NAPBRES
Journal of National Paradigm-Based Resilience Strategy
NAPBRES 2(1): 35–52
ISSN 3047-3799

Institute for Advanced Science, Social and Sustainable Future
MORALITY BEFORE KNOWLEDGE

A regulated fishing policy to support food security in the marine and fisheries sector

Rizal Rifai[1]*
[1] *Department of Environmental Science, Faculty of Environmental Science, Universitas Indonesia, Jakarta, DKI Jakarta 10430, Indonesia.*
*Correspondence: rizal.rifai@ui.ac.id

Received Date: January 18, 2025 Revised Date: February 22, 2025 Accepted Date: February 28, 2025

ABSTRACT
Background: Indonesia, as the world's largest archipelagic country, holds vast marine resources crucial for national food security. However, the increasing fish consumption coupled with unsustainable fishing practices has led to overfishing, impacting marine ecosystems and food security. To address this, a measured fishing policy is essential to optimize fish harvest while ensuring marine sustainability. **Methods:** This study employs a qualitative descriptive analysis method through a literature review approach. It examines concepts related to food security, the Blue Economy, and the implementation of measured fishing policies. Data are collected from scientific references, national policies, and international regulations to identify control instruments and develop comprehensive policy recommendations. **Findings:** The findings indicate that measured fishing, characterized by regulated fishing quotas, vessel numbers, and fishing zones, is effective in preventing overfishing while ensuring food security. The strategy includes setting quotas aligned with ecosystem capacity, managing vessel numbers, establishing integrated monitoring systems, and optimizing non-tax state revenue/*penerimaan negara bukan pajak* (PNBP). Additionally, empowering small-scale fishers and ensuring inter-sectoral synergy are crucial for sustainable fisheries management. **Conclusion:** Measured fishing policies significantly contribute to national food security by balancing economic growth and marine ecosystem sustainability. The implementation of this policy enhances fish resource management and supports the welfare of coastal communities. **Novelty:** This study offers a comprehensive framework for measured fishing policy as a strategic solution to overfishing, integrating sustainable practices with economic empowerment. It also highlights the role of Blue Economy principles in supporting Indonesia's food security and sustainable marine resource management.

KEYWORDS: fishing policy; food security; marine and fisheries factor.

1. Introduction

Indonesia is the largest maritime and archipelagic country in the world, with 17,504 islands and a total water area of approximately 6.4 million square kilometers. The length of Indonesia's coastline, which reaches 108,000 kilometers, makes Indonesia is among the countries with the richest marine resources. The existence of islands that are scattered throughout the territory of Indonesia provide great potential for the management of fisheries and marine resources (Permenko Marinves Number 6 of 2020). With such

Cite This Article:
Rifai, R. (2025). A regulated fishing policy to support food security in the marine and fisheries sector. *Journal of National Paradigm-Based Resilience Strategy, 2*(1), 35-52. https://doi.org/10.61511/napbres.v2i1.2025.1791

abundant natural resources, Indonesia has the responsibility to manage and conserve these resources for the welfare of the people and the sustainability of the marine ecosystem.

This wealth of marine resources provides enormous potential in supporting national food security. With a growing population, the need for affordable and nutritious protein sources is becoming increasingly urgent. One of the main sources of protein for the people of Indonesia is fishery products. Therefore, sustainable management of fisheries resources is not only important to preserve marine ecosystems, but also to ensure that people have sufficient access to healthy and nutritious food (Husen, 2024).

Fish consumption in Indonesia continues to increase along with population growth and public awareness of the importance of animal protein. Based on data from the Ministry of Marine Affairs and Fisheries, the per capita fish consumption rate in Indonesia will reach around 57.61 kg by 2023. Higher fish consumption not only contributes to improved public health, but also supports the overall growth of the fisheries and marine sector.

As the world's population increases and the challenge of malnutrition continues, fish can be a sustainable and affordable food option to meet people's nutritional needs, especially in areas experiencing food shortages (Phogat et al., 2022). In addition, the increasing demand for fish consumption leads to higher fishing pressure on fish resources. This makes the importance of sustainable management of fish resources necessary. This sustainability aims to avoid the decline of fish stocks and threatens the sustainability of marine ecosystems. Sustainable fish production is essential to ensure food security, especially in coastal areas that depend on marine products as the main source of income and food.

The main challenge faced in fulfilling food security in the fisheries sector is preventing overfishing, which has led to a significant decline in fish stocks. This phenomenon not only impacts the marine ecosystem, but also threatens the livelihood of fishermen and the availability of food for the community. The decline in the quality and quantity of fish catches results in instability of food prices and accessibility, which in turn affects food security at the local and national levels (Carmelite, 2019).

A deeper problem arises from fisheries management policies that are often ineffective. Many policies are not based on accurate scientific data, and therefore fail to address the problem of unmeasured fishing. In addition, the lack of law enforcement and supervision in fishing practices leads to further exploitation of the resource. Human resource limitations, such as the lack of training for fishers on sustainable fishing practices, are also factors that exacerbate this situation (Carmelite, 2019).

To overcome these problems, appropriate strategies and policies are needed through measured fishing. Measured fishing is a fisheries resource management system that aims to ensure sustainability and efficiency in fishing activities (Permen KP 28 of 2023). This policy regulates the fishing quota, the number of fishing vessels used, and the fishing gear applied. Thus, metered fishing is expected to optimize catches while preserving marine ecosystems and supporting Indonesia's food security in the marine and fisheries sector.

2. Methods

The research method in this paper is a qualitative descriptive analysis method. This method uses a literature study that covers the concepts of Food Security, Blue Economy, Measured Fishing and policy implementation. The data used in this study were obtained from various scientific references, research reports, international laws and national policies related to food security in the marine and fisheries sector. Data analysis was conducted to identify control instruments and develop comprehensive and practical policy recommendations to improve food security in the marine and fisheries sector.

2.1 Food security in marine and fisheries sector

The fisheries sector in general plays a vital role in a country's economy and food security, especially in countries with abundant marine resources such as Indonesia. The

sector not only provides an important source of animal protein for the people, but also creates jobs and supports the livelihoods of millions of people, ranging from fishermen, fish farmers, to processing industry players. Eating fish offers significant health benefits, including anti-oxidant, anti-inflammatory properties, and heart and brain protection. Fish is rich in polyunsaturated fatty acids, which play an important role in reducing inflammation and improving cardiovascular health (Chen et al., 2015).

In addition, fish also contains high-quality proteins and biopeptides that can support the immune system and prevent protein-calorie malnutrition. The benefits of sustainable fish consumption can be a solution to meet people's nutritional needs, especially in areas that depend on fisheries resources. With increasing awareness of the health benefits of fish, as well as the importance of sustainability in fisheries practices, fish consumption can contribute to global food security and improve people's quality of life (Chen et al., 2021).

The concept of food security in the marine and fisheries sector focuses on

the ability to provide sufficient, safe and nutritious access to food sources from the sea. This includes sustainable management of fisheries resources, which is critical to ensure that fish populations remain stable and can be utilized by future generations. Good management and sustainable fishing practices are key to achieving food security (Carmelite, 2019).

In addition, public education and awareness on the benefits of fish consumption as a healthy source of protein is crucial in the context of food security. People need to be provided with adequate information on the nutritional value of fish and the importance of integrating it into their daily diet. Warnings carried out by the government and related institutions are expected to increase public awareness, so that fish consumption can increase significantly. Therefore, food security in the marine and fisheries sector depends not only on the availability of resources, but also on effective management, accessibility and public awareness.

2.2 Blue economy policy as a basis for marine and fisheries resource management in support of food security

The Blue Economy policy in Indonesia plays an important role in supporting food security by integrating sustainable and environmentally friendly marine resource management. Through this approach, it is expected to increase the efficiency of utilization of fisheries resources without causing pollution, and encourage diversification of economic activities that are value-added and highly competitive. In addition, this policy also aims to increase local communities' access to economic resources, which in turn can accelerate innovative and creative investment in the fisheries sector (Puspitasari et al., 2023).

