



Strategic Approaches to Sustainable Inland Water Fisheries Management in Indonesia: Insights from the Draft WPPNRI-PD Fisheries Management Plan

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: <https://doi.org/10.9734/ajeaba/2024/v24i81461>

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/120791>

Original Research Article

Received: 02/06/2024

Accepted: 06/08/2024

Published: 13/08/2024

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ABSTRACT

Aim: This study analyzes capture fisheries production in several countries, showing that Indonesia has relatively low production compared to countries like India and Bangladesh, despite having a large inland water area.

Methodology: The study employs SWOT and Fishbone analysis to develop a comprehensive and sustainable fisheries management strategy.

Results: The results indicate that innovation can be implemented in the development of the Inland Waters Fisheries Management Plan (WPPNRI-PD FMP) through innovative approaches such as the Ecosystem Approach to Fisheries Management (EAFM), ecosystem-based zoning, and community-based co-management. An Integrated Inland Aquatic Fisheries Information System and a Penta-Helix Partnership Mechanism are also implemented for more comprehensive management.

Practical Implications: The implementation of these strategies is expected to ensure sustainable fisheries management, protect biodiversity, and meet the economic and social needs of Indonesia's coastal communities.

Research Limitations: The limitations of this study include data that may not cover all relevant aspects and challenges in implementing complex strategies.

Research Originality: This research offers a novel approach to inland water fisheries management in Indonesia by integrating various innovative and collaborative approaches to achieve climate and environmentally adaptive fisheries management.

Keywords: Critical thinking skills; fisheries management plans; inland water fisheries management; swot; RPP WPPNRI-PD.

1. INTRODUCTION

Indonesia has great potential in inland water fisheries, with 14 National Fisheries Management Areas of the Republic of Indonesia (WPPNRI) covering various water resources [1]. Fish production potential reaches 4,923,903 tons per year, with a stock of 2,705,087 tons and a sustainable potential of 1,643,626 tons per year. The total allowable catch (JTJ) is 1,314,901 tons per year, based on the calculation of potential fish resources (SDI) in 11 WPPNRI marine waters and 14 WPPNRI inland waters [2].

Indonesia is a country with the largest number of freshwater fish species in the world, which are spread across 8,128 watersheds, 5,590 main rivers, and 65,017 tributaries. In addition, there are 840 lakes, 735 ponds, 162 reservoirs, and unidentified swamps [1]. This diversity includes 331 threatened fish species and 14 endangered freshwater fish species in Sumatra. Indonesia alone has 9 species and subspecies of eels out of 18 existing species and subspecies, as well as a diversity of ornamental fish such as arowana, botia, cupang, and others that make up the wealth of Indonesia's inland waters [3].

However, inland water fisheries management faces various problems, such as the increasing distribution of foreign/invasive fish species such as glassfish, broomrape, alligator gar, tilapia, and

pomfret. Land activities that pollute waters, land use change, and modification of the aquatic environment and boundaries also have a negative impact [4]. The lack of optimal regulations, low capacity of human resources (HR), lack of economic access and capital, and uncontrolled, even destructive, fishing activities are challenges. The lack of synergy between management institutions and ecosystem-based data and information systems has also exacerbated this condition [5].

Production of aquatic capture fisheries in inland waters shows significant differences among major producing countries. Based on average production data per year, India takes the highest position with production reaching 1,890 thousand tons in 2022, which accounts for 16.7% of the total global production. Bangladesh follows with 1,322 thousand tons (11.7%), and China with 1,166 thousand tons (10.3%). Myanmar recorded a production of 855 thousand tons (7.5%), while Indonesia recorded a production of 464 thousand tons (4.1%) [6].

According to Aung et al., [7] the production reported by Myanmar, with an area of 9.838 million hectares, and Bangladesh is greater than that of Indonesia, even though Indonesia has a much larger inland water area of 87.951 million hectares [7]. This shows the difference in efficiency and productivity in fisheries

management in inland waters between these countries [8]. When viewed from the current conditions according to empirical facts such as 1) Degradation of inland water habitats is an environmental issue that is of increasing concern, which occurs due to various human activities such as pollution from industrial and household waste, land use change, and unsustainable exploitation of water resources, which reduce water quality, threaten biodiversity, and disrupt ecosystem functions. 2) Overfishing is also a serious problem [9], leading to drastic declines in fish stocks and fisheries collapse. 3) Climate change further exacerbates conditions by disrupting fish habitats and changing the distribution and productivity of fish species, challenging fisheries management which must adapt to changing environmental conditions [10]. 4) Lack of management and monitoring, 5) limited data and research, and 6) regulatory compliance are major obstacles to effective fisheries conservation and management. In addition, 7) public awareness and education is essential to support sustainable fisheries practices, which requires increased environmental education and awareness campaigns [11].

