; b. SIPI number and name of the authorized vessel; and c. coordinates (latitude and longitude) of the FADs installation location and radar reflector. Drifting FADs should follow RFMO Regulations
5.	Pre-Requirement Approval	No Approval Required	No Approval Required	Approval on the Suitability of Marine Spatial Utilization Activities.

Although Indonesia has had FADs regulation since 1997 through multiple upgrades and additions to the regulations, these regulations have not achieved adequate implementation or enforcement. A low level of understanding by the fisher community on how the laws are intended to operate and on the benefits that the laws will achieve for the fishers through improved sustainability of the fisheries have been key contributing factors to the lack of 'sign on' and adherence to them.

The willingness to obtain the FADs installation license (SIPR or *surat ijin pemasangan rumpon*) is high among the fishers. Nevertheless, implementing the FADs management was still lacking; Figure 2 shows the FADs installation license (SIPR) issued by North Maluku Province in December 2022. However, the fishers, fisher's group and private are still waiting for the approval on the suitability of marine spatial utilization activities granted by the Directorate General of Marine Spatial Management (DGMSM) – MMAF. The infrastructure and institutional arrangement to facilitate the licensing implementation is still poorly established. At the same time, the sanction for the violation of this requirement is an expensive penalty according to the Government Regulation Republic of Indonesia No 85/2021 concerning the types and rates of non-tax state revenues applicable to the Ministry of Marine Affairs and Fisheries – MMAF (GRI, 2021). Currently, most captains and boat owners do not know the regulations and the limited number of FADs allowed for each vessel. Efforts in socialization and enforcement of the ministerial regulation are needed, and the government are putting a series of socialization and dissemination. Tuna FADs management for artisanal fisheries is still a big challenge in Indonesia, but it cannot be ignored.


PEMERINTAH PROVINSI MALUKU UTARA

SURAT IZIN PENEMPATAN RUMPON (SIPR)

LAMPIRAN SURAT IZIN PENEMPATAN RUMPON (SIPR)

Figure 2. An example of a FADs Installation Licence (SIPR)

FADs legalization is crucial to sustainable FADs management and ensuring tuna fishers' safety and livelihood. Legalizing Fish Aggregating Devices (FADs) is a crucial solution for sustainable FADs management, ensuring the safety and livelihood of tuna fishers, and safeguarding the fishery business. FADs are devices used by fishermen to attract and aggregate tuna fish. However, using FADs can also negatively impact marine ecosystems and the sustainability of tuna stocks. Therefore, legalizing FADs plays a significant role in maintaining sustainable FADs management. Through FADs legalization, governments and relevant stakeholders can implement regulations that govern the responsible use of FADs. These include disseminating information and raising awareness among fishermen about best practices in FADs utilization, proper location selection, environmentally friendly FADs, and using protective gear to mitigate adverse impacts on the ecosystem.

Furthermore, FADs legalization helps ensure the safety and livelihood of tuna fishers. With clear regulations, fishermen can work in a safer environment, avoiding risks associated with uncontrolled FADs usage. Governments and stakeholders can also provide training and technical assistance to enhance fisher's understanding of sustainable FADs utilization. Additionally, FADs legalization plays a vital role in ensuring the sustainability of the fishery business. By regulating FADs usage, governments and stakeholders can prevent overfishing, thereby maintaining fish stocks. This measure positively impacts the fishing industry's continuity as fishermen can rely on sustainable fish resources. Until now, implementing FADs regulations has proved difficult primarily due to the lack of information needed to establish the management measures.

In conclusion, legalizing FADs is a crucial solution for sustainable FADs management. It ensures the sustainability of marine ecosystems and tuna stocks, protects the lives and livelihoods of tuna fishers, and safeguards the fishery business. Therefore, governments and stakeholders must collectively disseminate information, facilitate, and ensure compliance with FADs legalization. Innovation in regulation is needed to accelerate the legalization of FADs. FADs and FADs-related fishing fleet census and licensing could be proposed as first and priority programs in DGCF-MMAF involving other related ministries, government bodies, provincial government, associations, private sectors, fishers, academia, and NGOs.

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14. Transnational Organised Crime in Fisheries Threaten the Sustainability of Future Tuna Commodities in Indonesia

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Indonesia, positioned in the equatorial region between the Pacific Ocean and the Indian Ocean - two significant tuna fishing areas, is exposed to infringements of fisheries laws (Khan et al. 2019). Additionally, the country comprises over 17,000 islands distributed among eleven fishery management regions designated for stock assessment, monitoring, allowable catch allocation, and fishing licenses (Sunoko & Huang 2014; Khan et al. 2020). Indonesia is recognized as one of the leading tuna producing countries worldwide, and its tuna fishery is one of the most valuable seafood commodities in the country, supplying 16% of the world's seafood (Yuniarta et al. 2017; Khan et al. 2019; Khan et al., 2024).

We conducted a systematic literature review to shed light on this issue, as it is a national priority to combat IUU fishing practices to enhance the national income from the fisheries sector. The Presidential Decree Number 16 of 2017 concerning Indonesian Ocean Policy (IOP) was signed on 20 February 2017, with the goal of realizing the Global Maritime Fulcrum Vision of “Indonesia as a sovereign, advanced, independent, strong maritime nation that is able to provide positive contribution for peace and security in the region as well as to the world”. The IOP includes efforts in combating IUU fishing (e.g. Khan et al., 2024)

One of the fisheries in Indonesia, tuna fishery, is essential for the national income and livelihood of the coastal communities (Khan et al. 2018). However, IUU fishing practices are rampant in tuna fishing by local and foreign fishing fleets that use large bonded labour forces and destructive fishing gears (Table 1). These practices neglect the sustainability of the tuna resource and social fairness. The authors categorize the most typical unlawful actions as illegal, unregulated, and unreported, and they consider IUU fishing activities as crimes against human rights, which involve forced labor, human trafficking, corruption, and smuggling of tuna (Belhabib et al. 2020).

Table 1. Total number of fishing vessels sunk by their origin flags 2015-2017

No	*Flags*	*2015*	*2016*	*2017*	*Total*
1	Vietnam	35	39	88	162
2	Philippines	35	34	-	69
3	Thailand	18	19	4	41
4	Malaysia	8	7	8	23
5	Indonesia [domestic]	10	4	3	17
6	Papua New Guinea	-	2	-	2
7	Nigeria	-	1	-	1
	Total	106	106	103	315

Source: Nainggolan *et al*. (2018); Khan et al. (2024)

The violation of human rights in capture fisheries in Indonesia includes forced labor, child labor, violence against fishing communities, human trafficking, fishing crew slavery, and arms smuggling (Mackay et al. 2020). The Benjina Case in Kepulauan Aru, Maluku Province in 2015 involved more than 2000 people who were found in situations of forced labor and human trafficking in an integrated fishing company called PT. Pusaka Benjina Resources, most of whom came from neighbouring countries. Given the involvement of more than one nationality and across nations, it was classified as the biggest transnational organized crime in fisheries in Indonesia (Chapsos & Hamilton 2019).

The Indonesian government has taken strong measures to respond to IUU fishing practices. Many foreign and domestic fishing vessels whose companies were convicted of fisheries crimes were sunk between 2015 and 2017, sending a strong message about Indonesia's response to IUU fishing practices. Law enforcement activities and prosecution of illegal fishing continue to be carried out by the Directorate General of Marine and Fishery Resources Supervision, Ministry of Marine Affairs and Fisheries (e.g. Khan et al. 2024). However, law enforcement is complicated by intentional violations of fishing laws by national fleets, particularly when their countries have strictly imposed fishing moratoriums.

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15. Indonesia Archipelagic Tuna Industry Rapid Assessment

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This report assesses the current situation in Indonesia's tuna sector in Bitung, Ambon, and Kendari, including the impacts of Covid-19 on the industry. Data quality and availability varied widely between ports and government agencies. Where data was available, it sometimes contradicted data reported by industry. Bilateral trade data between Indonesia and the US for tunas showed similar discrepancies, a further indication of data challenges.

Major findings on the Indonesian tuna fishery include:

a. A significant decrease in pole and line catch in Bitung vis-à-vis purse seine, likely due to the higher catch efficiency of purse seine and the ability to target multiple species without the need for bait.
b. Bitung canneries continue to operate far below capacity and appear to struggle with access to the US market due to lack of engagement with sustainability initiatives (for purse seine caught fish) – there is industry interest in a (basic) FIP for purse seine in Bitung, and all indications are that a FIP would improve access to the US market.
c. Consolidation in the fresh/frozen yellowfin processing sector in Ambon due to the negative demand shock associated with Covid.
d. A significant decrease in pole and line industry in Ambon, reportedly due to a lack of skipjack in the surrounding waters and ongoing challenges with securing bait.
e. A substantial portion of high value adult yellowfin and commodity skipjack is exported to Vietnam and Thailand, respectively, for further processing and reexport, it could be impactful to convene a group of stakeholders to better understand this issue and attempt to identify initiatives to improve Indonesia's competitiveness.
f. A notable decrease in tuna catch in Kendari which appears to be driven by a restriction on licensing for (purse seine, pole and line) vessels above 30 gross tons in fisheries management area 714.
g. AP2HI is experiencing significant challenges regarding the payment of MSC fees by its members. The reasons for this are unclear but appear to be related to MSC demand challenges and potential underreporting by members.
h. Data from the Fish Quarantine and Inspection Agency (BKIPM) provides the greatest level of trade detail by shipping port, yet also appears to have the greatest challenges in terms of data accuracy and transparency. Understanding the nature of these challenges in ports such as Bitung and Ambon, as well as in Jakarta and Surabaya, could yield insights into potential "outside the box" fisheries data improvements.

Note : The full manuscript is not available in this proceeding.

16. Traceability and Certification

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The fair trade organization as well as the movement and the fair trade concept how it relates to tuna in Indonesia and what fair trade specific lessons have been learned so far in Indonesia and beyond.

As an organization fair trade in federate USA has been found in 1998 and since then mostly be known for bananas, tea, coffee certification like this bringing together farmers with consumers and giving consumers the choice consciously buy product that they know will benefit producer.

Since 2014 we are also doing seafood and that label can be used worldwide It’s not for seafood, its not just for USA thing, but it can be used in Europe, Japan and Indonesia potentially

In the fair trade concert in all our standards, we have several modules. All of the modules for all things that we certify including seafood a strong component of empowerment giving fishers and worker that mean to self regulate to organize themselves. Then we have of course fundamental rights at work, working agreement like destructive fishing watch has already mentioned those need to be in place people. Need to receive the correct rest periode not being overworked. People often forget there’s also resource management which actually quite strict, transparency and traceability requirement are in there as well as an internal management system which helps certificate holders and fishers workers to stay on track of all those requirements. A unique point for federal certification is that the requirement increase over time.

What that means for a two current tuna fisheries in Indonesia, one is up there in North Sulawesi pole and line and the other one with MDPI all over Moluccas. That increase over time and those fair trade groups which are now 6-7 years old that means we have by far worldwide the most experience fair trade implementers in seafood in Indonesia and in tuna. But also the other way around it means we have the most experienced fishers because fair trade remember works both ways its not just consumer asking for something but its also the fishers learning and being part of that experience

Specifically for traceability what we learn so far or I want to extend traceability from the typical thing just following the product until it ends up somewhere. For fair trade traceability also means tracing back the additional income that’s being earned and being paid from abroad following that back two community accounts following it back into projects and then having a accounting system making sure that traceability is also monitored. So it works both ways. Fisheries data and managing of fisheries data as well as those premium additional funding coming back. If the goal is to entrust fishers and workers you need to build capacity for those fishers and workers which is for fair trade the empowerment module and how exactly to do that and again for capture fisheries and for tuna Indonesia that’s most significant experience worldwide here in Indonesia

Fair trade is doing together with MDPI, we we’re doing focus group discussions with those fisher groups that have those experience and ask what is the main reason why did you start with fair trade? what we found is a big motivation for them is not necessarily the traceability, they are not interested in traceability. What motivates them is access to government service, access to training, and they agree that very strict rule within the groups are important and also follow up on meetings so adhering to rules to their own rules. And even after six years NGOs also still needed to support those groups. Even more so when its about establishing corporations because NGOs know more about the outside world, they know how to connect with the government, they know a little bit about legal stuff so they have more like the sensory organs for groups that want to establish themselves or for corporations.