The Blue Economy concept includes biological, environmental, economic and social aspects as the main pillars that must be considered. From a biological perspective, it is important to maintain fish populations so that they remain productive and do not decline (Lee et al., 2020). The environmental aspect emphasizes minimizing the negative impacts of fishing activities on the environment and non-target species. Economically, the blue economy seeks to generate optimal profits for businesses and communities, while ensuring sustainable revenues for the state. On the social side, the blue economy focuses on creating employment opportunities for fishermen and communities, maintaining harmony between stakeholders, and supporting national defense and security.

In implementing the Blue Economy policy, in the Marine and Fisheries sector, the Ministry of Marine Affairs and Fisheries establishes Blue Economy priority programs, namely by: expanding marine conservation areas, measured quota-based fishing, developing sustainable marine, coastal and inland aquaculture, supervision and control of coastal areas and small islands, as well as cleaning up plastic waste in the sea through a fishermen participation movement.

The benefits of the initiatives taken by the Indonesian Ministry of Marine Affairs and Fisheries are significant in supporting national food security. With a focus on the protection of marine ecosystems and sustainable management of fisheries resources, these initiatives contribute to increased production of quality fish, which is an important source of protein

for the community. In addition, wise management of marine and coastal resources helps maintain the balance of ecosystems, supports the survival of fishers, and improve the welfare of coastal communities. Through these programs, KKP seeks not only to increase the productivity of the fisheries sector, but also to ensure the sustainability of marine resources for national food security and community welfare (Luthfia, 2017).

2.3 Concept of measured fishing

One of the priority programs in the Blue Economy is Measured Fishing. Based on Government Regulation 28 Year 2023, Measured Fishing refers to fishing activities carried out in a controlled and proportional manner in certain zones, guided by fishing quotas. This policy aims to sustainably manage fish resources, which are crucial for food security in Indonesia. By setting fishing quotas and measured fishing zones, this policy ensures the sustainability of fish resources, so that the supply of fish as the main source of protein for the community is maintained.

As an implementation of the government regulation, KKP issued Regulation of the Minister of Maritime Affairs and Fisheries of the Republic of Indonesia Number 28 Year 2023. This regulation aims to manage fisheries resources in a sustainable and proportional manner. Measured fishing is carried out in the Measured Fishing Zone by observing the set quota, so as to preserve fish resources and the marine environment. The policy includes strict regulations on the type, size, and number of vessels used, as well as the fishing gears allowed, to ensure that fishing activities do not exceed the recoverable capacity of the ecosystem. Measured fishing policy plays an important role in ensuring the availability of quality animal protein sources for the community.

The Measured Fishing Policy is expected to be an effective solution for eradicate the practice of illegal, unreported, and unregulated (IUU fishing) which has been detrimental to marine ecosystems, the economy, and the welfare of fishermen (Mozumder et al., 2023). Through clear and controllable regulations, this policy not only aims to to stop illegal activities but also to encourage the sustainable utilization of fish resources. With proper implementation, Indonesia's marine and fisheries sector is expected to experience significant growth, including Indonesia is expected to experience significant growth, supported by a balance between preserving marine ecosystems, increasing economic value, social empowerment of coastal communities, and strengthening national food security. This policy also opens up opportunities to improve the competitiveness of Indonesian fishery products in the global market, creating more opportunities for more people to buy fishery products. Indonesia's fishery products in the global market, create more jobs, and provide sustainability for future generations. By managing fishing sustainably, it is expected that the catch can meet the food needs of the community without damaging the ecosystem that supports the existence of fish. In addition, this policy also supports local economic growth through the development of downstream fisheries industries, which can increase community access to fish resources and strengthen national food security. resources and strengthen national food security.

2.4 The concept of fishing quotas

One of the instruments to control fishing activities is the fishing quota, which is set to ensure that the amount of fish caught by fishers does not exceed the sustainable potential of fish resources or other maximum limits (Badiuzzaman et al. 2014). A fishing quota is a limit set by the government or fisheries management agency on the maximum number of fish that can be caught in a certain period. of fish that can be caught in a certain period. This concept aims to manage fisheries resources sustainably, prevent overfishing and ensure that fish stocks remain in good condition, and ensuring that fish stocks remain in a healthy condition for recovery (Hoshino et al., 2020).

Quota-based fisheries management has been implemented in many countries with positive results. This management includes input and output controls, as well as

international cooperation in fisheries management (Huang & He, 2019). The implementation of quota systems has been shown to provide economic incentives for fishers. A study in New England showed that implementing quotas increased fishers' income by 18% and reduced the risk of crew termination by 8% (T3). This suggests that quota implementation can adapt to the local context and deliver significant results in fisheries resource management.

Fig. 1 Implementation of Fishing Quota system in some countries (Chu, 2009)

While fishing quotas have many benefits, their implementation is not without challenges. Some of the challenges include fishers' non-compliance with set quotas, difficulties in monitoring and enforcement, and potential conflicts between small and large fishers (Hilborn et al., 2020). Therefore, a comprehensive and participatory approach is needed in designing and implementing a quota system. The implementation of fishing quotas also has a positive impact on the environment. By reducing pressure on fish stocks, quotas help maintain the balance of marine ecosystems and support the long-term sustainability of fisheries resources. Research shows that effective management can improve fish stock status and habitat quality (Hilborn et al, 2020).

In addition, measured fishing also contributes to food security by ensuring a stable supply of high-quality fish for communities (Farquhar et al., 2024). Through increased income of fishers and job creation in the fisheries sector, metered fishing supports local economic well-being, which in turn strengthens food security at the community level. Measured fishing thus serves not only as a resource management tool, but also as a strategy to achieve broader social and economic goals, including national food security (Trenggono, 2023).

3. Results and Discussion

3.1 Fish consumption

Food security in Indonesia is strongly influenced by fish consumption rates as an important source of animal protein for the community. In 2023, per capita fish consumption in Indonesia reached 56.4 kg, up from 43.5 kg in 2015, indicating public awareness of the importance of fish as a source of nutrition. The government targets a per capita fish consumption of 70 kg per year in the next few years, reflecting a commitment to improving food security through the utilization of fisheries resources.

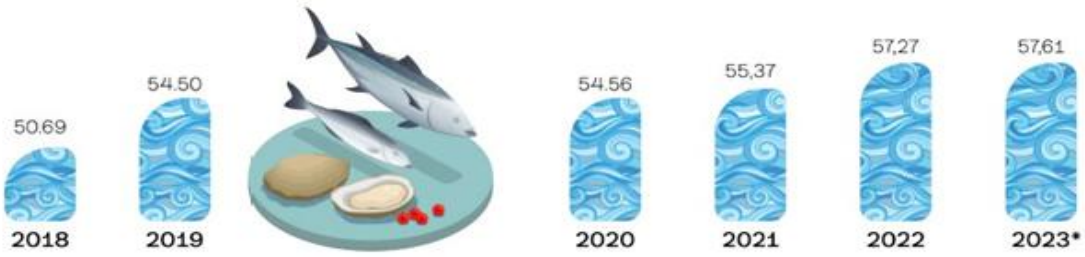


Fig. 2. Fish Consumption Rate

Programs and activities that support fish consumption in Indonesia are very important to improve food security and public health. The following are some of the programs and activities that have been implemented: Gemar Makan Ikan" Program, this program is a government initiative that aims to increase public awareness about the benefits of fish consumption. The program involves educational campaigns in schools, counseling to the public, and the promotion of local fishery products. Through this program, it is hoped that the public can understand the importance of fish as a good source of protein and nutrition. Improvement of fisheries production facilities and infrastructure, to support availability of fish, the government has implemented various activities, such as distribution of fishing boat engines, crew certification, and the development of fishery port facilities. In 2023, a total of 1,243 units of fishery boat engines were distributed in 24 provinces, and 49,812 people were certified. were distributed in 24 provinces, and 49,812 people have been certified as fishery boat crews. crew of fishery vessels. This aims to increase production capacity and efficiency in fishing.