The inland water fisheries issues addressed by the development of the WPPNRI PD FMP include the WPPNRI PD FMP (National Fisheries Management Area of the Republic of Indonesia Inland Waters) which provides a framework for the conservation and rehabilitation of inland water habitats to address habitat degradation [12]. Through the setting of fishing quotas and gear restrictions, WPPNRI PD FMPs seek to address overfishing that can damage fish populations and ecosystems. In addition, the WPPNRI PD FMP guarantees traditional fishing rights by implementing a zoning system and access restrictions, so that indigenous communities and traditional fishers continue to

have access to fisheries resources. To address potential conflicts between aquatic resource users, the PD WPPNRI FMP provides a conflict resolution mechanism and regulates zoning for resource utilization. The WPPNRI PD FMP also accommodates sustainable aquaculture activities by establishing aquaculture zones and standards for environmentally friendly aquaculture practices. The technical guidelines and central-local coordination mechanisms provided by the PD WPPNRI FMPs ensure that policies and actions at the local level are aligned with national policies and are effective. In response to the protection of threatened species and their habitats, the PD WPPNRI FMP establishes marine protected areas and species recovery programs to increase endangered species populations and maintain biodiversity.

To support sustainable inland water fisheries management in Indonesia, the Business Model Canvas (BMC) can serve as an effective strategic tool. BMC allows stakeholders to visualize and understand the key components of a sustainable fisheries management strategy. By utilizing BMC, various elements such as customer segments (fishermen, local communities, and markets), value propositions (resource sustainability, improved fisher welfare), distribution channels, customer relationships, revenue streams, key resources, key activities, key partnerships, and cost structure can be identified and analyzed comprehensively [13]. The implementation of BMC in the WPPNRI-PD fisheries management plan aims to create a holistic and integrated approach, which not only maximizes fish catch but also ensures the sustainability of inland water ecosystems and the welfare of the communities dependent on them. This approach is expected to provide a clearer view of how various components in fisheries management interact and support the long-term goals of resource sustainability in Indonesia [14].

Table 1. Empirical facts about fisheries production in several countries

Country of territory	Production (Average per year)				Production				Share in total, 2022 (%)
	1980s	1990s	2000s	2010s	2019	2020	2021	2022	
By country or territory									
India	495	584	584	1434	1787	1796	1847	1890	16.7
Bangladesh	441	502	859	1078	1236	1248	1301	1322	11.7
China	537	1457	2111	2027	1841	1457	1198	1166	10.3
Myanmar	142	146	478	852	887	891	786	855	7.5
Indonesia	272	311	307	471	712	497	459	464	4.1

According to Perpres 18/2020 RPJMN 2020-2024 concerning WPPNR-based SDI Management, where the mandate for the preparation of the FMP is based on Fisheries Law No. 31 of 2004 Article 7 paragraph (1) letter a: The Minister establishes a Fisheries Management Plan and PP No. 27 of 2021, Article 41: In the context of sustainable management of fish resources, the government establishes a Fisheries Management Plan. The guidelines are based on Permen KP No. 22 of 2021: The FMP is prepared based on WPPNRI and/or fish species and WPPNRI as referred to in paragraph (2) includes: a) WPPNRI in Sea Waters. b) WPPNRI in Land Waters which contains fish species in the management of WPPNRI PD determined based on central authority by the Minister of Maritime Affairs and Fisheries (KP) or according to regional authority. The criteria of fish species that affect this management include endemic native fish, nuisance fish, introduced fish, rare fish, and fish that have important economic value. The main objective of this management is "achieving optimal and sustainable benefits, and ensuring the sustainability of fish resources," in accordance with Law 31/2004 jo Law 45/2009. The Fishery Management Plan (FMP) is a document that contains a strategic plan for ecosystem-based fish resource management in inland and marine waters, as part of the RPPNRI which is regulated in Permen KP No. 22/2021 and PD 438 Strategic Plan (Renstra).