Next step from those focus group discussions within the tuna consortium we will consolidate the result into a draft manual of best practices how to proceed of organizing fish of groups organizing themselves probably evolving into corporations.

Note: The full manuscript is not available.

17. MCS System for Tuna Fisheries at the Indonesian Fisheries Management Area

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The monitoring Control and Surveillance (MCS) system is an integral part of fisheries management. Monitoring is defined as the continuous requirement for the measurement of fishing effort characteristics and resource yields. The activities of monitoring included the collection, measurement, and analysis of fishing data. For Example, the data on fishing activities, catch area of operation, and potential bycatch. Furthermore, the control defines regulations related to fishing activities, both nationally, regionally, or internationally. It includes things that are required or prohibited when carrying out fishing activities. Meanwhile, surveillance is an element related to compliance to ensure that fishing activities are in accordance with applicable regulations, and law enforcement (Flewwelling, 1994; Flewwelling et al., 2002; Flewwelling & Cullinan, 2000).

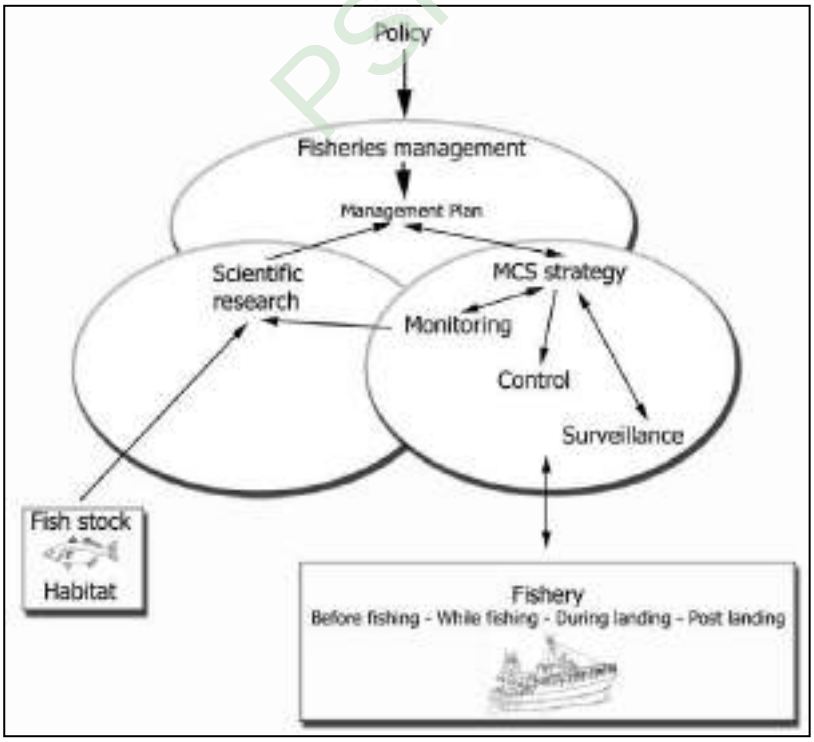

Figure 1. The main links between MCS and fishery management (Bergh & Davies, 2009)

The MCS system is needed to ensure the sustainability of fisheries resources including the tuna and tuna looks like when there are any issues of tuna fisheries. The tuna fisheries in the Indonesian Fisheries Management Area (IFMA) as a part of the world tuna habitat also facing some issues. The Minister of Marine Affairs and Fisheries Decree number 121 of 2021 on Fisheries Management Plan of Tuna, Cakalang, Tongkol in the IFMA stated of some tuna management issues related to MCS. The first issue is fish resource problems that the Bigeye Tuna and/or juvenile Yellowfin Tuna are still caught by purse seine fishing gear using fish aggregating devices (FADs) in the IFMA of 571-573, IFMA of 713 -715, and IFMA 716-717). Furthermore, the lack of adoption of regional provisions related to the prohibition and prevention of catching certain shark species (Cakalang). Secondly, the social economy problem related to the implementation of the catch documentation scheme for Southern Bluefin Tuna has not been optimal (in IFMA 571-573). The next issue related to the Skipjack and Tuna governance issues is that the application compliance and accuracy of fishing logbooks are not optimal, the minimum standard of observers on board has not been met, the practice of storing illicit bycatch still occurs, port state measures still not fully implemented, there has been no legal action against vessels listed on the IUUF vessel list in the Regional Fisheries Management Organizations (RFMO), the practice of destructive tuna fishing still occurs, the Vessel Monitoring System (VMS) has not been optimally utilized to support the level of compliance in reporting to RFMO (KKP, 2021).

This study material includes the Minister of Marine Affairs and Fisheries Decree number 121 of 2021 on the Fisheries Management Plan of Tuna, Cakalang, Tongkol, and the references to MCS implementation in Australia, the United Kingdom, and New Zealand. The data was analyzed by desk study, comparison, and drawing lessons learned (Martins, 2000).

The Australian Government through the Australian Fisheries Management Authority (AFMA) implemented the MCS System in some methods, namely the electronic monitoring program, observer program, VMS, logbooks and e-logs, and catch disposal record. Electronic monitoring is a system of video cameras and sensors capable of monitoring and recording fishing activities, which can be reviewed later to verify what fishers report in their fishing logbooks. These systems are now compulsory for most commercial fishing boats in the Eastern Tuna and Billfish Fishery, the Western Tuna and Billfish Fishery, the Gillnet, Hook, and Trap fishery, and the Midwater Trawl Sector of the Small Pelagic Fishery. The electronic monitoring also helps AFMA to verify that fishers accurately report the amount and type of fish they catch, allows AFMA to verify that fishers report all interactions they may have with threatened, endangered, and protected species, saves the fishing industry money, as on-board observers are not required for boats that have e-monitoring systems. The benefits of electronic monitoring are the fishers can show they are responsible operators and follow fisheries management arrangements, they are responsible for their own actions and AFMA can work with individual fishers to improve their practices without penalizing responsible fishers, and in the overtime the impact of e-monitoring leads to improved data, enabling AFMA to make better management decisions and improve compliance with measures designed to protect both commercial and protected species. For this reason, successful fishery management relies on the collection of data that accurately reflects fishing activities. Data on catch, effort and bycatch is used in scientific stock assessments to make sure that fishing is sustainable now and into the future. With e-monitoring, AFMA, scientists and the public can be confident that fishing activities are independently monitored, and that fisheries data is accurately reported. This in turn helps improve the overall quality of scientific assessments and decision-making. The use of e-monitoring in Australia provides greater insight into fishing operations, including the state of fish stocks and the impacts of fishing on the marine environment. This enhances AFMA's ability to manage common-wealth fisheries and provides consumers with confidence that the seafood they buy from common-wealth-managed fisheries is from a sustainable source with a low environmental impact. Electronic monitoring works as an e-monitoring system that includes several key components: three or more video cameras, a hydraulic gear sensor, a drum sensor, a GPS receiver, satellite communications and a control center. Sensors on the drum and the vessel's hydraulics trigger the video cameras to record both the gear being set and hauled. This fishing information is stored on the system's hard drive for detailed analysis. Some information such as vessel location is transmitted to AFMA for real-time monitoring (AFMA, 2022).

The AFMA also implements logbooks that are a record of daily catch information for fishing boats. They are designed to provide a continuous record of fishing operations undertaken by Commonwealth fishing concessions holders. The AFMA logbooks are used to collect information about when and where you are fishing, the type of gear is using, the composition of catch, and any interactions with threatened, endangered, or protected species. This information is important for determining the status of fish stocks and making management decisions, including the setting of total allowable catches. Logbooks are required to be completed in all Commonwealth fisheries. Logbooks can be submitted to AFMA electronically using electronic logs (e-logs) or manually using paper logs. The holder of the fishing concession is responsible for ensuring that this logbook is completed and that it is certified as complete and correct. The logbook must be submitted by the person responsible for the fishing operations of the boat (skipper) during the fishing trip. If the skipper is not the same person as the concession holder, they must be authorized as an agent of the concession holder. Not only electronic monitoring and logbook but also catch disposal records are used by fisheries managed under the quota system to gather and maintain data on the species caught. On landing, the fishing permit holder, statutory fishing right holder, or a nominated authorized person is required to complete a catch disposal record form detailing the species caught and their accurate weight. Depending on the fishery, operators may also have to record the number of boxes of each fish consigned and usually the processing state (whole weight, headed, gilled/gutted, etc.) in which the fish were landed and the number of shark carcasses. The fishing operator keeps a copy of the completed and signed form, forwards the original to AFMA, and sends the remaining two copies with the fish to the fish receiver. On arrival at the first fish receiver, who must hold a fish receiver permit, the fish must be weighed and the fish receiver (who may be a processor, retailer, or fish market) must record the species and weights (and shark carcass numbers) and sign the copy of the form consigned by the concession holder with the fish. The receiver forwards a copy of the form to AFMA and keeps the third copy on the premises, where it may be inspected if required. The data from the forms are entered into AFMA's fishery database. The catch information is integrated with records of quota entitlements. Updates on the remaining quota are provided periodically to management and the industry. The catch disposal records may also be used for non-quota fisheries. In these cases, detailed information is required on landed catches for stock assessment or other purposes (AFMA, 2022).

The Ministry of Primary Industries, New Zealand (2023) reveals that New Zealand ways to monitor fishing activities include E-logbook, patrols by fisheries officers, using satellite technology, aircraft, and patrol boats to monitor boats and crews, observers on commercial fishing boats who record what is caught (including by-catch of seabirds and marine mammals). The ministry also required you to have a fishing permit and Certificate of Registration for your vessel with you at all times when you are fishing. These documents need to be able to be supplied to a Fishery Officer on demand. All commercial fishing permit holders are required to report their fishing activity electronically using an approved e-logbook. As part of your electronic reporting obligations, you also need to register a GPR (geospatial position reporting) device. This can either be a fixed device mounted to your vessel or a mobile unit that you carry with you. It is important that you balance any catch with your ACE (Annual Catch Entitlement). All permit holders are required to supply a Monthly Harvest Return (MHR) by the 15th of the month following the month the catch was taken. This catch is balanced against ACE held by the permit holder as of the 15th of each month. If the catch is not “balanced” by ACE when the balances are run the permit holder will incur Deemed Value invoices for the excess catch. By law, catch limits for every fish stock must be set at levels that ensure their long-term sustainability. The government rigorously monitors the number of fish caught compared to set catch limits. There are financial penalties for commercial fishers who catch more than their entitlement in a year. Those who deliberately break the law can face serious consequences, including the confiscation of fishing vessels and jail. Moreover, fisheries observers join commercial fishing boat trips to collect data. They collect data on the kind of fish the fishers are catching, the size, sex, and ages of fish caught, the number of fish caught, by-catch and information on marine mammals and seabirds, biological information to help with assessing fish stocks, unusual specimens for museums, information about vessel safety and employment, fish processing and handling information, and how catches are retained.

Furthermore, the Marine Management Organization-United Kingdom implemented a catch record, the Landing Obligation (LO) applies to all fishing vessels including those under 10 meters in length but does not apply to recreational fisheries. The catch must create a catch record for everything you catch on every fishing trip for information about the trip and the live weight of what have caught. The weights can be converted to live weights by multiplying them by a conversion factor. The catch quota species or species subject to catch limits of all sizes of fish must be recorded unless exemptions apply. The United Kingdom Government also regulates that all quota species must be landed and counted against quota unless exemptions apply. The view is a list of stocks for which a total allowable catch (TAC) is set. The LO applies to all sizes of fish so it is important to minimize catches of undersized fish which will use up the quota. (The Marine Management Organization-United Kingdom, 2023).

