



Strategic approaches to sustainable fisheries management in west aceh district: integrating the code of conduct for responsible fisheries

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ABSTRACT

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Aceh is a province located in the western part of Indonesia, and most of its region is a coastal area that faces rapid population growth, which puts pressure on sectors like fisheries and marine resources. One of those is the West Aceh District the location of this research. Capture fisheries represent a crucial economic sector for the livelihoods of many communities, provided it is well-managed. One of the important factors contributing to the decline in fish populations is the use of environmentally harmful fishing gear. This paper aims to determine a strategy for environmentally- friendly capture fisheries management based on the code of conduct for responsible fisheries in West Aceh District, which is crucial for protecting aquatic habitat sustainability and future fish stock populations. A descriptive method combined with a survey was conducted during the research and SWOT was used as a data analysis method. The result is several important measures should be implemented in Aceh Barat District based on the code of conduct for responsible fisheries, from providing enough information and training for fishermen to enhance their knowledge and skills on sustainable fisheries management, to constructing representative fishing ports is also necessary to support efficient and environmentally friendly fishing activities, lastly, maximising the monitoring of fishing gear usage that meets the environmental standards and strengthening the law enforcement.

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Introduction

As a developing nation with the fourth largest population globally (Chaliluddin *et al.*, 2023), Indonesia faces rapid population growth, which puts pressure on sectors like fisheries and marine resources. These sectors are anticipated to be pivotal for meeting food demands, including fish (Yonvitner, 2020). The Aceh province, located in the western part of Indonesia, borders the Malacca Strait to the east and the Indian Ocean to the west (Chaliluddin *et al.*, 2021). West Aceh District, a region within Aceh province, directly borders the Indian Ocean (WPP 572) and possesses significant potential for utilizing both pelagic and demersal fish resources. The District comprises 12 subdistricts, four coastal ones (BPS, 2023).

Capture fisheries represent a crucial economic sector for the livelihoods of many communities, including those in West Aceh District, provided it is well-managed (Chaliluddin *et al.*, 2021). However, a key factor contributing to the decline in fish populations is the use of environmentally harmful fishing gear (Ernaldi *et al.*, 2017). Furthermore, Atikasari (2021) emphasizes that the primary means of exploiting fish resources, fishing gear, needs to be regulated to prevent adverse environmental impacts on aquatic ecosystems and fish stocks. Environmentally friendly fishing gear is defined as equipment used in fish capture efforts that do not have negative effects on the aquatic environment and fish resources (Hanafi *et al.*, 2019).

According to Sartika *et al.* (2023), current fishing activities are alarming due to the use of non-

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environmentally friendly fishing gear by fishers. Improper management of fishing gear can lead to habitat destruction and depletion of fish resources (Chaliluddin et al., 2019). Conversely, using such gear can temporarily benefit fishers by increasing their catch and income (Chaliluddin et al., 2021).

The Code of Conduct for Responsible Fisheries has been adopted by the government and incorporated into various policies to address deviations in fisheries, including capture fisheries (Sumardi et al., 2014). These guidelines serve as a national and international reference to ensure the sustainable, environmentally friendly exploitation of marine resources (Pramesthy et al., 2020). Selective fishing aims to reduce or limit unwanted bycatch (Dieterle, 2022). Therefore, a strategy for managing sustainable and environmentally friendly fishing gear is essential.

The enactment of this strategy is expected to empower the utilization of environmentally friendly and sustainable capture fisheries resources. The strategy formulation must consider various internal and external factors influencing capture fisheries management. One approach to supporting environmentally friendly capture fisheries management is the application of environmentally friendly fishing gear. Although there has been extensive research on environmentally friendly fisheries management, no such study has been conducted in West Aceh District, specifically.

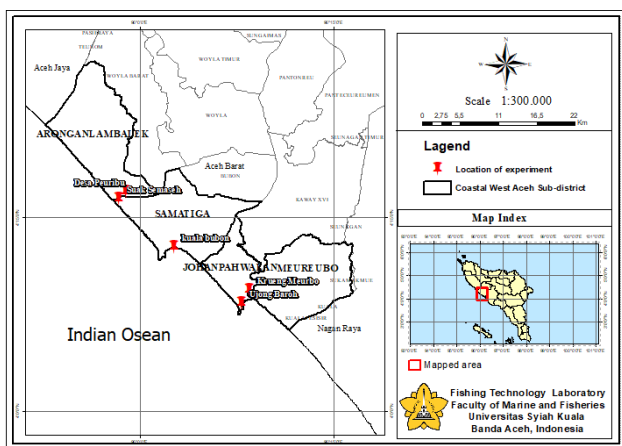


Figure 1. Map of the research locations

Thus, the objective of this research is to determine a strategy for environmentally friendly capture fisheries management based on the code of conduct for responsible fisheries in West Aceh District. This effort is crucial for protecting aquatic habitat sustainability and future fish stock populations.

Materials and Methods

Location and time of research

This research was conducted in May 2024 in West Aceh District, encompassing the sub districts of *Arongan Lambalek, Samatiga, Johan Pahlawan, and Meureubo*. The complete research locations are shown in Figure 1 below.