Development of fishery product processing infrastructure, the government is also investing in the development of infrastructure that supports the distribution and marketing of fishery products. This includes the construction of fishing ports and modern fish processing facilities, which can help maintain fish quality and extend the shelf life of fishery products. Counseling and training, counseling and training activities for fishermen and fisheries business actors are also conducted to improve their skills and knowledge about fisheries. conducted to improve their skills and knowledge on sustainable fisheries practices and efficient aquaculture techniques. This includes training on the use of new technologies in fish farming and fishery product processing of fishery products. Assistance program, the government provides assistance in the form of fish seeds, feed, and other production facilities to fish farmers to improve aquaculture productivity. In addition, the program also includes financial support through access to "kredit usaha rakyat" (people's business credit) to assist fishermen and fisheries business actors in developing their businesses. Nutrition campaign, in addition to the "Gemar Makan Ikan" program, a broader nutrition campaign was also conducted to increase public awareness of the importance of a healthy diet. conducted to raise public awareness about the importance of a balanced diet that includes fish. This includes collaboration with health to promote fish consumption as part of a healthy diet.

3.2 Estimation of fish resources potential and production

Indonesia's marine waters cover a vast area with diverse biological, ecological, social and economic characteristics. Based on the vast area and diverse characteristics, Indonesia's marine waters through Regulation of the Minister of Maritime Affairs and Fisheries (Permen KP) Number 18/Permen- KP/2014 on the State Fisheries Management Areas of the Republic of Indonesia/*Wilayah Pengelolaan Perikanan Negara Republik Indonesia* (WPPNRI) are divided into 11 WPPNRI, to optimize management in the context of sustainable fisheries. In determining the 11 WPPNRIs, Indonesia refers to the fishing areas established by FAO; fishing area 57 (Indian Ocean, Eastern) and fishing area 71 (Pacific, Western Central). 71 (Pacific, Western Central). The division of WPPNRI is WPPNRI 571, 572, and 573 for the

Malacca Strait, West Sumatra Waters, South Java Waters to the Southern Waters of Nusa Tenggara and WPPNRI 711, 712, 713, 714, 715, 716, 717, and 718 for the Natuna Sea area.

Furthermore, in each WPPNRI, the Ministry of Maritime Affairs and Fisheries conducts an assessment to determine the estimated potential, Jumlah Tangkap Boleh (number of catches allowed), and utilization rate of each fish group in accordance with the characteristics of each WPPNRI. in accordance with the characteristics of each WPPNRI. Thus, the Ministry of Maritime Affairs and Fisheries can then carry out management actions in each WPPNRI, based on the potential and level of utilization of fish resources and problems related to fish resources by involving all stakeholders in accordance with the characteristics of each WPPNRI. by involving all stakeholders in accordance with their respective roles.

The Government of Indonesia through the Ministry of Maritime Affairs and Fisheries in the Regulation of the Minister of Maritime Affairs and Fisheries Number 34 of 2023 concerning the National Commission for the Assessment of Fish Resources which is an independent non-structural institution and is tasked with providing input and/or recommendations to the Minister of Maritime Affairs and Fisheries through the collection and review of the results of research/studies on fish resources from various sources, including the best scientific evidence available, in determining the potential and amount of catch allowed as policy material in responsible fisheries management in the fisheries management area of the Republic of Indonesia.

These recommendations on fisheries potential and Jumlah Tangkap Boleh (number of catches allowed) will then be used by the Ministry of Marine Affairs and Fisheries as one of the bases for fisheries management policies in each WPPNRI. The latest recommendations from National Commission Fish Resources Assessment regarding the potential, Total Allowable Catch, and status of fisheries in each WPPNRI have been stipulated in the Decree of the Minister of Marine Affairs and Fisheries Number 19 of 2022 concerning Estimation of Potential, Total Allowable Catch, and Utilization Level of Fish Resources. KP Ministerial Decree Number 19 Year 2022 is the basis of policy for fisheries management, especially for the determination of the quota/allocation of fish resource utilization in each WPPNRI.

Estimated Potential represents the annual Maximum Sustainable Yield (MSY) that can be utilized to keep the fish sustainable. Jumlah Tangkapan yang Diperbolehkan / JTB represents the Total Allowable Catch (TAC), which is the total utilization allowed to keep the fish sustainable. In detail, the estimated potential in each WPPNRI is described in Table 1. Furthermore, after obtaining the estimated value of the potential of fish resources, it is determined the number of allowed catches, hereinafter referred to as JTB. JTB is the number of fish resources that may be caught in the fisheries management area of the Republic of Indonesia with due regard to sustainability so that accurate data and information is needed about the availability of fish resources that can be accounted for, both scientifically and factually each fishing area. In addition, the implementation of the principle of the number of catches allowed must pay attention to international obligations in the field of Fisheries.

As a precautionary approach, the JTB value is obtained from the estimated potential divided by the level of utilization. JTB value for groups of species that have experienced overexploited is 50% of the estimated potential that has been set. The value of JTB for fully-exploited groups is 70% of the estimated potential that has been set. JTB value for moderate type group is 90% of the estimated potential that has been set.

The utilization rate of Fish Resources describes the level of exploitation that has been done to fish resources. The value of utilization rate obtained from the ratio between the current utilization rate of fish resources (F actual) with the optimum utilization rate of fish resources (F optimal). F optimal is the recommended fishing effort to achieve optimal utilization of fish resources or more simply defined as the amount of effort arrest when JTB is reached, while the "actual F" is the current capture effort according to the recorded data.

The level of resource utilization is divided into 3 (three) conditions, namely moderate, fully-exploited, and over-exploited. Moderate condition is obtained if the ratio of F actual To F optimum value below 0.5. Fully-exploited condition is obtained if the ratio of F actual to f

optimum is 0.5 to below 1,0. Over-exploited condition obtained if the ratio of F actual to f optimum is equal to 1.

Table 1. Estimation of potential fish resources in WPPNRI

Fisheries Managemen Area Republic of Indonesia	Small Pelagic Fish	Large Pelagic Fish*	Demersal Fish	Coral Reef Fish	Penaeid Shrim	Lobster	Crab	Small Crab	Squid	Total
Potential (ton)	157,151	75,095	230,000	34518	47.610	477	10,870	2,906	32,511	591,139
JTB (ton)	141,436	37.548	115.000	31,066	23,805	239	5.435	2,034	22,758	-
Potential (ton)	479,503	438,877	204.500	33,429	35.560	2,722	6.787	2,533	26.039	1,229.950
JTB (ton)	431,553	219.439	143,150	16.715	17.780	1,361	6.108	1,267	23,435	-
Potential (ton)	624,366	354.215	299.600	23,725	8,514	1,563	585	3,750	22.124	1,338,442
JTB (ton)	437,056	247.950	269.640	11,863	4.257	782	410	2.625	11,062	-
Potential (ton)	536,917	163,744	289.300	197.580	71,810	1,467	3,388	9.804	32,369	1,306.380
JTB (ton)	375,842	114.621	202,510	138,306	50,267	734	1,694	4.902	22,658	-
Potential (ton)	275,486	145,863	358,832	71,526	83,820	1,481	7.360	23,508	66.609	1,034.485
JTB (ton)	247.937	72,932	179.416	57.221	58,674	1,037	5,152	16.456	46.626	-
Potential (ton)	284.302	162,506	374.500	167.403	56.835	765	6.213	9.253	11,370	1,073,147
JTB (ton)	142,151	113,754	337.050	83,702	39.785	383	4.349	4.627	5,685	-
Potential (ton)	222,881	370,653	292,000	121,326	6.472	724	1,758	4.705	13,460	1,033,979
JTB (ton)	156.017	259.457	204.400	60,663	3,236	362	879	3,294	9.422	-
Potential (ton)	443,944	74.908	80,226	105,336	5,295	1,217	336	157	3,874	715,293
JTB (ton)	310,761	52,436	56.158	52.668	3,707	609	235	110	2.712	-
Potential (ton)	197.012	176.382	215,900	24.909	6.705	1,494	1,470	265	1,908	626.045
JTB (ton)	137.908	123,468	194.310	12.455	4.694	1,046	1,029	186	1,336	-
Potential (ton)	135,140	189.718	69.210	19.814	7.423	736	545	291	1,826	424.704
JTB (ton)	121,626	132.803	48,447	9.907	6.681	515	491	146	1,278	-
Potential (ton)	836.973	818,870	876.722	29.485	62.842	1,187	1,498	775	9.212	2.637.565
JTB (ton)	669.579	655,096	701,378	23,588	50,274	950	1,198	620	7.370	-
				Potential Amount (ton)						12,011,129