All three countries mentioned implement relatively similar surveillance systems, using electronic logbooks, patrol boats, integrated monitoring systems, and observers, the reporting is done independently by the ship owner, ship operator, or designated person using the electronic logbook. The Australian Government implements also catch disposal reports that catch recipients should be prepared. For the UK, landing obligations are also applied covering undersize reporting, protected fish, bycatch (non-targeted species), and discard reporting. There are verification methods applied in each country. The violations of reporting obligations and fishing regulations are subject to serious sanctions ranging from administrative sanctions, confiscation of fishing vessels, and even criminal sanctions.

The opportunity for the Indonesia Government specifically to the Ministry of Marine Affairs and Fisheries is related to information technology readiness, the implementation of a self-reporting system for the utilization of other natural resources, the availability of adequate regulations, both regulations related to fisheries exploitation and MCS, the surveillance system readiness. The challenge that must be considered is the readiness of business actors/fishermen, the same business actors carry out catch, processing, and distribution activities, and the readiness of local governments, bonded areas, other agencies, and Special Economic Zone Authority, catch report of the provincial fishing vessel and small fishermen. Therefore, the MCS system proposed to implement in IFMA is a self-reporting system through logbooks, electronic monitoring programs, observer programs, VMS, integrated surveillance systems, sea and air patrols, catch disposal records, and landing obligations.

The conclusion of the study is the key element of the catch data records is self-reporting by a logbook. However, there are needs to ensure the accuracy of the catch data record, namely i). a verification system, ii). an observer, and iii). catch disposal data. In addition, the patrol vessel, implement the sanctions, and the integrated surveillance system needs to strengthen action to prevent and combat illegal activities by tuna fishing boats. Moreover, it is necessary to apply landing obligations to reduce bycatch, observer programs, and a surveillance system (before fishing, while fishing, during landing, and post landing).

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TUNA TALKS SESSION IV

18. Diversity, Abundance and Distribution of Tunas Larvae and Their Relationship with Oceanographical Parameters in Banda Sea, The Indonesian Fisheries Management Area (WPP) 714.

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Indonesia has 11 Fishery Management Areas (FMA), and Banda Sea or sometimes called FMA 714 is one important FMA with tuna as main fishing catch. Thus, the Banda Sea is well known as one of the most potential fishing grounds for tuna in Indonesian waters (Marten, 1981; Matsuda, 1987; Amin E, 1990; Muawanah, 2021). Over 2,000 fishing vessels with various fishing gears such as purse seine, handline, troll line, longline, and pole and line are operated in this area and catch close to 17,000 tons of tuna and tuna-like per year (Suman,2014). Besides, the Banda Sea has very rich marine resources including pelagic and demersal fishes as well as reef fishes (Wouthuyzen S, 2018).

Banda Sea is very important area for tuna catching. Thus, the Indonesia government shows the very much concern on the tuna fishery sustainability in this area. For example, in 2015, the Ministry of Marine Affair and Fishery of the Republic of

Indonesia issued the Ministerial Regulation No. 4/2015. The main point form this regulation is to limit the operation of tuna fishing vessels with more than 30 GT to catch any tunas, especially yellowfin tuna (*Tunnus albacares*) during the spawning period in Banda Sea from October to December. It is a one strategy to reduce tuna fishing industry to catch many under size tuna for commercial purpose.

To understand more about tuna fishery in Banda Sea, there are many research on tuna fisheries have been conducted in Banda Sea since 1980s (Satrioajie, 2018), including study on ichthyoplankton or fish larvae (Soewito, 2018). However, the results could not show clearly where is the spawning location of tuna in Banda Sea. Therefore, several studies with more focus on tuna larvae were conducted recently to understand the tuna spawning sites in Banda Sea (Romdon, 2019; Taufik M, 2005; Wagiyo, 2007; 2014; 2019).

This study was aimed to understand the spawning locations of tuna species in Banda Sea, and the result of this study is very useful to develop the management strategy for tuna fishery in FMA 714, and could be also used as a lesson learned to other tuna fishing areas in Indonesia.

Larval tuna study was conducted at 25 sampling sites on March to April 2011 in the Banda Sea and surrounding waters. Some sampling sites are laid in the Manipa Strait, Piru Bay, Tuhaha Bay, and Elpa putih Bay, but all these stations are still influenced by Banda Sea water mass. Fish Larvae sampling was collected using a Bongo net (with #500 µm) with the net diameter of 0.6m. The net was operated up to 10 m depth, and hauling speed was 2.0 knots for 15 minutes at every sampling sites. Collected fish larvae are sorted especially for tuna fish larvae only, while other species of fish larval are stored for other analyzes. Larval tuna samples were identified following the larval fish identification key (Leis JM, 1989; 2000).

Data analysis in this study, we used tuna larvae data both from secondary data, which collected by KKP in 2011 and primary data collected by us from many cruises in the Banda Sea. Bathymetry chart was obtained from the general bathymetry chart of the oceans (GEBCO) provided by the British Oceanographic Data Center (BODC). SST (^{o}C) and Chlorophyll-a (mg/m^3) data are obtained from https://giovanni.gsfc.nasa.gov/giovanni web. SSS (PSU) data were developed by us using Remote Sensing Reflectance at 412 nm, in which data are collected from the same web. All of these data are the montly average data of March 2002-2018. Additional data that used in the analysis are the nearest distance of the sampling site to Land/Island (miles) and the depth of each sampling sites (m). Simple regression analysis was performed to know whether there are relationship between the abundance of tuna larvae and those of oceanographic parameters.

A total of 219 tuna larvae was collected from 25 stations. Those larvae belongs to 7 species of tuna i.e, *Thunnus macoyii* (Southern Bluefin tuna), *T. Obesus* (Bigeye tuna), *T. Albacares* (Yellowfin tuna), *T. Alalunga* (Albacore tuna), *Euthynnus affinis* (Kawakawa or Mackerel tuna), *Katsuwonus pelamis* (Skipjack tuna) and *Auxis thazard*. (Frigate tuna). From total of 25 stations, 7 stations (Stn. 2, 9, 12, 14-17) were absent from tuna larvae.

The abundance of tuna larvae in the Banda Sea which dominated at the first high rank were Bigeye tuna and Yellowfin tuna with 78 and 62 individual (ind.)/1000 m^3, respectively, while in the second rank were Albacore, Kawakawa/Mackerel tuna and

Pacific Bluefin tuna with abundance of 33, 23, and 17 ind./1000 m^3, and the lowest were Frigate and Skipjack tunas with abuncance of 4 and 3 ind./1000 m^3, respectively.

In term of diversity and the abundance distribution of tuna larvae, Station 18 (Banda Islands) was the most diverse station with 4 species of tuna larvae and the most abundance station with > 41 ind./1000 m^3 followed by Stations 20 and 22 (Banda Islands) with 3 species and the abundance ranging from 1-10 and 21-30 ind./1000 m^3, respectively. Stations 4, 19 (Banda Islands) and 25 with 2 species, while larvae abundace at station 19 was ranging of 21-30 ind./1000 m^3. Other stations has only 1 species of tuna larvae with abundance ranging of 1-10 and 11-21 ind./1000 m^3.

It seems that the highest abundance of tuna larvae shown is associated with a group of small islands, such as the Banda Islands (except Station 17) followed by Lease Islands (Ambon, Haruku, Saparua and Nusa Laut Islands). On the other hand, tuna larvae were not found for the stations close to massive land or large islands, such as Seram Island (St. 9, 12, 14-16), as well as the station that relatively located in the open sea (St. 2). Therefore, this finding can hypothesize that various tuna species spawning areas are close to the coastline around small islands with deep waters range of 1000-2000 m.

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19. Utilization of Multisensor Satellite Data for Estimating the Dynamics of Large Pelagic Fisheries in North Maluku

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Waters in North Maluku (WPPNRI 716) have high potential pelagic fish resources. The potential for large pelagic fish resources of 154,329 tons/year is in the top 2 after small pelagic fish. The utilization rate of large pelagic fish, including tuna and skipjack, based on the Decree of the Minister of Maritime Affairs and Fisheries of the Republic of Indonesia 2022 Number 19/KEPMEN-KP/2022, is fully-exploited. Large pelagic fishing activities in WPPNRI 716 must be maintained, and strict monitoring efforts are needed so that large pelagic fish resources remain sustainable. A purse seine is commonly used to catch large pelagic fish in North Maluku waters. Purse seine tuna production dominates 75% of the catch from eastern Indonesian waters (Harsono, 2014).

In the oceanic waters of North Maluku, the Halmahera Eddy (HE) natural phenomenon, which has a close relationship with the presence of pelagic fish, is indicated as a source of variability in the biological and biogeochemical processes of a water body (Harsono et al., 2014). Chlorophyll-a and sea surface temperature (SST) closely influence the abundance and dynamics of fish in a body of water. High chlorophyll-a concentrations are stirred up and carried by the Halmahera Eddy around its vortex (Harsono 2014). Changes in water surface temperature (±0.02°C) can cause changes in fish density (Amri 2008).

Remote sensing technology produces information that makes it easier for governments to make policies. Spatial information from oceanographic satellites can make it easier for fishermen to determine the location of potential fishing grounds (Gaol and Sadhotomo 2017). Suomi NPP satellite boat detection with the Visible Infrared Imaging Radiometer Suite (VIIRS) sensor can detect fisheries activities using light for mapping fishing grounds (Susanto 2015). VIIRS Boat Detection (VBD) as real-time data of fisheries operating in North Maluku waters. Utilization of the Aqua MODIS satellite sensor as spatial information to determine the dynamics of oceanography following the characteristics of large pelagic fish.

The research aims to map the dynamics of oceanographic parameter conditions in pelagic fishing vessel dynamics and calculate the productivity of large pelagics using purse seine fishing gear in North Maluku. The period of data used in the study was January-December 2020. Oceanographic data was downloaded from https://oceancolor.gsfc.nasa.gov/, VIIRS Boat Detection (VBD) was obtained from https://eogdata.mines.edu/vbd/, and logbook data from the Ministry of Marine Affairs and Fisheries. The data analysis used was spatial analysis by overlaying several data in 1 layer, Catch per Unit Effort (CPUE) analysis, and descriptive analysis.

The results showed that North Maluku waters in 2020 experienced fluctuations and shifts in oceanographic dynamics every month. Monsoon winds carrying water masses from the Pacific Ocean to the Indian Ocean through the Maluku Sea cause fluctuations in chlorophyll-a concentrations (Tangke, 2014).

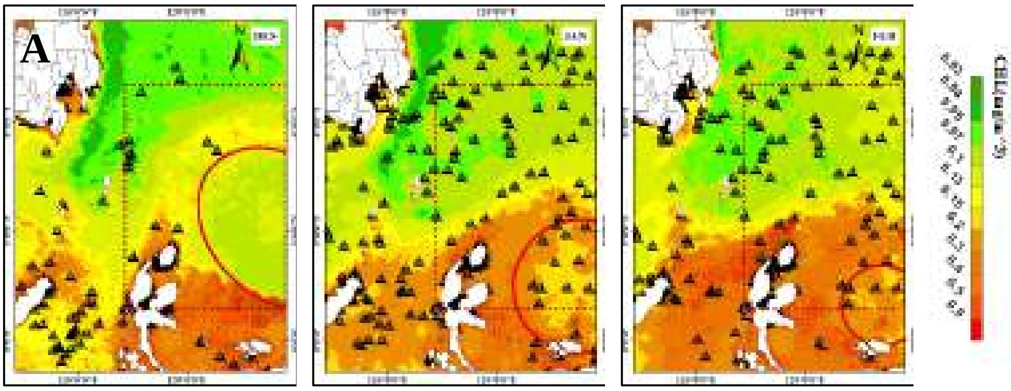


Figure 1. Chlorophyll-a distribution and position of fishing vessels in the west season

Figure 1 shows that the neritic waters have high concentrations during the western season (December, January, February). Chlorophyll-a forms a yellow-to-orange hue with a value range of 0.15-5 mg/m3 from December to February. Chlorophyll-a tends to be low, as shown by the green color, which is 0.05-0.1 mg/m3 in the oceanic region or open sea. Runoff from large rivers around Halmahera causes chlorophyll-a concentrations in open ocean waters to be lower than in coastal waters (Tangke 2014).