Based on the above regulations, the preparation of inland water fisheries management plans is carried out where the stages of preparing a Fisheries Management Plan (RPP) and its main objectives, namely achieving optimal and sustainable benefits and ensuring the sustainability of fish resources (SDI). This process begins with estimating the potential, utilization rate, SDI allocation, and allowable catch. The FMP development stage involves the establishment of a drafting team by the Director General of Capture Fisheries (PT) or by the Regional Head, followed by the collection of relevant data and information. The collected data is then analyzed to identify issues and potentials, which serve as the basis for the preparation of the initial FMP document. This initial document is then discussed in a public consultation to obtain input and suggestions. After obtaining inputs, the final RPP document is prepared and then stipulated by the competent authority [15].

The objective of fisheries management, in accordance with Law 31/2004 jo Law 45/2009, is

the achievement of optimal and sustainable benefits and the preservation of SDI. The components of an FMP include an introduction that presents the background, purpose and objectives, and scope of the FMP; analysis related to SDI, environment, socioeconomics, and fisheries governance; identification of important issues that must be addressed in fisheries management; strategic plans to address these issues; and establishment of goals, objectives, and action plans to achieve the objectives of sustainable fisheries management.

2. METHODS

This research uses SWOT analysis combined with Fishbone diagrams to determine the Strategic Approach to Inland Waters Fisheries Management Based on the Draft Fisheries Management of the Republic of Indonesia Fisheries Management Area in Inland Waters (Rpp Wppnri-Pd).

2.1 Research Design Plan

This research is included in the first research, namely problem solving, which discusses the Strategic Management of Inland Waters Fisheries Based on the Draft Fisheries Management of the Republic of Indonesia Fisheries Management Area in Inland Waters (RPP WPPNRI-PD) with existing problems, then alternative solutions to the problems caused are sought. This research uses SWOT analysis techniques. Data analysis uses thematic analysis through interpretation of text and numbers. SWOT analysis is a systematic identification of various factors in the process of formulating a company's internal strategy, this analysis is based on logic that can maximize advantages and opportunities while minimizing weaknesses and threats [16]. The analysis is based on the assumption that an effective strategy will maximize the advantages and opportunities that exist within the company and minimize its weaknesses and threats.

The next stage is using the fishbone analysis tool. Cause and effect diagrams are tools that help writers combine the main points of view about the underlying causes of problems. The fishbone figure is quite practical in use and leads the author to think and find out the main reasons for the problems that occur. The image below is also called a fishbone image because it resembles a fishbone [17]. The problem that occurs is considered the head of the fish, and the

causes of the problem are represented by the fish bones connected to the fish head. The smallest bone is the most specific cause based on the larger cause.

3. RESULTS

From the SWOT analysis above, it can be combined as follows:

1. S-O Strategy (Strength-Opportunity)

- a) Optimizing the potential of natural resources for local economic development based on sustainable fisheries
- b) Integrating local knowledge with modern technology in fisheries management.

2. W-O (Weakness-Opportunity) strategy

- a) Increase the capacity of human resources through training and international cooperation
- b) Develop an integrated data collection and management system.

3. S-T (Strength-Threat) Strategy

- a) Strengthen the implementation of conservation policies to address environmental degradation
- b) Develop conflict resolution mechanisms that involve various stakeholders.

4. Strategy W-T (Weakness-Threat)

- a) Improve inter-agency coordination to address illegal fishing practices
- b) Develop an adaptive approach in fisheries management to deal with climate change

The Fishbone analysis above reveals that the preparation of the WPPNRI-PD FMP is influenced by various interrelated factors. Human factors, particularly limited expertise and coordination, are one of the main challenges. This is in line with findings that emphasize the importance of an ecosystem approach and multidisciplinary collaboration in groundwater fisheries management [8].

4. DISCUSSION

Based on the results of the above study, it was found that innovation can be implemented in the preparation of the Fisheries Management Plan for the Republic of Indonesia National Fisheries

Management Area for Inland Waters (WPPNRI-PD FMP). With the philosophy of simplification, the WPPNRI-PD FMP, as one document regulating inland fisheries management, includes several innovative approaches. The Ecosystem Approach to Fisheries Management (EAFM) allows the integration of ecological, social, and economic aspects in fisheries management strategies. Ecosystem Support-based Utilization Zoning facilitates the use of areas with a zoning system that is dynamic and adaptive to changing conditions.