Based on one data KKP (2024), data on capture fisheries production in 2023 showed a total production of 7,706,223 tons. Fish catch production small pelagics dominate with the highest total at WPPNRI 712 (561,109 tons), followed by large pelagics which also show significant numbers, especially at WPPNRI 713 (342,096 tons). Demersal and reef fish species have lower variation, with the highest demersal at WPPNRI 712 (533,609 tons) and reef fish at WPPNRI 711 (156,318 tons). Meanwhile, penaeid shrimp, lobster, crab, crab and squid showed smaller numbers, with a total overall catch of reached 75,777 tons.

Table 2. Production of fish resources in WPPNRI

Group Of Fish Species	WPPNRI 571	WPPNRI 572	WPPNRI 573	WPPNR I 711	WPPNRI 712	WPPNRI 713	WPPNR I 714	WPPNR I 715	WPPNR I 716	WPPNRI 717	WPPNRI 718	High Seas of the Indian Ocean
Small Pelagic	150,979	236,024	196,464	246,144	561,109	340,528	275,240	249,255	103,255	57,644	47,223	5,707
Large Pelagic	82,316	219,932	177,130	101,887	157,234	342,096	215,900	292,865	98,777	113,581	35,882	69,087
Demersal	94,906	131,531	53,913	246,637	533,609	198,200	107,661	149,989	30,021	22,029	43,859	634
Coral Reef Fish	25,549	42,248	24,764	156.318	97,760	111,164	68,424	113,159	22,039	16,160	12,595	27
Penaeid Shrimp	34,325	28,568	10,001	72,485	65,042	39,726	1,851	7.559	8,759	1,256	4,823	-
Lobster	22	4,897	1,387	314	-	-	275	1,540	119	4	1,830	-
Crab	3,677	2,473	941	10,863	12,119	51,029	1,207	4,341	2,453	349	1,368	-
Small Crab	6.815	1,967	2,083	24,818	33,608	56,646	2,713	13	185	425	129,273	-
Squid	7,137	9,601	24,300	66.208	94,796	23,521	5,847	17,367	995	421	19,736	322
Total	460,225	703,969	555,913	959,964	1,592,115	1,183,290	685,850	836,400	272,161	211,774	168,785	75,777

Per capita fish consumption in Indonesia currently reaches 56.4 kg, while the target to be achieved is 70 kg per year, with an estimated population in 2024 of 282,477,584 people. Under existing conditions, the total fish needs for the population is about 15,925,000 tons (56.4 kg x 282,477,584 inhabitants). However, to achieve the target consumption of 70 kg per capita, it takes about 19,773,308 tons of Fish (70 kg x 282,477,584 inhabitants). With the potential of available fish resources of 12,011,129 tons and the current production of only 7,706,223 tons, there is a significant gap between the needs and availability of fish, both in existing conditions and when reaching the target. This emphasizes the urgency of sustainable management of fish resources to ensure that marine ecosystems are maintained and can support increased fish production. Implementation of quota-based metered fishing becomes very important in this context, as it can help regulate the number of fish caught according to the carrying capacity of the environment, prevent overfishing, and ensure the sustainability of fish resources.

3.3 Strategies to improve food security in the Marine and fisheries sector through scalable fishing

The increasing need for food from fish to meet the needs of the population and the significant gap between the needs and availability of fish, causing sustainable management of fish resources to be an important factor. This is to ensure that the marine ecosystem is maintained and can support increased fish production and requires several strategies that can be applied. Strategies that can be applied include: to ensure sustainable fisheries and contribute to national food security, several key strategies must be implemented. First, fishing quotas should be determined based on the carrying capacity of fish stocks to prevent overexploitation and allow for natural regeneration, maintaining ecological balance and food supply. Second, regulating the number of fishing vessels is essential to avoid overfishing and reduce pressure on marine ecosystems; this requires determining an optimal operational threshold and enforcing compliance with marine resource regulations. Third, the zoning of fishing areas should be aligned with ecosystem-based management principles and regional development goals, ensuring equitable resource distribution and boosting local economies.

Fourth, establishing an integrated surveillance system from upstream to downstream is vital for monitoring fishing activities, curbing illegal practices, and ensuring fair catch distribution, especially for small-scale fishers. Fifth, the optimization of non-tax state revenue/*penerimaan negara bukan pajak* (PNBP) from the fisheries sector can enhance state income and fund initiatives that support fishermen's welfare, such as infrastructure development and social assistance programs. Sixth, fishermen empowerment programs, including the development of advanced fishing villages, should be prioritized to strengthen capacity, resilience, and livelihoods of small-scale fishers, allowing them to play a stronger role in supporting food security. Finally, achieving cross-sectoral synergy among national and regional governments, as well as private stakeholders, is crucial for creating coherent, integrated policies that enhance the effectiveness and sustainability of fisheries governance.

3.3.1 Fishing quotas

Fishing quotas are allocations of fish resources or the amount of fish that may be utilized through measurable and regulated fishing activities. These quotas are established based on core principles of sustainable fisheries management, equitable utilization, regulatory compliance, and social responsibility. The quota system consists of two main categories: the National Fishing Quota and the Tuna and Skipjack Quota. The National Fishing Quota refers to the estimated availability of fishery resources and the allowable catch, determined through input and recommendations from the National Commission for Fish Resource Assessment for each Indonesian Fisheries Management Area/*Wilayah Pengelolaan Perikanan Negara Republik Indonesia* (WPPNRI). On the other hand, the Tuna and Skipjack Quota is regulated under Regional Fisheries Management Organizations (RFMO), covering Indonesia's Exclusive Economic Zone (EEZ) and parts of the High Seas, typically in the form of specific catch limits or allocated quotas.

To accurately determine fishing quotas, several critical data and information components are required, including: stock assessment data, which provides insight into the current status and trends of fish populations; catch data and fishing effort, reflecting the actual harvest and level of fishing activity; ecosystem and environmental parameters, such as oceanographic conditions and climate variability, which influence fish distribution and abundance; socio-economic data, which considers the livelihoods of coastal communities, fishing fleet composition, and market dynamics; legal and institutional frameworks, to ensure alignment with national regulations and international commitments. By utilizing comprehensive and science-based data, fishing quotas can be set in a way that maintains the balance between ecological sustainability and economic viability—ensuring that Indonesia's marine resources are preserved for future generations while continuing to support food security and fisher welfare.