The mass of water that forms Halmahera Eddy carries few nutrients. The high chlorophyll-a concentration is due to the upwelling phenomenon in its neritic region. The Halmahera Eddy (HE) shown in red circles/ellipses experiences a weak phase or does not form during the western season. The wind moves from the north to the southeast, causing the NGCC current flow to move opposite to the formation of the HE (Ramadhan et al. 2020). Light fishing detected by the VIIRS sensor during January-February was evenly distributed to as many as 104 vessels in the waters of North Maluku. Purwanti et al. (2017) mentioned that the upwelling phenomenon is related to pelagic fish abundance. The northern waters of Halmahera experienced moderate waves (1.25-1.5 m) and medium rainfall (150-300 mm) in January-February 2020, while December 2020 had higher rainfall (300-400 mm) (Prasetyaningtyas 2020). Water conditions affect the quantity of fishing activities carried out. Slightly calmer water conditions will be utilized to catch fish, even briefly (Wibowo et al. 2016).

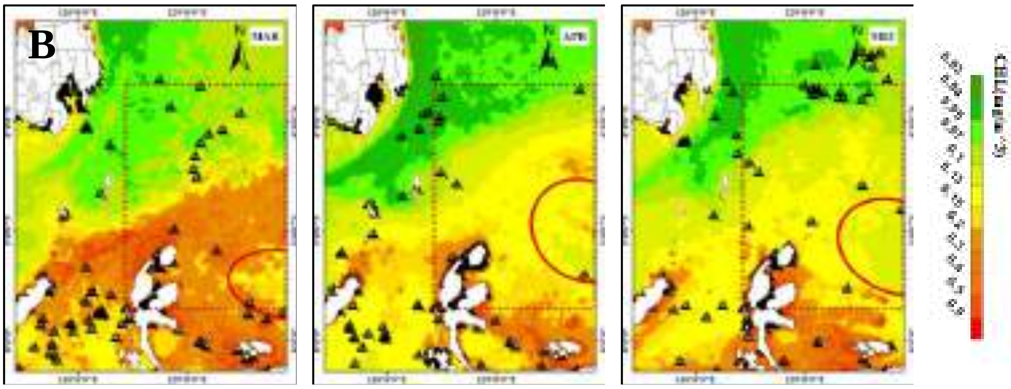


Figure 2. Chlorophyll-a distribution and position of fishing vessels in the transitional season I

The distribution of high chlorophyll-a gradually fades in the neritic region during the first transitional season (March, April, and May), as shown in Figure 2. The HE undergoes an eastward zonal shift as it enters the middle of the year (Harsono et al. 2014). Fewer vessels (32) were detected in the oceanic region during the first transitional season. Wave conditions were higher (1.5-2 m) than during the western season (BMKG 2020). In May, there was a collection of vessels caught in the transitional zone of green and light green color hues. This condition indicates differences in chlorophyll-a values.

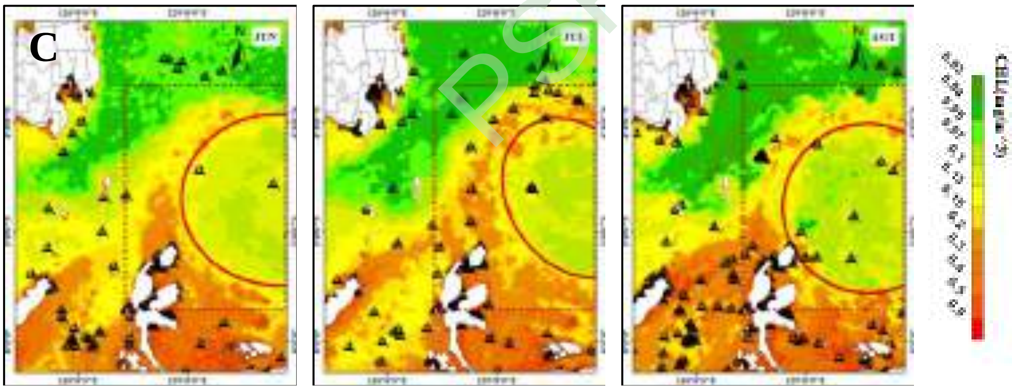


Figure 3. Chlorophyll-a distribution and position of eastern season fishing vessels

Figure 3 shows that in July-August 2020, chlorophyll-a formed a belt of higher concentrations at longitudes 127 ºE-129 ºE. Chlorophyll-a belts are formed due to the circulation of the Halmahera Eddy (HE) current, which makes the surrounding environment have low chlorophyll-a values (Harsono et al. 2014). High chlorophyll-a concentrations are seen in the north of Maluku, turning eastward to form a belt. The shape of the HE vortex was elliptical in July. Chlorophyll-a carried by the HE belt corresponds to the movement of the Papuan Coastal Current, which turns eastward and joins the Mindanao Current (Rintaka 2015). The number of fleets detected (52 vessels) during the eastern season in the oceanic waters of North Maluku concentrated around the chlorophyll-a that formed the Halmahera Eddy (HE) belt. Vessels congregate around the nutrient-rich HE region where food chains are established for large pelagic fish (Harsono et al. 2014).

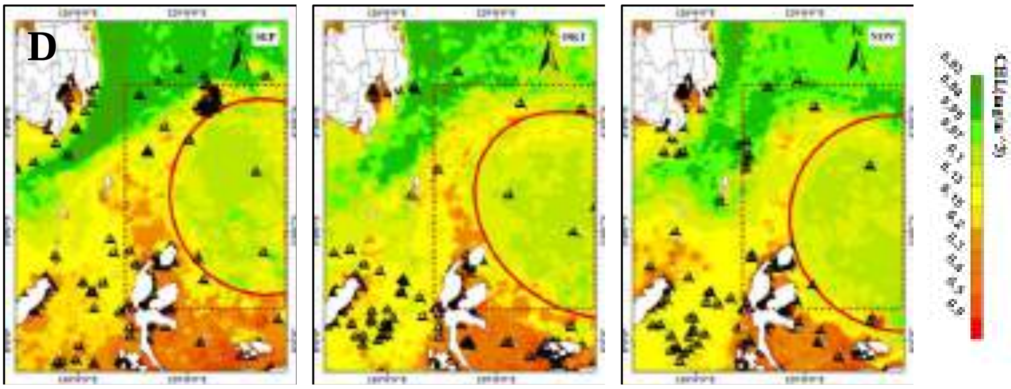


Figure 4. Chlorophyll-a distribution and position of fishing vessels in transitional season II

The transitional season II chlorophyll-a belt began to fade from September to November 2020, showing that the Halmahera Eddy (HE) was quite strong in Figure 4. Ramadhan et al. (2020) also explained that Halmahera Eddy is in a frail condition during the transitional season II. The very weak HE is characterized by weak eddies caused by the weakening of the North Equatorial Counter Current (NECC) and New Guinea Coastal under Current (NGCC). Vessels around the belt (48 vessels) decreased as the chlorophyll-a hue that formed the belt faded.

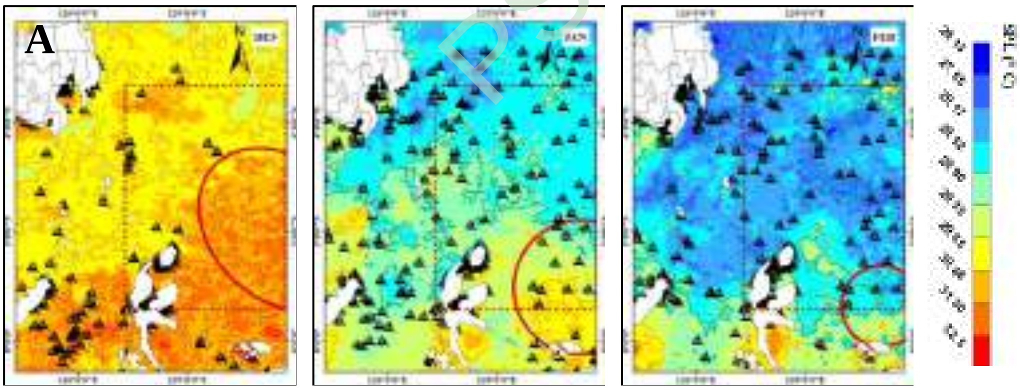


Figure 5. Distribution of SST and position of western season fishing vessels

Figure 5 shows sea surface temperature (SST) conditions have low values (26-29 ºC) in the west season. Sea surface temperature was warmer (29-31 ºC) in December 2020. The location of the Halmahera Eddy (HE) formation is more difficult to recognize based on the temperature regime. Strong seasonal winds result in cooler surface temperatures (Harsono 2014). Active vessels were numerous and evenly distributed at the beginning of the year (104 vessels) in North Maluku waters. Many vessels were detected during the western season, and it is possible that not only vessels that operate to catch large pelagic fish. Cold surface temperatures indicate upwelling, which has a positive ecological impact, namely increased fertility followed by fisheries productivity (Ashari et al. 2014).

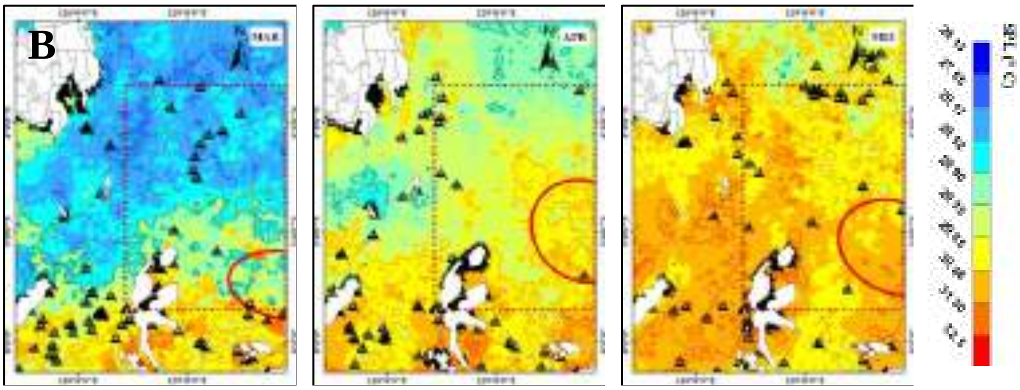


Figure 6. Distribution of SST and position of fishing vessels in transitional season I

Sea surface temperature (SST) images (Figure 6) show a significant increase in temperature during the first transitional season. SST values were highest in May and lowest in March. The downwelling phenomenon causes the warming of sea surface temperature. The location of HE is more difficult to recognize based on the warm temperature hue formed in the middle of the vortex (Harsono 2014). During the transitional season I, the fleet detected 32 vessels by the VIIRS sensor. Purwanti et al. (2017) explained the erratic wind direction conditions in the first transitional season.

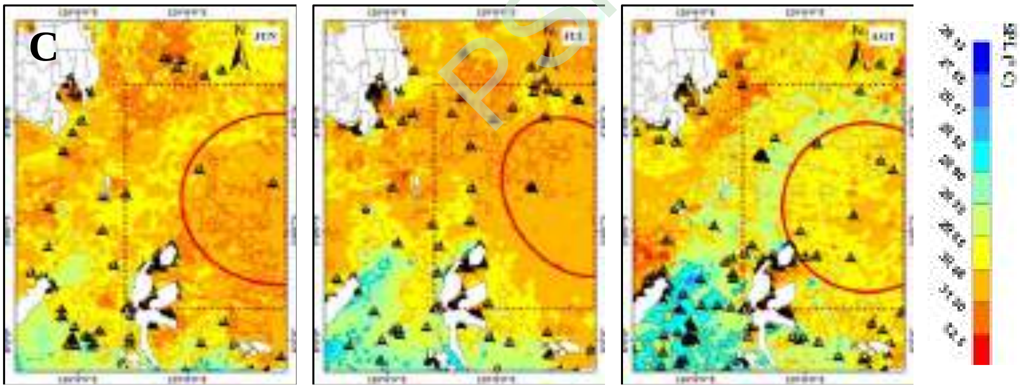


Figure 7. Distribution of SST and position of fishing vessels in the eastern season

Figure 7 shows that the southeast season (June-October) sees cold temperatures entering the waters of North Maluku. The cold temperature flow marks upwelling from the Maluku Sea to the Pacific Sea (Harsono 2014). The warm SST value (>29 ºC) around the Western Pacific waters, including North Maluku waters, is a Warm Pool area known as a producer of 40% of world tuna production or around >1.5 million tons/year (Lehodey 2001; Harsono 2014). The eastern season of June-August 2020 did not clearly show the Halmahera Eddy vortex. Harsono (2014) explained that the indistinct SST image indicates the location of the HE and cannot be recognized due to the mixed Warm Pool flow in the eastern part. Large pelagic fish favor waters with

SST conditions like this because they match the biological properties that live in warmer areas. The presence of the vessels is spread out, but the fishing locations appear to be in areas that indicate a temperature difference. Thermal fronts indicate that a body of water is experiencing upwelling accompanied by a decrease in sea surface temperature (Rintaka 2015).