Another innovation is the Integration of Local and Scientific Knowledge, where FMPs accommodate traditional fisheries practices that have proven effective, combining them with scientific knowledge. The Integrated Inland Aquatic Fisheries Information System enables more comprehensive plan management, integrating biological, ecological, and socio-economic data from multiple sources. The Penta-Helix Partnership mechanism underscores the importance of collaboration between the five elements: government, academia, business, community, and media in fisheries management.

In addition, the WPPNRI-PD FMP adopts an Ecosystem-Based Adaptation to Climate Change strategy to ensure resilient management to climate change impacts. Community-based Co-Management is also an important part, where the FMP adopts a model tailored to the socio-cultural context of local communities, ensuring the active involvement of communities in fisheries management. These innovations aim to create fisheries management that is sustainable and adaptive to environmental and social change.

The Business Model Canvas (BMC) developed by Osterwalder and Pigneur [18] offers a framework that can be adapted to enhance the effectiveness of drafting fisheries management plans (RPP). BMC has advantages in analyzing an activity or effort, as it can provide a simple and comprehensive depiction of a company's current condition based on customer segments, offered value, value delivery channels, customer relationships, revenue streams, vital assets, partnerships, and cost structure. BMC is presented in the form of a canvas that illustrates nine elements, including customer segments, value proposition, channels, customer relationships, revenue streams, key resources, key activities, key partnerships, and cost structure [19].

Table 2. SWOT analysis

Strengths	Weaknesses
1. The abundance of natural resources in inland waters	1. Limited accurate and up-to-date data on fish stocks and ecosystem conditions
2. Government policy support for sustainable fisheries management	2. Insufficient human resource capacity in modern fisheries management
3. Experience and local knowledge in managing traditional fisheries	3. Inadequate infrastructure in several management areas
4. The diversity of inland water ecosystems that support biodiversity	4. Weak coordination among institutions

Opportunities	Threats
1. Potential for local economic development through sustainable fisheries	1. Environmental degradation and climate change affecting inland water ecosystems
2. Increasing public awareness of the importance of conserving inland water resources	2. Conflicts of interest among various stakeholders
3. Technological advancements that can support fisheries management and monitoring	3. Illegal and unsustainable fishing practices
4. Technological advancements that can support fisheries management and monitoring	4. Competition for land and water use with other sectors