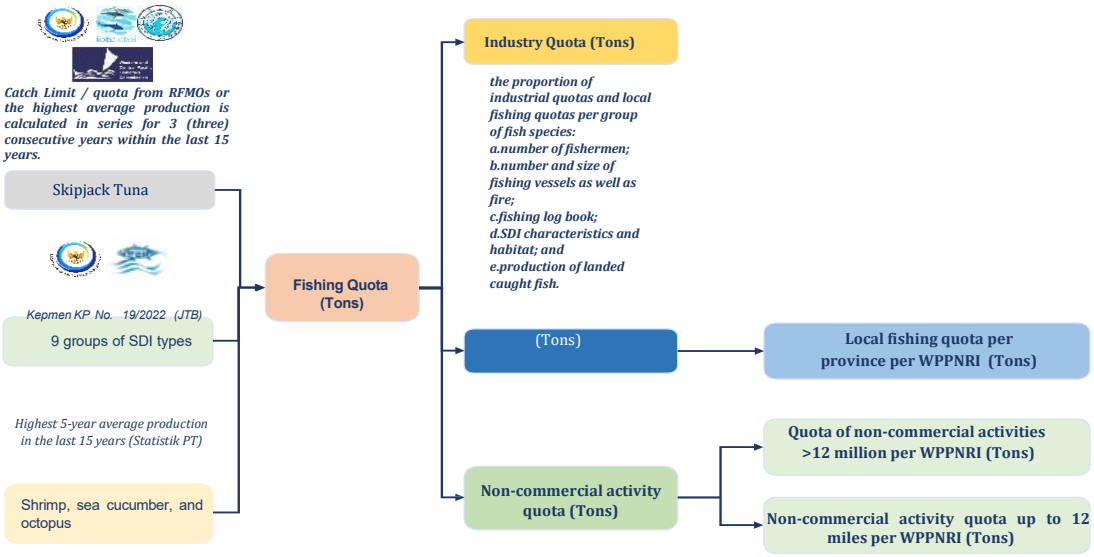
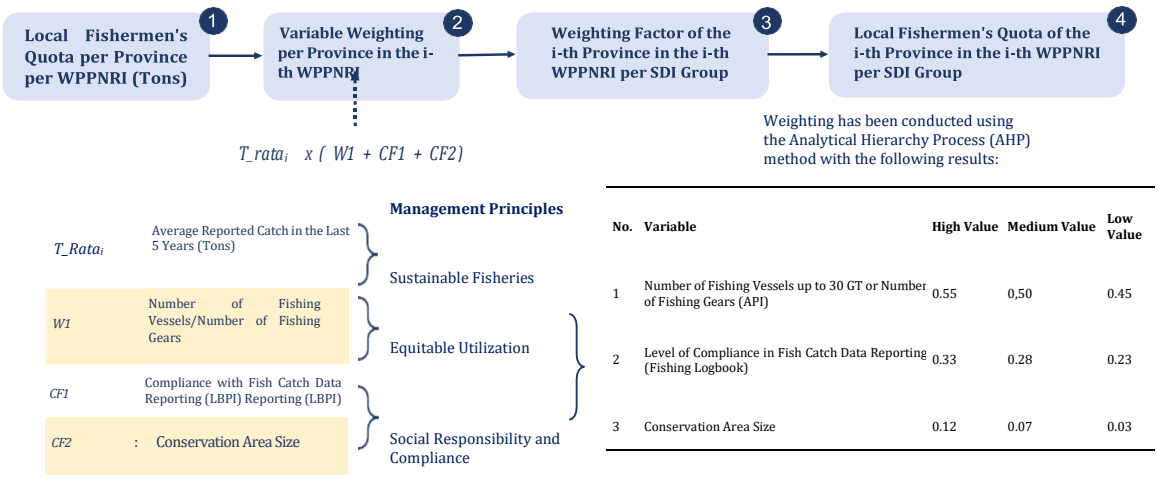


Fig. 3 Procedure for calculating fishing quotas

Fishing quotas are determined through a comprehensive and data-driven approach that ensures sustainability, equity, and compliance with both national and international fisheries regulations (Kauer et al., 2024). These quotas are calculated based on a variety of important data and information related to fish resources, fishing activities, and socioeconomic conditions. Among the critical data used are the estimation of fish stock and Maximum Sustainable Yield (JTB) in each National Commission for Fish Resource Assessment for each Indonesian Fisheries Management Area/*Wilayah Pengelolaan Perikanan Negara Republik Indonesia* (WPPNRI), the number and types of fishing vessels and gear operating in both WPPNRI and the High Seas, and the national income target for fishermen—where the term "income" is more appropriate than "revenue" when referring to the earnings of individual or small-scale fishers. In addition, the average market price of fish, the number of local fishermen per WPPNRI and province, and production data for each fish group over the past five years are also essential components.



No.	Variable	High Value	Medium Value	Low Value
1	Number of Fishing Vessels up to 30 GT or Number of Fishing Gears (API)	0.55	0,50	0.45
2	Level of Compliance in Fish Catch Data Reporting (Fishing Logbook)	0.33	0.28	0.23
3	Conservation Area Size	0.12	0.07	0.03

Fig. 4. Procedures for allocating local fishermen's quota per province per WPPNRI in the fishing zone

Historical performance data, such as the average tuna and skipjack production over the last 15 years, is used to manage these high-value species effectively. Quotas set by Regional Fisheries Management Organizations (RFMOs), particularly for Indonesia's Exclusive Economic Zone (ZEEI) and the High Seas, are incorporated to ensure compliance with

international standards. Other supporting information includes the total coastline per province, results from fishing logbook evaluations, the implementation status of Fisheries Management Plans (RPP), participation in fisheries management bodies, and the extent of marine conservation areas in each region.

Based on this data, fishing quotas are divided into three categories: quotas for local fishers, quotas for industrial or commercial operations, and non-commercial quotas allocated for research, education, or conservation purposes. This structured and balanced approach helps ensure that fisheries remain productive and sustainable while also promoting food security and the welfare of coastal communities. The complete mechanism for calculating these quotas is typically illustrated in diagrams such as Figure 3 and Figure 4. Based on the results of the fish catch quota calculation, the values obtained for the industrial quota, local fishermen's quota, local fishermen's quota per province, and the quota for non-commercial activities are as follows:

Table 3. Fish catch quota calculation

Industrial quota											
SDI Group	Zone 1	Zone 2		Zone 3			Zone 4		Zone 5	Zone 6	
Type	WPP-NRI 711	WPP-NRI 716	WPP-NRI 717	WPP-NRI 714	WPP-NRI 715	WPP-NRI 718	WPP-NRI 572	WPP-NRI 573	WPP-NRI 571	WPP-NRI 712	WPP-NRI 713
Large Pelagic	89,395	98,765	110,215	101,178	36,177	628,829	166,757	176,027	33,039	58,340	92,132
Small Pelagic	150,322	64,810	62,023	62,401	186,438	401,707	293,427	244,727	56,569	106,602	56,855
Demersal	80,996	91,317	19.377	81,752	33,691	420,785	97.332	150,983	45,995	77141	134,807
Coral Reef Fish	27.658	3,612	3,962	23,050	16,852	9,434	7,855	4,745	12.425	6,294	33,477
Shrimp	20,105	-	-	-	-	30,161	-	-	9.521	24,054	15,912
Squid	9,062	628	511	3,768	1,627	4,422	15,934	6,194	9.102	20,047	2.274
Industrial Quota for Tuna Commodities											
SDI Group	Zone 1	Zone 2		Zone 3			Zone 4		Zone 5	Zone 6	
Type	WPP-NRI 711	WPP-NRI 716	WPP-NRI 717	WPP-NRI 714	WPP-NRI 715	WPP-NRI 718	WPP-NRI 572	WPP-NRI 573	WPP-NRI 571	WPP-NRI 712	WPP-NRI 713
		and the High Seas					and the High Seas				
Albacore	-	-	-	-	-	-	796	7,467	-	-	-
Skipjack Tuna	2,284	47,489	6,759	32,452	68,853	21,697	41,92	37,227	12,437	-	38,809
Bigeye Tuna	-	5,222	1,351	6,260	2,062	19.771	4,250	13,207	1,146	-	5,707
Southern Bluefin Tuna	-	-	-	-	-	-	-	1,031	-	-	-
Yellowfin Tuna	-	14,276	1,606	32,776	80,728	2,079	7,858	4,379	809	-	16,449
Local Fishermen's Quota in Tons											
SDI Group	Zone 1	Zone 2		Zone 3			Zone 4		Zone 5	Zone 6	
Type	WPP-NRI 711	WPP-NRI 716	WPP-NRI 717	WPP-NRI 714	WPP-NRI 715	WPP-NRI 718	WPP-NRI 572	WPP-NRI 573	WPP-NRI 571	WPP-NRI 712	WPP-NRI 713
Large Pelagic	25,214	24,691	22,574	158,253	16,254	26,201	52,660	71,898	4,505	14,585	21,611
Small Pelagic	225,483	73,084	59.591	93,601	124,292	267,805	138,083	192,285	84,853	141,310	85,282
Demersal	121,494	102,974	29.065	122,628	22,461	280,523	45,803	118,630	68,993	102,257	202,210
Coral Reef Fish	110,634	8,842	5,944	37,607	35,811	14,151	8,858	7,117	18,638	50,922	50,216
Shrimp	30,157	4,694	6,680	3,236	3,707	20,108	17,778	4,257	14,282	34,614	23,869
Lobster	734	1,046	515	362	609	950	1,361	782	239	1,037	383
Squid	13,593	708	767	5,653	1,085	2,948	7,498	4,867	13,653	26,574	3,411
Small Crab	4,902	186	146	3,294	110	620	1,267	2,625	2,034	16,454	4,627
Crab	1,694	1,029	491	879	235	1,198	6,107	410	5,434	5,151	4,349
Shellfish	14,506	1,002	-	236	78	1,221	714	1,136	16,442	10,321	650
Sea Cucumber	115	93	-	425	150	407	166	127	25	784	852
Octopus	78	131	-	2.256	325	115	364	1,154	301	686	1,188
Skipjack	1,285	-	-	19.250	31,112	-	4,658	1,151	1,230	-	24,993

Tuna Bigeye	-	-	-	796	369	-	-	-	-	-	1,956
Tuna Yellowfin Tuna	-	-	-	12,351	22,574	-	-	-	-	-	9.352

Based The regulation of fishing vessels and fishing gears is essential for maintaining the sustainability of fisheries in Indonesia. According to One Data KKF 2024, the total number of vessels operating in the Fish Resource Assessment for each Indonesian Fisheries Management Area/*Wilayah Pengelolaan Perikanan Negara Republik Indonesia* (WPPNRI) in 2023 showed considerable variation across different categories. In the motorless boat category, there were 89,337 units recorded, with WPPNRI 573 (8,001 units) and WPPNRI 714 (20,636 units) having the highest concentrations. The outboard motorboat category accounted for the largest number, totaling 418,497 units, with the most found in WPPNRI 572 (33,670 units) and WPPNRI 711 (25,232 units). For motorboats under 10 Gross Tonnage (GT), 311,264 units were registered, with WPPNRI 711 (58,763 units) and WPPNRI 712 (58,514 units) reporting the highest numbers. In the 10–30 GT motorboat category, there were 53,812 units, the majority in WPPNRI 712 (19,692 units) and WPPNRI 711 (4,901 units). Meanwhile, the motorboats over 30 GT totaled 7,513 units, with WPPNRI 712 again leading with 4,859 units, followed by WPPNRI 711 with 382 units. Altogether, the total number of vessels across all categories reached 880,423 units. This data highlights the need for effective policy and monitoring mechanisms to control fishing efforts, optimize resource use, and ensure ecological balance in Indonesia's marine ecosystems.

Table 4. Number of vessels by category

Vessel Category	WPP NRI 571	WPP NRI 572	WPP NRI 573	WPP NRI 711	WPP NRI 712	WPP NRI 713	WPP NRI 714	WPP NRI 715	WPP NRI 716	WPP NRI 717	WPP NRI 718	Total
Non-Motorized Boat	3,320	3,829	8,001	8,005	739	8,577	24,419	20,636	7,042	3,686	1,083	89.337
Outboard Motor	6,302	33,670	67,269	25,232	57,866	77,642	58,754	53,847	25,201	10,276	2,438	418,497
Motorized Vessel <10 GT	46,894	18,195	18,964	58,763	58,514	68,645	21,618	8,577	8,422	1,611	1,061	311,264
Motorized Vessel 10-30 GT	3.515	5,699	7,283	4,901	19.692	6,073	1,997	2,429	611	92	1,518	53.812
Motorized Vessel >30 GT	743	478	682	382	4,859	8	7	233	91	-	30	7,513

The Total number of fishing equipment (API) reached 937,978 units, with fishing rods as the most dominant (241,233 units), followed by gill nets drifted (152,560 units) and gill nets fixed (87,109 units). Other methods such as Trap (56,627 units) and Tonda (46,671 units) have also shown significant use. In addition, there are variations of tools such as basic longlines and combined gill nets, as well as other API categories that include 166,468 units. These Data reflect diversity in fishing practices, which is important for the sustainable management of fishery resources.

Table 5. Number of fishing gears

Fishing Gears Type	Number of Fishing Gears (unit)
Handline Fishing	241,233.00
Drift Gillnet, Oceanic Gillnet	152,560.00
Set Gillnet, Liong Bun Net	87,109.00
Bubu	56,627.00
Tonda	46,671.00
Bottom Longline	32,149.00
Combination Gillnet with Trammel Net	26,976.00

Layered Gillnet, Klitik Net	26,968.00
Small Pelagic Purse Seine with One Vessel	20,744.00
Pole and Line Fishing	18,307.00
Squid Angling, Squid Fishing	17,443.00
Seine Net (Payang)	16,035.00
Encircling Gillnet	15,025.00
Boat Lift Net	13,663.00
Other Fishing Gears	166,468.00
Total	937,978.00

Regulation of the number of vessels and fishing equipment aims to determine the optimum point of the number of vessels that can operate without causing overfishing. This process involves establishing fishing quotas that each vessel must follow, as well as close monitoring of fishing activities in the metered fishing zone. In practice, this arrangement includes several steps, such as the determination of the permissible types and sizes of vessels, as well as the fishing gear used (Permen KP No.36 of 2023). In addition, each operating vessel must have the appropriate permits and periodically report on their catch.

To enhance food security through responsible fisheries governance, several strategies can be implemented to regulate the number of vessels and fishing equipment operating within Indonesian Fisheries Management Area/*Wilayah Pengelolaan Perikanan Negara Republik Indonesia* (WPPNRI). One key strategy is the determination of vessel quotas, where the number of vessels permitted in each WPPNRI is aligned with the area's biological and ecosystem carrying capacity. This is calculated by converting fishing quotas (in tons) into vessel productivity, thereby determining the optimal number of vessels allowed to operate. Additionally, regulating the types of fishing equipment is crucial. This involves enforcing environmentally friendly and efficient fishing gear in accordance with Permen KP No. 23 of 2023, aiming to minimize ecological impact while maintaining productivity. Regular monitoring and evaluation is also essential—this includes assessing the number of vessels and gear in use, and evaluating catch volumes through permit systems that are periodically reviewed against available quotas.