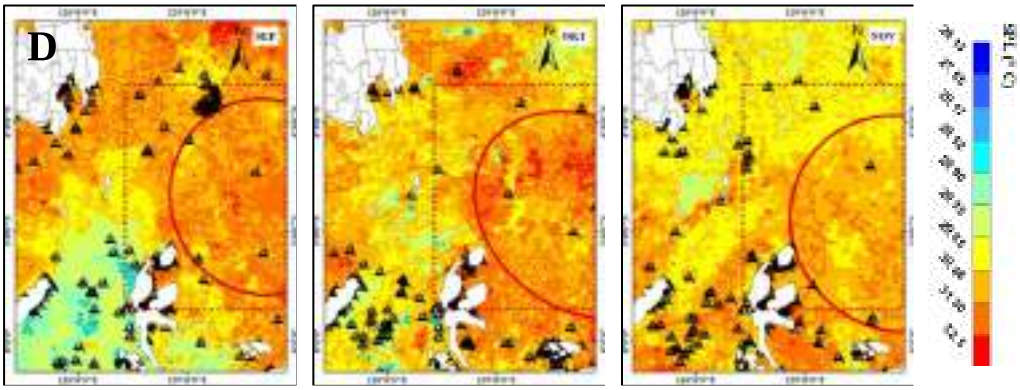


Figure 8. Distribution of SST and position of fishing vessels in transitional season II

Figure 8 shows that the distribution of sea surface temperature (SST) experienced cooling in the oceanic region during September-November 2020, moving from the Maluku Sea to North Maluku waters. In September, the ship gathered at one point with a somewhat contrasting thermal front. Warm waters are the criteria for a favorable water environment for large pelagic fish. The influence of SST is not visible on the Halmahera Eddy (HE) conditions in the vicinity. Equatorial conditions that are warm and evenly distributed make the HE more challenging to recognize. An anticyclonic eddy is more easily recognized in mid-latitude regions with contrasting temperature characteristics (Harsono 2014). Vessels gather at one point where a front is quite contrasting during September. According to Latumeten et al. (2013), madidihang fish have characteristics that favor environmental conditions that form fronts.

Large pelagic fish are caught using 3-150 GT fishing gear. A purse seine is a large pelagic fish fishing gear with the largest catch. The purse seine fleet based at PPS Bitung is >100 GT and catches fish in the Sulawesi Sea and Pacific Ocean. The <30 GT purse seine fishermen only catch around the coastal area (Wibowo et al. 2016). Large pelagic fish species in 2020 were dominated by tuna 1,226,988 kg/year (19.50%) and skipjack 4,046,997 kg/year (64%) of the total catch. Figure 9 shows that skipjack productivity is higher than madidihang. The CPUE value of skipjack decreased sharply during the west season, especially in February.

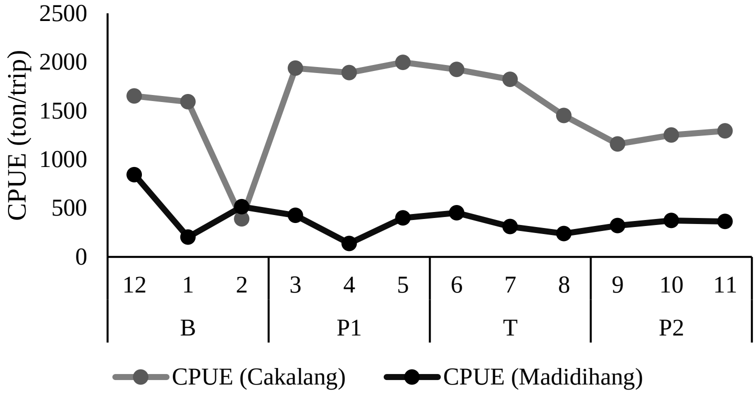
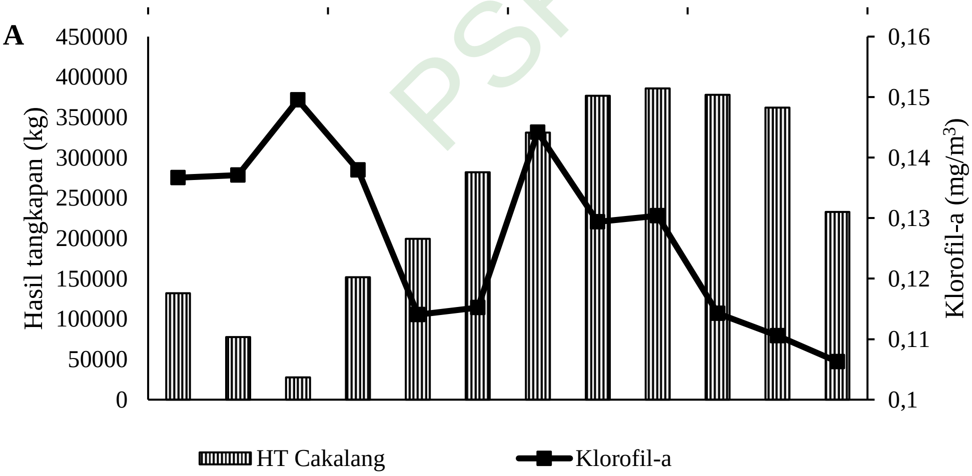


Figure 9. CPUE (Catch per Unit Effort) of skipjack and madidihang using purse seiner

Figure 9 shows that the skipjack catch is relatively low, <150,000 kg/month, not proportional to the chlorophyll value in the west season of December, January, and February 2020. Chlorophyll-a abundance does not directly affect the number of fish in the waters due to the time lag of chlorophyll-a (Harsono et al. 2014). The fluctuation pattern of madding fish is almost similar to skipjack. Chlorophyll-a conditions in North Maluku waters ranged from 0.1-0.16 mg/m3. Skipjack and madding are primarily caught in this range. The oligotrophic waters of North Maluku are suitable areas for skipjack and madding (Tangke and Deni 2014).



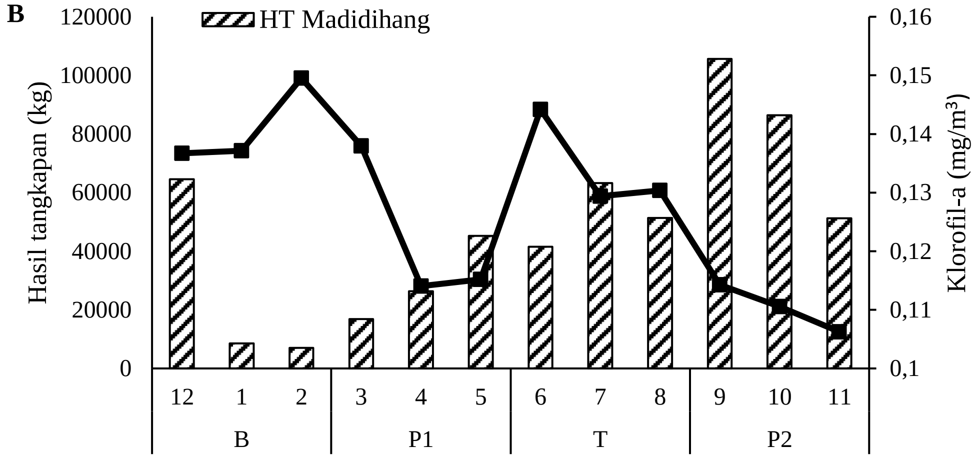
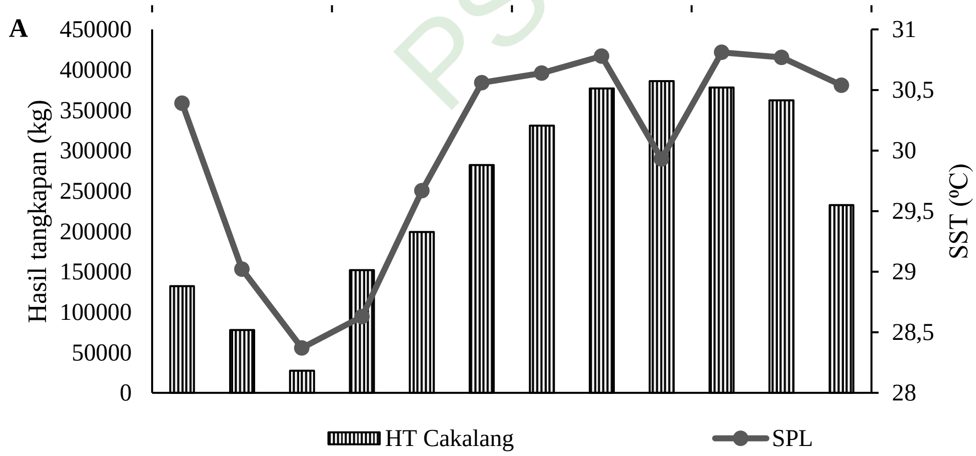


Figure 10. Graph of chlorophyll-a and catch (A) skipjack (B) madidihang with purse seiner

Sea surface temperature was warm >29 ºC in North Maluku waters during the transitional season I-transitional II (Figure 11). Skipjack and madding catches are directly proportional to sea surface temperature. The optimum temperature for madidihang fish habitat is 14-22 ºC (Cahya et al. 2016). Warm temperatures are less suitable for madding fish. With the presence of Halmahera Eddy and warm surface temperatures, the eastern season is suitable for catching large pelagic fish, especially skipjack, in North Maluku waters.



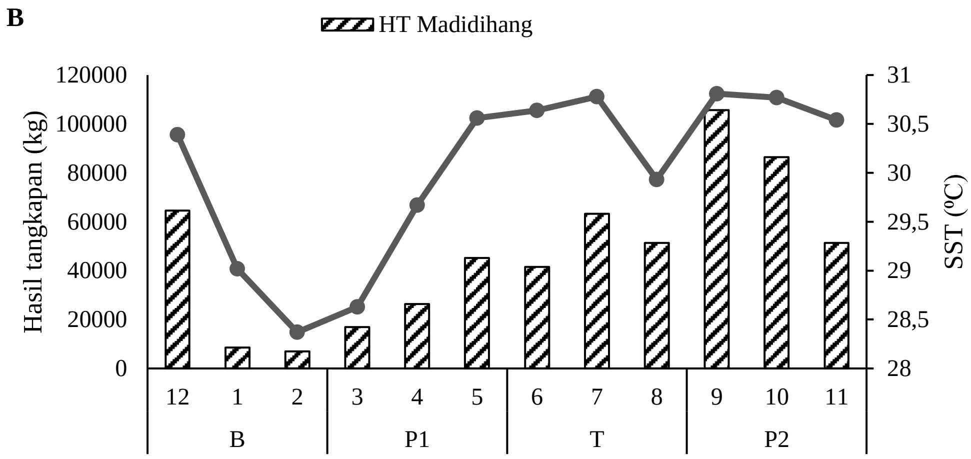


Figure 11. Graph of sea surface temperature (SST) and catch (A) skipjack (B) madidihang with purse seiner

The eastern season is the right season to catch large pelagic fish using purse seine in North Maluku waters. The results showed the transitional and eastern seasons as the appropriate fishing seasons for madidihang fish. The skipjack fishing season is by Nasution et al. (2016), and the peak season is April-September. The madding fishing season occurs almost every month, but the study results show that the western season is less suitable for madding fish. The location around Halmahera Eddy is a suitable fishing location with the biological characteristics of large pelagic fish.