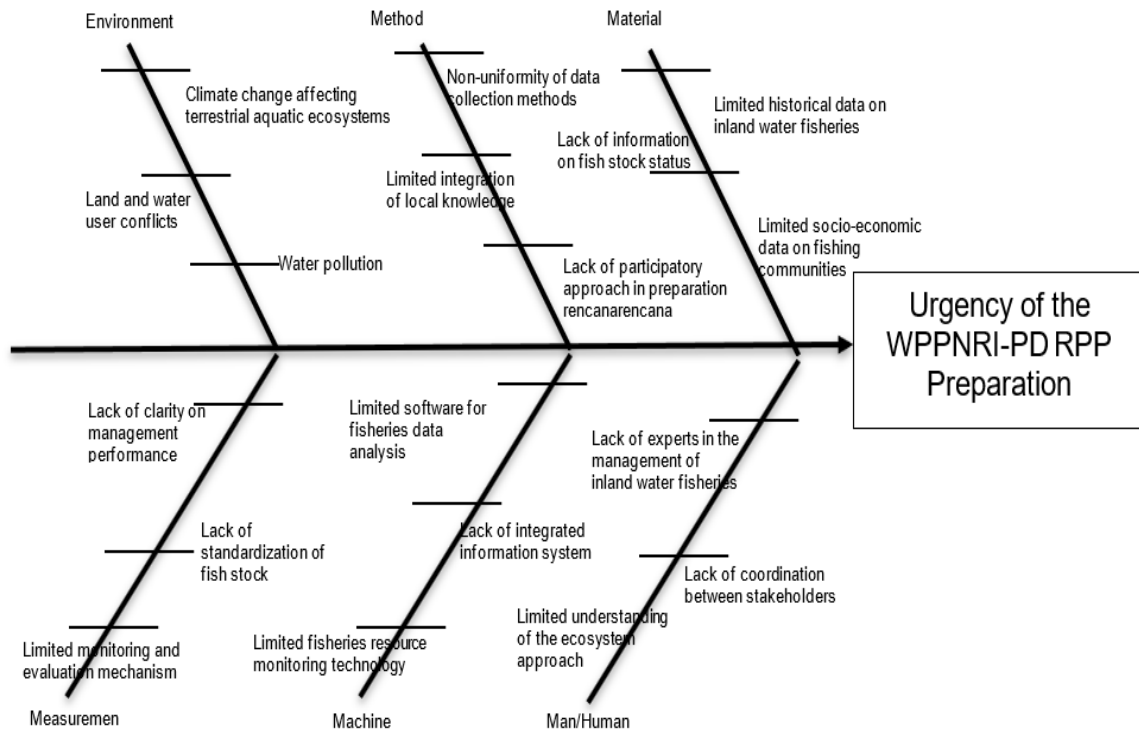


Fig. 1. The next step is fishbone analysis

The challenges in the implementation of drafting the WPPNRI-PD fisheries management plan at the Directorate of Fishery Resource Management are then mapped using the Business Model Canvas as follows [20]:

<p>The Business Model Canvas</p>	<p>Key Activities Include: 1. Fish stock assessment, 2. Regulation development, 3. Fisheries monitoring, 4. Fishermen empowerment. Rini et al. (2021) identify these as key activities in inland water fisheries management.</p>	<p>Value Propositions Include: 1. Resource sustainability 2. Improved fisher welfare 3. Food security Fauzi et al. (2023) highlight the ecological and economic balance in fisheries management.</p>	<p>Customer Relationships Include: 1. Outreach programs 2. Stakeholder forums, 3. Fisheries information systems. Rini et al. (2021) demonstrate the importance of effective communication among fisheries stakeholders.</p>	<p>Customer Segments Include: 1. Traditional fishermen, 2. Fish farmers, 3. Fish product processors, 4. Consumers. Ely et al. (2020) identify various segments within the inland fisheries value chain.</p>
<p>Key Partners Includes: 1. Local government, 2. Research institutions, 3. Fishermen organizations, 4. Environmental NGOs. Ely et al. (2020) Emphasize the importance of multi-stakeholder collaboration in sustainable fisheries management.</p>	<p>Key Resources Include: 1. Fishery data, 2. Human resources and training, 3. Fisheries infrastructure 4. Management budgets. Ely et al. (2020) Emphasize the importance of effective resource management for sustainable fisheries.</p>	<p>Channels Include: 1. Fisheries extension offices, 2. Social media, 3. Mobile apps, 4. Partnerships with local governments. Ely et al. (2020) Identify various effective channels for disseminating fisheries information.</p>	<p>Cost Structure Includes operational costs, research and development investments, and community empowerment programs. Fauzi et al. (2023) emphasizes the importance of budget analysis in fisheries management.</p> <p>Revenue Streams Include increased fishery production and sustainability, improved fisher welfare, and enhanced contributions to the national economy. Ely et al. (2020) Analyze the various revenue impacts in fisheries management.</p>	

Source: [21,22,23]

The next stage is the blue economy policy, which highlights important steps in protecting the ocean and its resources and preserving marine areas. The first step is to expand marine protected areas to protect marine ecosystems and biodiversity. The second step is to reduce the pressure from unfriendly fishing activities by implementing quota-based metered fishing, which aims to prevent overfishing and maintain fish populations. The third step is the development of sustainable marine, coastal and inland aquaculture, which helps reduce pressure on natural fisheries resources. To preserve marine areas, the fourth measure involves the monitoring and control of coastal areas and small islands. This includes efforts to protect critical habitats and manage resources effectively. The fifth step is the control of marine plastic debris, which is critical to maintaining the quality of marine ecosystems and their ecosystem services [24].

Stakeholder mapping in grouping various stakeholders into four categories: Promoters, Defenders, Latents, and Apathetics. Promoters consist of the Ministry of Marine Affairs and Fisheries (MMAF), Research Institutions and Academics, and Non-Governmental Organizations (NGOs). KKP plays an important role in fisheries policy and resource management

to ensure the success of the WPPRN-PD FMP, and is involved in policy monitoring and implementation. Research Institutions and Academia, consisting of universities and research institutions, provide data and analysis related to inland water ecosystems, as well as the impacts of various human activities on fisheries resources. NGOs focus on environmental conservation and natural resource sustainability, often liaising with communities to support fisheries-related policies. Defenders, consisting of Mass Media and the International Scientific Community, have a significant role in disseminating information related to fisheries issues and raising public awareness. Mass Media disseminates information and raises public awareness on fisheries issues, while the International Scientific Community educates the global community on fisheries sustainability and the impact of human activities on inland aquatic ecosystems [25].