Another critical strategy is the regulation of capture zones, where fishing zones are developed as integrated units for both economic development and ecosystem management. This approach helps ensure balanced development across regions, supports local economies, and strengthens food security. The delineation of measurable fishing zones takes into account various factors, including the geographical characteristics of each WPPNRI, the presence of established conservation areas, and proportional alignment between fishing quotas and vessel capacity. These zones are divided into six major metered fishing zones: zone 01 encompasses WPPNRI 711 (Karimata Strait, Natuna Sea, and North Natuna Sea); zone 02 includes WPPNRI 716 and 717 (Sulawesi Sea, North Halmahera, Cendrawasih Bay, and Pacific Ocean), and the High Seas of the Pacific; zone 03 covers WPPNRI 715, 718, and 714 (Tomini Bay, Maluku Sea, Seram Sea, Berau Bay, Aru Sea, Arafura Sea, Timor Sea, and Banda Sea); zone 04 comprises WPPNRI 572 and 573 (Indian Ocean west of Sumatra, Sunda Strait, south Java to Nusa Tenggara, Sawu Sea, and Indian Ocean High Seas); zone 05 involves WPPNRI 571 (Strait of Malacca and Andaman Sea); and zone 06 covers WPPNRI 712 and 713 (Java Sea, Makassar Strait, Bone Bay, Flores Sea, and Bali Sea). These zoning strategies not only contribute to sustainable fisheries management but also promote equitable access and long-term resilience in Indonesia’s marine and coastal food systems.

Fig. 5. Metered Fishing Zones

3.3.2 Integrated surveillance

Some strategies that can be done related to supervision is the importance of building an integrated supervision system from upstream to downstream. This means that supervision is not only carried out at the time of fishing, but also covers the entire supply chain, from the capture process to the distribution of the catch to the market. Through an integrated system, each stage in the fishing process can be monitored and managed more effectively. Fishing practices one of the main focuses of the surveillance strategy is to ensure that fishing practices are carried out legally. This includes: implementation of strict regulations: ensuring that all fishermen and fishery business actors comply with established regulations, including the use of allowed fishing gear and limits on catch quotas (Trenggono, 2023).

Supervision of the Prevention of illegal practices good supervision is expected to prevent illegal practices, such as unlicensed fishing or the use of prohibited fishing gear. This is done through strengthening patrol teams and conducting regular inspections of fishing vessels to ensure that all fishing activities are in accordance with applicable regulations, implementing strict measures against violators of regulations to provide a deterrent effect and maintain the integrity of the surveillance system, and the implementation of monitoring technology such as the Vessel Monitoring System (VMS) to monitor the movement of fishing vessels and ensure compliance with regulations.

3.3.3 Optimization of non-tax state revenues

Optimization of non-tax state revenues/*penerimaan negara bukan pajak* (PNBP) is a strategic step that can improve food security through sustainable management of fishery resources. The challenges faced, namely switching the non-tax state revenues/*penerimaan negara bukan pajak* (PNBP) system from preproduction to post-production, are expected to increase state revenue, preserve fish resources, and encourage regional economic growth through increasing the profitability of the capture fisheries sector, which will ultimately have a positive impact on the welfare of fishermen and the health of marine ecosystems (Trenggono, 2023).

Strategies that can be done include improving the accuracy of fish production data is very important, which can be achieved by the implementation of an integrated e-logbook system to record catches in real-time. Training for ship captains and business actors is also needed to ensure accurate and consistent data filling. Furthermore, non-tax state revenues/*penerimaan negara bukan pajak* (PNBP) policy reform should be carried out by reviewing and adjusting tariffs based on accurately calculated fish production values, as well as implementing a fair and sustainable tariff system. Strengthening the monitoring and

enforcement system is also crucial to ensure compliance by business actors in reporting and non-tax payments, as well as strict enforcement of laws against violations. In addition, the allocation of non-tax revenues for programs to empower fishermen, such as the provision of facilities and infrastructure and skills training, will encourage the participation of fishermen in increase their productivity and income. Finally, education and socialization to business actors about the importance of non-tax state revenues/*penerimaan negara bukan pajak* (PNBP) and its impact on food security needs to be done to improve their understanding and participation in sustainable fisheries resource management. With these measures, it is expected that non-tax revenues can contribute significantly to national food security and the welfare of fishing communities.

3.3.4 Empowering fishermen to improve food security

Fishermen empowerment programs that can be implemented include: the development of the concept of fishing village. Kampung Nelayan Maju Design: Build infrastructure that supports fisheries activities, such as ports, fish processing sites, and storage facilities (cold storage). Kampung Nelayan Maju will become an integrated Center for fisheries activities, facilitating fishermen's access to markets and resources. Education and training, organizing training programs to improve fishermen's skills in sustainable fishing techniques, catch processing, and fishery business management.This education and training Program aims to improve fishermen's understanding of the concept of Fisheries Sustainability, teach selective and environmentally friendly fishing techniques and introduce and encourage the use of fishing gear that does not damage the marine ecosystem. Human resource and institutional development of fishermen can improve partnership relationships that can ensure the sustainability of fishing businesses, improve the welfare of fishermen and in the long term to realize sustainable fisheries development (Asiati & Nawawi 2016). Steps that can be done to support the implementation of human resources and institutional development strategies, namely: (1) strengthening and development of human resources fishermen and fishermen groups (Priyatna and Purnomo 2007; Retnowati et al. 2014); (2) increased participation and interaction of fishermen groups in the planning and implementation of government programs; (3) cooperation with investors to strengthen business capital and expand market share; 4) empowerment of technical assistance/extension workers to maintain institutional sustainability of fishermen groups (Amarullah 2017).

Provision of access to capital and resources, provide access to microfinance for small fishermen to purchase environmentally friendly fishing gear, boat repairs, and working capital. Cooperation with local financial institutions to facilitate low-interest loans. In addition, replacing fishing gear that damages the ecosystem with more environmentally friendly fishing gear, and providing subsidies for the purchase of such equipment. Institutional and organizational strengthening of fishermen, *e*ncourage the establishment of fishing cooperatives to increase the bargaining power of fishermen in the marketing of catches. Cooperatives can assist in the procurement of fishing gear, marketing, and access to market information. In addition, it provides training on cooperative management and business management to the management of fishing cooperatives to improve efficiency and transparency.

3.3.5 Synergies between sectors

Encourage synergy between various sectors, including Central and local governments, as well as the private sector. This collaboration is important to create a comprehensive and integrated policy in fisheries management, so as to increase the effectiveness of food security programs. Mathematical equations, variables, and anything representing a value should be italicized. Formulae should be numbered consecutively throughout the manuscript as Eq. 1, In cases where the derivation of formulae has been abbreviated, it is of great help to the reviewers if the full derivation can be presented on a separate sheet (not

to be published). Formulae should be centered and numbered. In this case the number will appear in the right margin.

4. Conclusions

Indonesia, as the world's largest archipelagic country, has enormous marine and fisheries potential to support national food security. The high level of fish consumption among the population, coupled with increasing demand for healthy and affordable animal protein, necessitates sustainable management of fisheries resources. However, challenges such as overfishing, weak enforcement, and policies not based on scientific data are exacerbating the condition of fish stocks and threatening the well-being of fishermen and marine ecosystems. To address these challenges, strategies such as implementing a measured fishing system, setting catch quotas, dividing fishing zones based on ecosystem carrying capacity, integrated monitoring, optimizing state revenue from fisheries, and empowering fishermen through access to capital, training, and institutional strengthening are crucial. In addition, synergy between sectors and relevant parties is also needed so that the policies implemented can be more comprehensive and effective. Through these approaches, it is hoped that Indonesia's fisheries management can be sustainable and make a real contribution to food security and the welfare of coastal communities now and in the future.

Acknowledgement
The author would like to express their gratitude for the support and inspiration that have contributed to the completion of this work. The process of conducting this study has been enriched by valuable insights, constructive discussions, and continuous learning.

Author Contribution
The author solely contributed to the study's conception, design, data collection, analysis, and manuscript preparation. The author was responsible for drafting, reviewing, and approving the final version of the manuscript for publication.

Funding
This research received no external funding.

Ethical Review Board Statement
Not available

Informed Consent Statement
Not available

Data Availability Statement
Not available

Conflicts of Interest
The author declare no conflict of interest.