The VIIRS sensor still needs to identify the types of fishing gear and types of fishing activities. Future research can be refined using purse seine fishing coordinate data using field data or other supporting satellite data. The Government of North Maluku Province can use the results of this study as basic information in managing large pelagic fish fisheries using purse seine fishing gear. The government can deliver this information through the Smart Fishermen Information System (SINP) and the Fishing Port Weather Information System (SICP). Fishermen can access information about the right time and fishing grounds for large pelagic purse seine fisheries in North Maluku waters.

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20. Approach of Feedback Harvest Control Rule (FHCR) Application and Schaefer 1954 Method to Yellowfin Tuna (Thunnus albacares) Fishery Production in Benoa Harbor, Bali

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Yellowfin tuna (*Thunnus albacares*) the local name madidihang is a highly migratory group of fish because of its wide distribution throughout the tropical and subtropical waters of the three oceans (Indian, Atlantic, and Pacific). The distribution area of tuna in Indonesia includes the southern and western waters of Sumatra, the southern waters of Java, Bali, and Nusa Tenggara, the Banda and Flores Seas, the Sulawesi Sea and the western waters of Papua (Darondo, 2014). These waters are rich in several economically important species. Yellowfin tuna is a large pelagic group known as a leading commodity in total capture fisheries exports in Indonesia (Kantun, 2012). As one of the leading commodities, yellowfin tuna contributes to providing the highest catch of 68.43% of the total production of other tuna groups (Jatmiko, 2016). The increase in the number of yellowfin tuna catches every year will pose a risk to yellowfin tuna resources. Where this risk will reduce the number of yellowfin tuna populations in their habitat. Based on data from the 2016 IUCN report, the status of yellowfin tuna is in the Critically Endangered category (IUCN Red List Category & Criteria) or almost threatened. This is the center of special attention of the international community to regulate the availability of yellowfin tuna resources to be sustainable (Chomariyah, 2017).

Benoa fishing port, Bali is one of the highest tuna fishing port and production centers in Indonesia. Based on production data from the fishing logbook at Benoa Harbor, the total tuna production from 2018 to 2021 reached 26,390 tons. The amount of production has increased in recent years. The exploitation ratio of the catch has almost increased by 50% from the previous year. The increasing risk of overutilization of yellowfin tuna resources is of concern to the government and fisheries researchers. Therefore, the purpose of this study is to estimate (the amount of allowable biological catch (ABC)) and (the amount of allowable biological effort (ABE)) of yellowfin tuna with the application of the feedback harvest control rule (FHCR), to determine the condition of yellowfin tuna (*Thunnus albacares*) utilization status based on parameters Fmsy, Ymsy, Umsy, Yjtb, Fjtb, utilization rate and utilization status with the Schaefer 1954 method. A comparison of the estimation results will be carried out using the production surplus model based on the precautionary principle (Harlyan et al., 2021). This aims as a form of effort to optimize the strategy of catching yellowfin tuna (*Thunnus albacares*) landed in Benoa fishing port, Bali.

The data used in this study are secondary data in the form of catch data (kg) and fishing effort (time intensity of trips in a year) sourced from fishing logbooks for 10 years in the period 2012-2021 in the fishing grounds of the Republic of Indonesia Fisheries Management Area (WPPNRI) 573 and the Indian Ocean Offshore Sea landed at Benoa Harbor, Bali (Figure 1). This study estimated the allowable biological catch (ABCy) using two harvest control rules, namely the feedback harvest control rule and the conventional Schaefer (1954) production surplus model. The application of the feedback harvest control rule is a fisheries management strategy to provide scientific recommendations for the annual catch quota (allowable catch/JTB) by considering the previous stock abundance to obtain the catch in the following year (Harlyan et al., 2021).

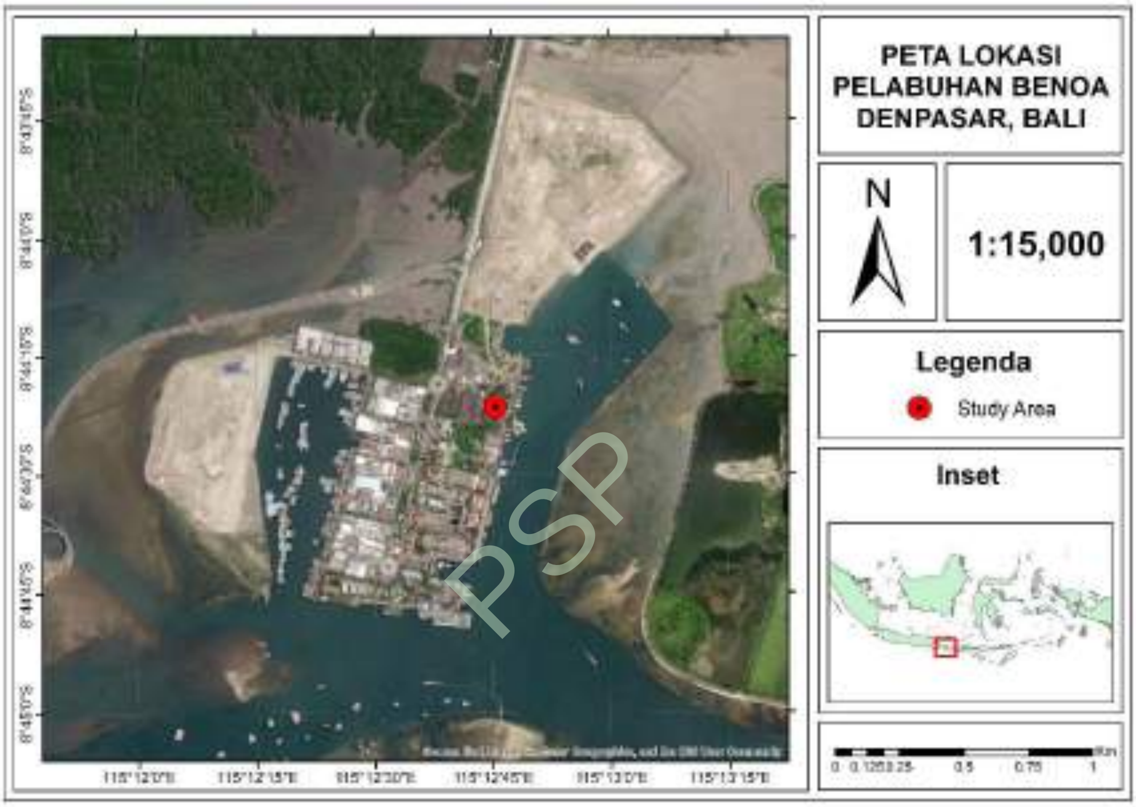

Figure 1. Map of Study location

Statistical data on tuna fisheries landed at Benoa Harbor during the period 2012-2021 shows a significant change in the last 10 years (Table 1). Based on the data presented in Table 1. Calculation of the allowable catch amount using two fishing strategies, namely the Schaefer 1954 production surplus method and the feedback harvest control rule (FHCR) application. The Schaefer 1954 model was used as a simple method from other surplus production models, aiming to estimate biomass which is then used to determine the level of fishing effort (maximum sustainable yield/MSY). Meanwhile, the analysis of the feedback harvest control rule (FHCR) calculation aims to estimate the amount of catch that is biologically safe to be utilized in year-y (the next year).

Table 1. Catch- Effort and effort data

Tahun	Spesies (Kg)	
	Catch (kg)	**Effort (trip)**
2012	3346289	2417
2013	4046385	3292
2014	3108202	3158
2015	2801294	1080
2016	3554461	941
2017	2424827	606
2018	2265983	460
2019	1342255	340
2020	207794	483
2021	2500041	483

The estimated relationships of catch per unit effort in the yellowfin tuna (*Thunnus albacares*) fishery during 2012-2021 to fishing effort show a negative correlation (Figure 2). The resulting regression model provides a coefficient of determination of 0.43, which indicates that fishing effort can influence the variability of catch per unit effort in tuna fisheries by 43%. The remaining 57% of the variability is caused by other factors not included in the object of study. The regression model equation shows that an increase in the number of fishing trips for 1 time will reduce the catch per unit of effort by 0.9 kg/trip. Based on the intercept (a) value of 4154.37 and the regression coefficient of 0.9, the sustainable catch effort value FMSY is 2103.64 trips, the sustainable catch value YMSY is 4370.24 kg, the optimum CPUE value UMSY is 2077.19 kg/trip, the allowable catch effort value FJTB is 718. 7 trips, the value of the allowable catch YJTB of 3495.6 kg and the utilization rate of 77% and is classified in the fully exploited category which means that the resource stock in the waters of WPPNRI 573, Indian Ocean Shelf Sea has been fully exploited. This means that the increase in the number of catches can still increase because it can disturb the sustainability of fish resources.

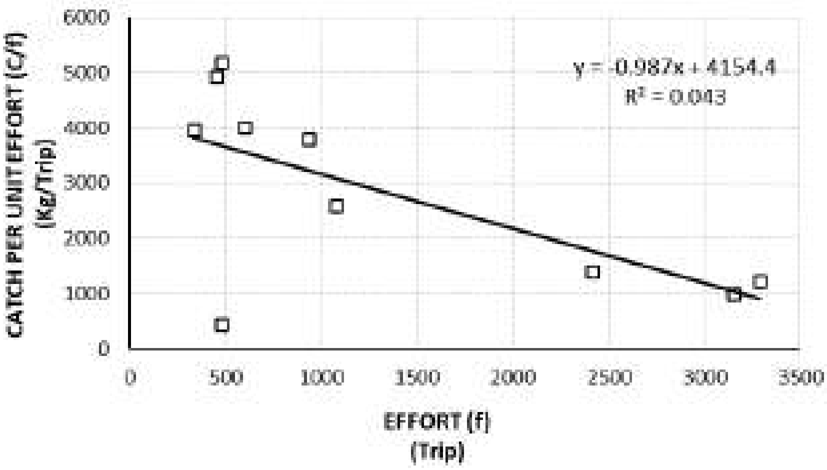

Figure 2. Data analysis grafic catch unit effort (y) and fishing effort (x)

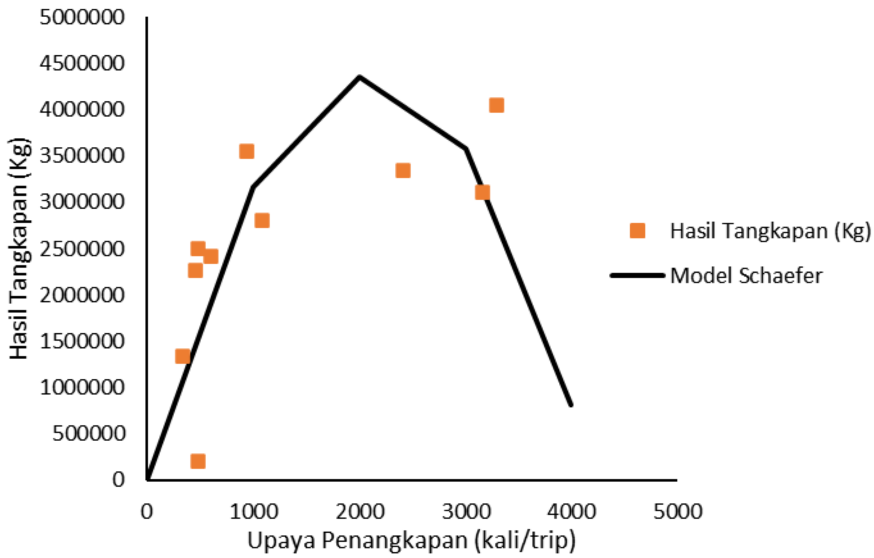

Figure 3. Surplus production model of Schaefer Tuna Fisheries

Based on the calculation of the stock level (δ) obtained from the stock trend in the period 2012-2021, it shows that it is at the middle level which is 1.0 (Figure 4). The stock level is known from the trend of the stock abundance index, which in this study is the CPUE trend. The CPUE trend regression coefficient (b) is 1.0 and the average CPUE trend (I) is 0.00092, both values can produce FCR which will make it easier to estimate ABC and ABE. The catch of yellowfin tuna (Thunnus albacares) in the two years before the estimation (Cy-2) was 134,225 kg. From the above calculations, the resulting value of biologically safe JTB to be utilized (ABC2022) is 2251.80 kg and the value of fishing effort (ABE2022) was 523.1 fishing trips.