Latents consist of the local community and the private sector. The private sector, including companies operating in the field of fishing and related industries, has a lower interest but remains important in the implementation and sustainability of the WPPRN-PD RPP. Apathetics, consisting of the general public, tend to be less involved or less aware of landfishing issues.

Nevertheless, they remain important in the overall context as they can be affected by the implemented fisheries policies. This mapping helps identify the roles and responsibilities of each stakeholder group in supporting the success of the WPPRN-PD RPP and ensuring the sustainability of land-water fisheries resources.

Overall, these measures are aimed at extending protection, reducing the stress and negative impact of human activities, as well as preserving and improving the quality of marine ecosystems. On the other hand, it has also taken strategic measures to protect the sea and its resources, as well as to maintain the sustainability of the maritime territory. The first step is to expand the marine conservation area, which aims to protect marine ecosystems and biodiversity. The second step focuses on reducing the pressure from unfriendly fishing activities by implementing quota-based measured fishing. This is important to prevent overfishing and ensure the sustainability of fish populations. The third step is the development of sustainable agricultural fisheries at sea, coast, and land, which helps reduce the pressure on natural fisheries resources and provides more environmentally friendly alternatives. To maintain the sustainability of marine areas, the fourth step involves monitoring and control of coastal areas and small islands, which are part of the efforts to protect vital habitats and efficient resource management. The fifth step is the control of plastic waste in the sea, which is crucial to improving the quality of the marine ecosystem and its services. All these measures are designed to expand protection, reduce the stress and negative impact of human activities, as well as preserve and maintain the quality of marine ecosystems. Implementation of these strategies is expected to preserve the health and productivity of marine ecosystems for future generations.

5. CONCLUSION AND RECOMMENDATION

The study results show that innovation can be implemented in the preparation of the Fisheries Management Plan for the Republic of Indonesia National Fisheries Management Area for Inland Waters (WPPNRI-PD FMP). With a philosophy of simplification, the WPPNRI-PD FMP includes several innovative approaches such as the Ecosystem Approach to Fisheries Management (EAFM), Ecosystem Support Based Utilization

Zoning, and Integration of Local and Scientific Knowledge. An Integrated Inland Aquatic Fisheries Information System and a Penta-Helix Partnership Mechanism involving government, academia, business, community, and media are also implemented for more comprehensive management. Ecosystem-Based Adaptation Strategies to Climate Change and Community-Based Co-Management ensure resilient management and engagement of local communities. The next phase involves blue economy policies that include expanding marine protected areas, implementing quota-based fishing to prevent overfishing, developing sustainable aquaculture, monitoring coastal areas and small islands, and controlling marine plastic debris. Planning the membership of an effective team with various positions and responsibilities involved is expected to support the implementation of the desired changes. Stakeholder mapping identified the roles and responsibilities of each group in supporting the success of the WPPRN-PD FMP. These groups are divided into Promoters (MPAs, Research and Academic Institutions, NGOs), Defenders (Mass Media, International Scientific Community), Latents (Local Communities, Private Sector), and Apathetics (General Public). These strategies are designed to expand protection, reduce pressure from human activities, and preserve marine ecosystems for future generations.

Recommendations for the implementation of the results of this study include several important steps. First, the development and application of innovative approaches in the WPPNRI-PD FMP should continue. Approaches such as EAFM, Ecosystem Support-based Utilization Zoning, and Integration of Local and Scientific Knowledge should be prioritized. The Integrated Inland Aquatic Fisheries Information System must function properly and data must be accessible to all stakeholders. Second, the Penta-Helix partnership needs to be strengthened by encouraging active collaboration between government, academia, business, community and media. Each element must contribute according to its role to achieve sustainable fisheries management. Third, ecosystem-based adaptation strategies to climate change and co-management must be improved, by ensuring the active involvement of communities in fisheries management tailored to the local socio-cultural context. Fourth, blue economy policies should be implemented by expanding marine protected areas, implementing quota-based fishing, developing sustainable

aquaculture, and controlling marine plastic waste. Monitoring of coastal areas and small islands needs to be improved to protect important habitats. Fifth, stakeholder mapping and engagement should be conducted by ensuring each stakeholder group understands its roles and responsibilities in supporting the WPPRN-PD FMP. Involving all stakeholders in the policy planning and implementation process will increase the effectiveness and sustainability of the program. Finally, regular monitoring and evaluation of the implementation of strategies and policies needs to be carried out. Evaluation results should be used to make necessary improvements and adjustments so that the objectives of sustainable fisheries management can be achieved.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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