References

Amarullah, T. (2017). Strategi peningkatan produktivitas perikanan tangkap skala kecil yang berkelanjutan di Kabupaten Aceh Jaya Provinsi Aceh. *Jurnal Perikanan Tropis*, *4*(1), 11–21. http://jurnal.utu.ac.id/jptropis/article/view/52

Asiati, D., & Nawawi, N. F. N. (2016). Kemitraan di sektor perikanan tangkap: Strategi untuk kelangsungan usaha dan pekerjaan. *Jurnal Kependudukan Indonesia*, *11*(2), 103–118. http://dx.doi.org/10.14203/jki.v11i2,204

Badiuzzaman, Wijayanto, D., & Yulianto, T. (2014). Analisis potensi tangkap sumberdaya rajungan (*blue swimming crab*) di perairan Demak. *Journal of Fisheries Resources Utilization Management and Technology*, 3(3), 248–256, https://ejournal3.undip.ac.id/index.php/jfrumt/article/view/5570

Brown, C. J., Desbiens, A., Campbell, M. D., Game, E. T., Gilman, E., Hamilton, R. J., Heberer, C., Itano, D., & Pollock, K. (2021). Electronic monitoring for improved accountability in western Pacific tuna longline fisheries. *Marine Policy, 132*, 104664. https://doi.org/10.1016/j.marpol.2021.104664

Carmelite, M. A. (2019). Konsep ketahanan pangan pada kasus overfishing pada kawasan Laut Jawa. *Dinamika Global: Jurnal Ilmu Hubungan Internasional, 4*(1), 158-177, https://doi.org/10.36859/jdg.v4i01.103

Chen, J., Jayachandran, M., Bai, W., & Xu, B. (2021). A critical review on the health benefits of fish consumption and its bioactive constituents. *Food Chemistry, 369*, 130874. https://doi.org/10.1016/j.foodchem.2021.130874

Chu, C. (2009). Thirty years later: The global growth of ITQs and their influence on stock status in marine fisheries. *Fish and Fisheries, 10*(2), 217–230. https://doi.org/10.1111/j.1467-2979.2008.00313.x

Farquhar, S. D., Heck, N., Maps, F., Wade, E., Asch, R. G., Cenek, M., & Kirchoff, J. F. (2024). Industrial fishing and its impacts on food security: A systematic review. *Frontiers in Ocean Sustainability, 2*, Article 1419236. https://doi.org/10.3389/focsu.2024.1419236

Hanani, N. (2011). Penguatan kondisi sosial ekonomi masyarakat dalam mewujudkan ketahanan pangan. Dalam *Prosiding Seminar Nasional Hasil Penelitian Dosen Pertanian* (hlm. 183–192). Fakultas Pertanian, Universitas Jambi.

Hilborn, R., Amoroso, R. O., Anderson, C. M., Baum, J. K., Branch, T. A., Costello, C., de Moor, C. L., Faraj, A., Hively, D., Jensen, O. P., Kurota, H., Little, L. R., Mace, P., McClanahan, T., Melnychuk, M. C., Minto, C., Osio, G. C., Parma, A. M., Pons, M., Segurado, S., Szuwalski, C. S., Wilson, J. R., & Ye, Y. (2020). Effective fisheries management instrumental in improving fish stock status. *Proceedings of the National Academy of Sciences, 117*(4), 2218–2224. https://doi.org/10.1073/pnas.1909726116

Hoshino, E., Putten, I. V., Pascoe, S., & Vieira, S. (2020). Individual transferable quotas in achieving multiple objectives of fisheries management. *Marine Policy, 113*, 103744. https://doi.org/10.1016/j.marpol.2019.103744

Huang, S., & He, Y. (2019). Management of China's capture fisheries: Review and prospect. *Aquaculture and Fisheries, 4*(5), 173–182, https://doi.org/10.1016/j.aaf.2019.05.004

Husen, O. O., Abdullah, N., Farastuti, E. R., Rumondang, A., Huda, M. A. J., Gaffar, S., Rombe, K. H., Rosalina, D., Lesmana, D., Wahyudin, Y., Nisari, T., Rachman, R. M., Kartini, N., & Irawan, H. (2024). *Potensi dan pengelolaan sumber daya kelautan Indonesia.* PT. Kamiya Jaya Aquatic.

Kauer, K., Bellquist, L., Humberstone, J., Saccomanno, V., Oberhoff, D., Flumerfelt, S., & Gleason, M. (2024). Advancing fisheries sustainability and access through community fisheries trusts. *Marine Policy, 165*, 106210. https://doi.org/10.1016/j.marpol.2024.106210

Kementerian Kelautan dan Perikanan Republik Indonesia. (2023). *Laporan kinerja Kementerian Kelautan dan Perikanan 2023.* Kementerian Kelautan dan Perikanan.

Lee, K.-H., Noh, J., & Khim, J. S. (2020). The blue economy and the United Nations' sustainable development goals: Challenges and opportunities. *Environment International, 137*, 105528. https://doi.org/10.1016/j.envint.2020.105528

Luthfia, S. S. (2023). Mengupas tata kelola perikanan nasional melalui PP No. 11 Tahun 2023 tentang penangkapan ikan terukur demi mewujudkan blue economy. *Jurnal RechtsVinding*, *12*(3), 483–502, https://rechtsvinding.bphn.go.id/ejournal/index.php/jrv/article/view/1374

Mozumder, M. M. H., Uddin, M. M., Schneider, P., Deb, D., Hasan, M., Saif, S. B., & Nur, A.-A. U. (2023). Governance of illegal, unreported, and unregulated (IUU) fishing in Bangladesh: Status, challenges, and potentials. *Frontiers in Marine Science, 10*, 1150213. https://doi.org/10.3389/fmars.2023.1150213

Priyatna, F. N., & Purnomo, K. (2007). Strategi pengembangan kelembagaan kelompok nelayan sebagai kelembagaan pengelola waduk di perairan Waduk Wadas Lintang, Kabupaten Wonosobo. *Jurnal Sosial Ekonomi Kelautan dan Perikanan*, 2(2), 209–217. https://ejournal-balitbang.kkp.go.id/index.php/sosek/article/view/5872/5086

Purwanto, P., Sadiyah, L., & Satria, F. (2015). Model pengendalian output penangkapan untuk penyesuaian terhadap kuota nasional tuna sirip biru selatan. *Jurnal Kebijakan Perikanan Indonesia*, *7*(2), 103–114. https://ejournal-balitbang.kkp.go.id/index.php/jkpi/article/view/81

Puspitasari, D., Chasanah, A. N., & Wardhani, M. F. (2023). Strategi peningkatan ketahanan ekonomi untuk perikanan berkelanjutan berbasis konsep blue economy. *Value: Jurnal Manajemen dan Akuntansi*.

Phogat, V., Kumar, A., & Kumar, S. (2022). Nutritional benefits of fish consumption for humans. *International Journal of Environment and Climate Change, 12*(12), 1443–1457. https://doi.org/10.9734/IJECC/2022/v12i121585

Retnowati, E. (2011). Nelayan Indonesia dalam pusaran kemiskinan struktural (perspektif sosial, ekonomi dan hukum). *Perspektif, 16*(3), 149–159. https://doi.org/10.30742/perspektif.v16i3.79

Trenggono, S. W. (2023). Penangkapan ikan terukur berbasis kuota untuk keberlanjutan sumber daya perikanan di Indonesia. *Jurnal Kelautan dan Perikanan Terapan, Edisi Khusus*, 1–8. https://doi.org/10.15578/jkpt.v1i0.12057

Biography of Author

Rizal Rifai, Student at Department of Environmental Science, Faculty of Environmental Science, Universitas Indonesia.

- Email: rizal.rifai@ui.ac.id
- ORCID: N/A
- Web of Science ResearcherID: N/A
- Scopus Author ID: N/A
- Homepage: N/A