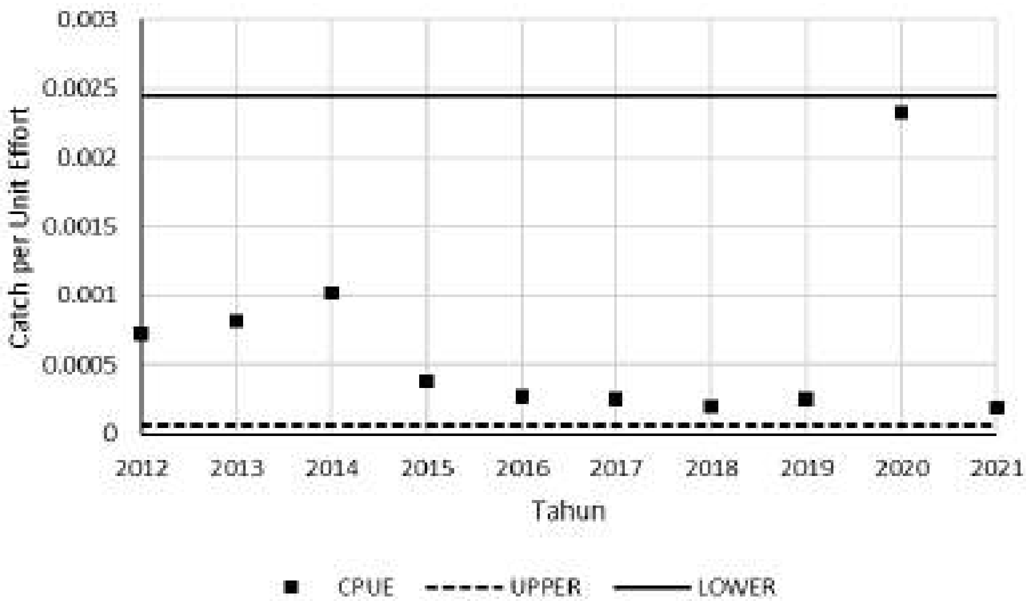

Figure 4. Grafic of level stok *feedback HCR*

Indonesia's catch control regulations state that the allowable catch is 80% of the sustainable potential (Harlyan et al., 2021). The biologically safe JTB values resulting from the two fishing strategies are shown in Table 2.

Table 2. Result of comparison of both fishing strategy on tuna fisheries

Parameters	Schaefer 1954	*Feedback* (HCR)
Y_{jtb}(2022) or ABC(2022) (kg)	3495.6	2251.80
F_{jtb}(2022) or ABE(2022)(trip)	718.7	523.1

This study shows the results of the comparison of capture fisheries management strategies of feedback harvest control rule analysis and the Schaefer 1954 production model provide a value of the amount of catch that is biologically safe to utilize (JTB) almost the same as each other. However, fisheries management in Indonesia is still unable to solve the problem of overfishing. Both methods use a fairly high precautionary principle in estimating the allowable catch (JTB). However, the two fishing strategies provide different results in generating the fishing effort used to produce a catch that is biologically safe to utilize. The Schaefer 1954 model provides higher values of fishing effort (Fjtb/ABE) and (Yjtb/ABC) than the feedback harvest control rule.

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21. Economic Analysis of Tuna Fisheries in Morotai Island, North Maluku

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Tuna is an important fish that contributes to the Indonesian economy as a consumption and leading export commodity. It makes a significant contribution to the country's foreign exchange (Sumadhiharga 2009). The main tuna-producing areas in the Eastern Region are the Banda Sea, Sulawesi Sea, Halmahera Sea, Maluku Sea, Arafura Sea, Cendrawasih Bay, Bitung, Ternate, Sorong, and Ambon (Firdaus 2018). Based on the Decree of the Minister of Maritime Affairs and Fisheries Number 107/KEPMEN-KP/2015, North Maluku as a national tuna production area is included in the Tuna, Skipjack and Tuna Fisheries Management Plan (RPP-TCT).

One of the largest tuna fishing areas in North Maluku is Morotai Island which contributes 34 percent of total production (DKP North Maluku 2018). Yellowfin tuna (YFT, *Thunnus albacares*) is a commercially important species targeted in this area. The average tuna catch in Morotai was 3,009 tons in 2015 (DKP Morotai 2015). Tuna fishing activities use hand lines as fishing gear and are dominated by fishermen with vessels < 5 GT, totaling 1458 units in 2017 (Muksin 2022).

Tuna fishing is a complex process, encompassing catching, processing, and marketing of products. In each step of this process, there is economic value generated. In the distribution of tuna, costs are incurred during the process of logistics transportation of products. Measuring logistics costs is useful as an indicator and evaluation of logistics activities, reflecting performance, and efficiency levels (Sylvia et al., 2018; Zakariah and Pyeman, 2013). By comprehending the economic aspects of tuna, stakeholders can make informed decisions and implement sustainable practices that ensure the long-term viability of tuna fisheries, promote economic benefits, and safeguard marine ecosystems. In this research, we aim to analyze the economic impact of tuna fisheries, considering the perspectives of fishermen, the value of tuna sales, and the transportation logistics value in Morotai Island.

The data was collected from January to March 2023 on Morotai Island, with a focus on handline vessels <5 GT. This research involved 50 respondents, including fishermen, suppliers, traders/collectors, fishery product processors, and related stakeholders such as the Maritime Affairs and Fisheries Service of North Maluku Province, as well as the Fish Quarantine Center and Quality Control of Morotai Island (Figure 1). The benefits for fishermen were analyzed using the Revenue Cost Ratio (R/C) ratio, while the economic aspects of tuna were analyzed through qualitative descriptive methods.

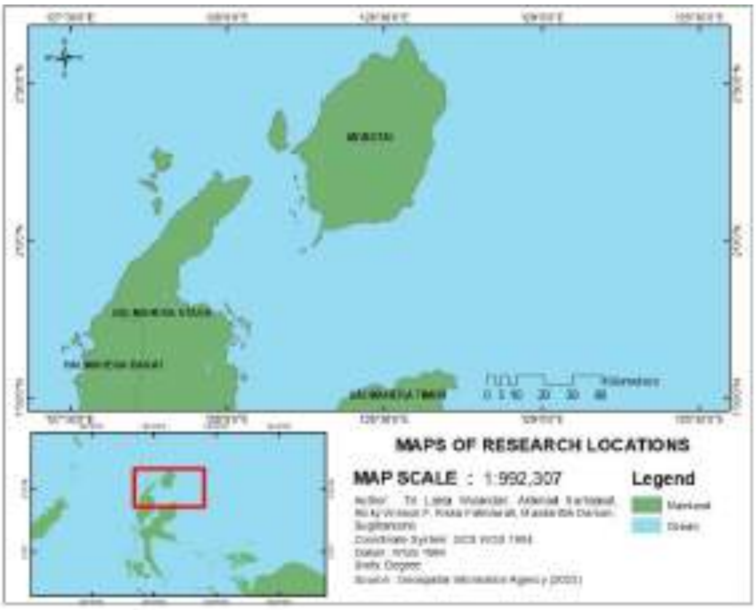

Figure 1. Research Locations

Morotai Island is a prominent tuna-producing island in North Maluku, with a significant number of fishing vessels reaching 1467 units in 2022. The average monthly profits of tuna fishermen ranged from Rp 3,307,971 in September 2022 to Rp 9,494,104 in March 2023. The highest monthly profit was recorded in March 2023 with a value of Rp 9,494,104, while the lowest monthly profit was in September 2022 with a value of Rp 3,307,971. The Revenue Cost Ratio (R/C) ranged from 1.4 to 2.3, indicating varying levels of profitability for tuna fishermen throughout the year. The highest R/C ratio of 2.3 was achieved in April 2022, indicating that for every unit of cost incurred, the fishermen generated 2.3 units of revenue. On the other hand, the lowest R/C ratio of 1.4 was recorded in September 2022. Overall, the R/C ratios remained relatively stable throughout the year, ranging from 1.4 to 2.3.

Table 1. The average profits of tuna fishermen in Morotai Island

No	Month	Year	Value		R/C
1	January	2023	Rp	6.664.206	2,1
2	February	2023	Rp	7.396.188	2,2
3	March	2023	Rp	9.494.104	2,0
4	April	2022	Rp	8.363.294	2,3
5	May	2022	Rp	5.627.250	2,1
6	June	2022	Rp	6.901.875	1,7
7	July	2022	Rp	4.427.500	1,9
8	August	2022	Rp	4.387.996	1,9
9	September	2022	Rp	3.307.971	1,4
10	October	2022	Rp	5.306.850	1,6
11	November	2022	Rp	5.901.619	1,9
12	December	2022	Rp	7.587.242	2,0

Based on this research, the trade of tuna fisheries in Morotai Island is dominated by the domestic market, accounting for 74%, followed by export trade at 26% (Table 2). The average domestic trade of tuna is 457 tons/year with a value of Rp 26.735.378.452, while the export trade amounts to 163 tons/year with a value of Rp 17.573.134.355.

Table 2. The Average of Tuna Trade in Morotai Island, 2018-2022

	Trade Volume of Tuna (Ton)		Trade Value of Tuna (Rp)	
	Domestic	Export	Domestic	Export
	457	163	Rp 26.735.378.452	Rp 17.573.134.355
Percentage (%)	74	26	60	40

Source: Morotai Island Fish Quarantine Center and Quality Control Statistics 2018-2022

Manado, Bitung, Ternate, Jakarta, and Surabaya are destinations for domestic tuna sales (Figure 2). The analysis of tuna sales data from 2018 to 2022 demonstrated the varying trends in tuna sales values among the selected cities. Bitung showcased its dominance in 2018, while Jakarta took the lead in 2019.

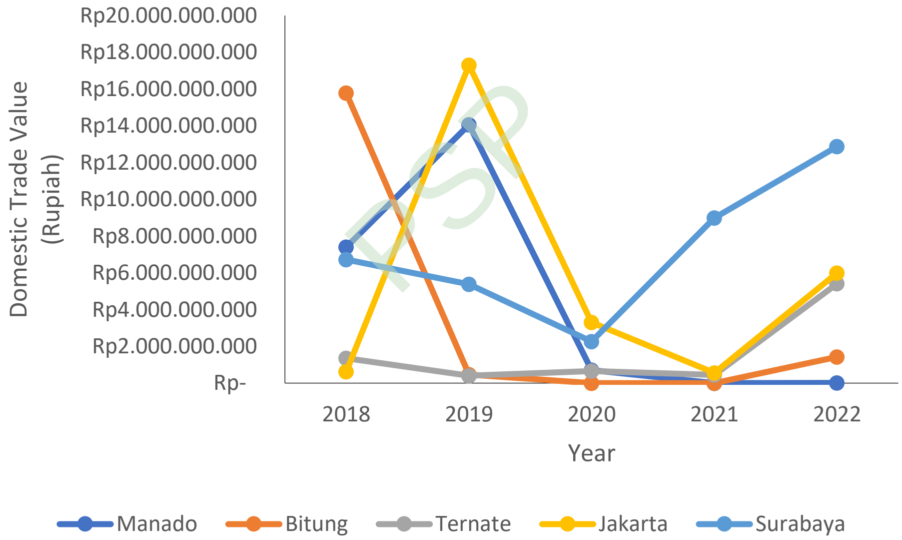

Figure 2. Domestic Trade Value (Rp) in Morotai Island, 2018-2022 (Source: Morotai Island Fish Quarantine Center and Quality Control Statistics 2018-2022)

The volume of tuna exports to Vietnam showed an increasing trend from 2018 to 2021, with a peak of 262.416 Kg in 2021 (Figure 3). However, there was a slight decrease to 196.431 in 2022. The value of tuna exports to Vietnam also exhibited a similar increasing trend from 2018 to 2021. The average volume and value of tuna export was 163085 Kg and Rp17.573.134.355. The highest value was recorded in 2021 with Rp 26.793.591.581. However, there was a decrease in the value of exports to Rp 24.935.904.813 in 2022. Overall, there has been a positive growth in both the volume and value of tuna exports to Vietnam from 2018 to 2021, indicating an expanding market for tuna products.

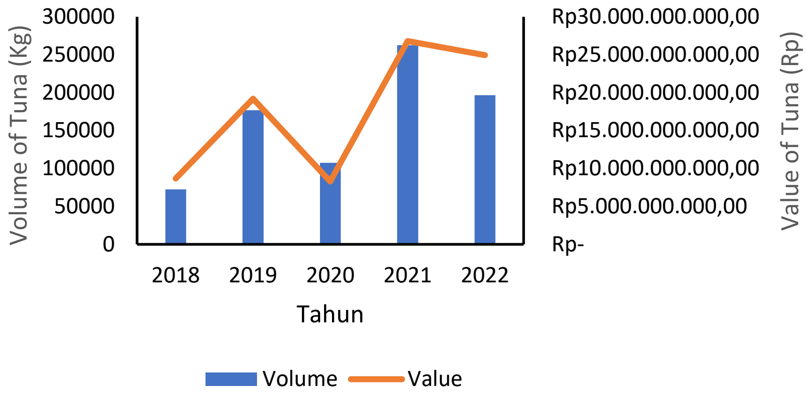

Figure 3. Export Trade Volume (Kg) and Value (Rp) in Morotai Island, 2018-2022 (Source: Morotai Island Fish Quarantine Center and Quality Control Statistics 2018-2022)

The analysis of transportation costs and economic value in tuna trading from Morotai Island to various destinations provides valuable insights (Table 3). The transportation costs per 1 kg of tuna different depending on the route. The cost is Rp 708 for supplier, Rp 6.708 shipments to Ternate, Rp 5.908 shipments via Tobelo to Ternate, Rp 6,108 for shipments to Surabaya, Rp 7.708 for shipments to Manado and Bitung. However, shipments to Manado and Bitung incur the highest transportation cost of Rp 7.708. The economic value of transportation in tuna trading is significant. The total economic transportation value for tuna trading from Morotai Island reaches Rp 3.315.925.760 per year. This analysis underscores the importance of transportation costs in the economic value of tuna trading. Optimizing transportation routes and costs can positively impact profitability and ensure efficient trade operations. Stakeholders should consider these findings to make informed decisions regarding transportation strategies and resource allocation in the tuna trading industry.

Table 3. The Economic Transportation of Tuna in Morotai Island

	Suppliers	Traders (Morotai to					Total/Year
		Ternate					
		Ternate (Ship)	Ternate (Via Tobelo)	Surabaya	Manado	Bitung	
Transportation cost for 1 Kg tuna (Rp)	708	6.708	5.908	6.108	7.708	7.708	
Average trades tuna/year (Kg)	631129	16578	16000	189000	85066	110697	1048470
Economic transportation value/year (Rp)	446.839.2	111.205.224	94.528.000	1.154.412.000	655.688.728	853.252.476	3.315.925.760

The results of this research are crucial as fundamental information for the management and development of tuna fisheries in Morotai Island. Based on the research findings, it was discovered that the R/C ratios remained relatively stable throughout the year, demonstrating the profitability of tuna fishermen on Morotai Island. The months that bring significant profits to fishermen from November to May, there is a subsequent decrease in profits from June to October. Beside that, the production and economic value of tuna in Morotai Island are significant. This is evident from the volume and value of tuna production in both the export and domestic markets. The tuna market in Morotai is dominated by domestic products/people, with the main destinations being Manado, Bitung, Ternate, Jakarta, and Surabaya. Furthermore, the economic value of tuna can be assessed by examining transportation costs across the supply chain, which helps determine the scale of economic activity generated by tuna fishing. According to the research findings, the economic turnover resulting from tuna transportation is substantial with the total economic transportation value for tuna trading from Morotai Island reaches Rp 3.315.925.760 per year. Therefore, it is imperative to implement serious management measures to enhance the profitability of tuna fisheries in Morotai Island for fishermen and relevant stakeholders. This, in turn, will contribute to economic progress and advancement.

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TUNA TALKS CLOSING REMARKS

Interfacing Science and Management for Sustainable and Regenerative Tuna Fishery

There are mainly three themes have been discussed in this workshop, and delivering some recommendations:

1. Fishery Resources

Scientific Data and Research on Resource Considerations: Sound scientific knowledge is crucial for understanding fish stocks, their population dynamics, and the impacts of fishing activities. Robust data collection, monitoring, and research are essential to inform management decisions accurately. We have to consider applying effective implementation for Ecosystem Approach to Fisheries Management. Data are an important part of fisheries management, especially in developing Harvest Strategy. There is also a request to strengthen the networks of Scientists and practitioners.

There are still a number of stock assessment scientists in the region, and national stock assessment programs have continued. However, very few stock assessment reports have been published in recent years. Part of the reason might be confidentiality, but it is also because this work is not publicly available in English.

Data collection and management using Citizen Science for fisheries management, some lessons can be used to develop data collection and management, and back to give awareness resources condition. Crowed Data Crawling may be a future practice for data collection and management and business intelligence.

These analyses are, in turn, used to inform on the global progress towards achieving SDG14 to "Conserve and sustainably use the oceans, seas and marine resources for sustainable development," particularly targets addressing:

a) Natural resources and people with a focus on: Sustainable fishing; conserving coastal and marine areas; Increasing the economic benefits from the sustainable use of marine resources; and

b) How these outcomes above can be achieved through: Increasing scientific knowledge, research and technology for ocean health; supporting small-scale fishers. Therefore, data collection and monitoring are the keys to the success of Harvest Strategy implementation. Opportunities will be gained with collaboration works, such as: Citizen Science and Crown Data Crawling, Crew-Operated Data Recording System (CODRS), Fishing-logbook system and Fish Resource Account.

c) To achieve the goal of the tuna Harvest strategy, integration of fisheries and conservation management is an important need in the implementation of HS Tuna fisheries. MPA needs to be tested for its impact on HS goal, particularly to stock rebuilding, there is a connectivity of tuna fishing production and MPA effective management.

2. Socio-Economic

Fisheries management and management of conservation areas should impact socio-economic conditions, especially related to the resilience of fishers. In this case, a Fisheries Sustainability Model (Sustainable Livelihood Assessment – SLA) needs to be developed to measure the resilience of fishing communities and, simultaneously, measure the impact of the Harvest Strategy Implementation. Of course, in emergency condition such as covid-19 pandemic, marketing facilities for small-scale tuna fishers, and equity of fuel price. In the case of Buru Island, the fisher not need to have BLT (Cash subsidy by governance).

Thus, measuring the welfare of fishers is an important aspect of sustainable fisheries management. By understanding the social, economic, and environmental factors that influence the well-being of fishers, policy makers and managers can develop effective strategies that promote the long-term well-being of fishing communities, and the conservation of fish ecosystems and resources.

3. Governance

There is a need to strengthen the science-policy interface in support of Tuna Harvest Strategy implementation, so that policy reform can lead to increased integration of sustainable resource management with social and economic development.
To sustain the tuna fishing future, it is necessary to improve the capacities of governments and stakeholders to develop and strengthen regulatory and policy frameworks for the successful implementation of the Tuna Harvest Strategy.

The issue still apparent in Indonesia is the lack of governance structure in place for tuna fisheries labor and worker governance. Therefore, improving governance and regulation for fishery workers need to be strengthened. The studies explore the social structures and power relations resulting in gender-differentiated access to, and control over, livelihood assets. This has important implications that affect the ability of men and women to participate in governance and policy, achieve social-ecological resilience to change in global processes and the environment and livelihood sustainability

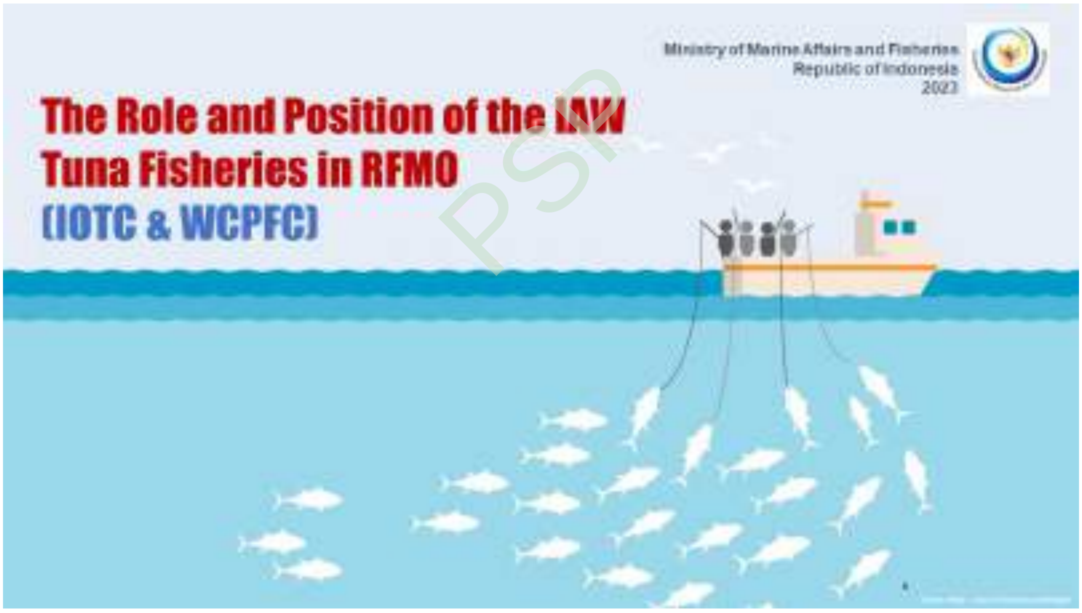
To move towards regenerative and sustainable fisheries, accurate, scientifically based, and reliable fisheries management efforts are needed, including using good data to produce strong fishery stock studies and good policy recommendations. Unfortunately, in Indonesia complete fishery data is still very limited. Some of the proposed solutions include using big data and fish length data (length-based stock assessment) as a method for assessing fish stocks and applying CDC to combine stock assessment and business development.

Illegal, unreported, and unregulated (IUU) fishing is a transnational organized crime in fisheries, has significantly affected Indonesia's national losses of fisheries resources and socio-economic problems. There is an opportunity to combat IUU fishing. How to battle against IUU Fishing in Tuna and Governance regulation Initiatives. It is necessary to be created systematically. Announcements through media (website) like “name” and “shame “ like *spyglass.net* may be useful.

Government for consumer-facing traceability is not just secure and safety tuna products, but traceability is also applied to broader issues. We pledge to eliminate all forms of slavery and ensure suppliers meet at least the minimum social standards in management practices as recommended in the Universal Declaration of Human Rights and International Labor Organization Conventions and Recommendations. The importance of traceability, Fair Trade, and MSC certification is how we can increase fishers' prosperity and invest self-reliant fishers in the future without any subsidies and incentives.

APPENDIX


TUNA CONSORTIUM
BRIN
CROWD DATA CRAWLING
as an Alternative Tuna Data Sources: How Big Data Supports Fisheries Business Intelligent and Policy Recommendation
Tuna Talks / Bali, 23rd May 2023
Irfan Yulianto, Mohamad Natsir, Prihatin Ika Wahyuningrum, Muhammad Iqbal and Budy Wiryawan


Ministry of Marine Affairs and Fisheries
Republic of Indonesia
2023
The Role and Position of the IAW Tuna Fisheries in RFMO
(IOTC & WCPFC)

KEMENTERIAN KELAUTAN DAN PERIKANAN

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