Method of collecting data

The method used in this research is a descriptive method combined with survey techniques. The survey technique was employed to obtain or gather information about the research subjects through interviews with fishers. According to Nazir (2014), the descriptive method is a research method used to study the status of a group of people, an object, a condition, a system of thought, or a class of events in the present, aiming to describe and explain the current state or a problem with data analyzed based on the approach used in the research.

The assessment of the environmental friendliness of fishing gear was conducted based on the Code of Conduct for Responsible Fisheries (FAO, 1995), which includes nine criteria; High selectivity; Non-destructive to habitats/environment; Produces high-quality fish; Safe for operators/fishers; Produces products that are safe for consumers; Low by-catch; No adverse impact on biodiversity; Does not catch protected fish species; Socially acceptable.

The data collected in this research consists of both primary and secondary data. Primary data includes the types of fishing gear, the number of fishing gear used by fishers in each research location. Secondary data collected includes captured fisheries statistics, research findings, journals, and other studies related to this research topic. Sampling was determined using the purposive sampling method, with a sample size of five individuals per type of fishing gear per research location, resulting in a total of 115 samples for this study.

Data analysis

The primary criteria for evaluating environmentally friendly fishing gear are based on Monintja (2000), which states that fishing gear is considered environmentally- friendly if it meets nine criteria. Once the scores are obtained, a reference point is established to rank the gear, with the score ranges provided in Table 1 below.

Table 1. Classification of Environmental Friendliness Categories

No	Environmental Category	Friendliness	Score Range
1	Very Environmentally Friendly		28 – 36
2	Moderately Environmentally Friendly		19 – 27
3	Not Environmentally Friendly		10 – 18
4	Very Not Environmentally Friendly		01 – 09

The strategy for environmentally friendly capture fisheries management based on the CCRF is analyzed using SWOT analysis. SWOT analysis is a method to systematically identify various factors in order to formulate a change strategy. This analysis is based on the logic of maximizing strengths and opportunities while simultaneously minimizing weaknesses and threats (Rangkuti, 2015). SWOT analysis uses the IFE matrix, EFE matrix, and SWOT matrix. The IFE (Internal Factor Evaluation) matrix is designed to identify strategies based on internal factors, indicating weaknesses and strengths.

SWOT analysis begins with identifying the position of a capture fisheries management activity by evaluating the internal and external factors. The development of the three matrices in SWOT analysis can be done through weighting. The weighting stages used are as follows: 1) Compile a list of factors considered important as internal and external factors of capture fisheries in West Aceh District, 2) Assess the weight of each internal and external strategy factor. The weighting aims to quantify the analyzed internal and external factors, 3) Assign weights to each internal and external strategy factor, ranging from 1.00 (very important) to 0.00 (not important), as shown in Table 2 below.

Table 2. The scoring of SWOT Factors

Internal Factors				External Factors			
Strengths	score	Weaknesses	score	Opportunities	score	Threats	score
S1	A1	W1	B1	O1	C1	T1	D1
S2	A2	W2	B2	O2	C2	T2	D2
S3	A3	W3	B3	O3	C3	T3	D3
S4	A4	W4	B4	O4	C4	T4	D4

The weighting of each strategic factor will be ranked according to its importance. The factors included in the IFE and EFE matrices have weighted scores that can range from a minimum of 1.00 to a maximum of 4.00, with 2.5 as the average. A total weighted score significantly below 2.5 indicates an organization that is internally weak, whereas a total weighted score significantly above 2.5 indicates a strong internal position. Subsequently, several alternative strategies will be formulated using the SWOT matrix.

Results

Fishing Gear and Their Environmental Friendliness Scores

There are nine types of fishing gear are used by fishers in West Aceh District. These gears were analysed according to the Code of Conduct for Responsible Fisheries criteria, identifying which gears are environmentally friendly and which are not (Table 3).

Table 3. Fishing Gear and Their Environmental Friendliness Scores in West Aceh District

No	Criteria	Fishing Gear								
		A1	A2	A3	A4	A5	A6	A7	A8	A9
1.	High selectivity	4	2	4	4	3	1	4	1	3
2.	Non-destructive to habitats/environment	3	4	4	3	4	4	3	4	4
3.	Produces high-quality fish	4	3	4	4	3	4	4	3	4
4.	Safe for operators/fishermen	4	3	4	4	4	4	4	4	4
5.	Produces products safe for consumers	1	4	4	4	4	4	4	4	4
6.	Low by-catch	3	3	4	4	4	3	4	2	3
7.	No adverse impact on biodiversity	4	3	4	4	4	3	4	3	4
8.	Does not catch protected fish species	2	4	4	4	4	4	2	2	4
9.	Socially acceptable	1	4	4	4	3	4	4	4	4
Total		26	30	36	35	33	31	29	27	34

Notes: A1 = Trawl; A2 = Danish seine; A3 = Troll line; A4 = Handline; A5 = Purse seine; A6 = Trap; A7 = Millenium gillnet; A8 = Trammel net; A9 = Bottom longline.

Environmentally Friendly Fisheries Management Strategy

The environmentally friendly fisheries management strategy in West Aceh District can be developed by understanding the factors related to fisheries management, including both internal and external factors. The identification of components in the SWOT analysis conducted in West Aceh District is further elaborated, considering various influencing factors, meanwhile, IFE (Internal Factor Evaluation) and EFE (External Factor Evaluation) in West Aceh District are restricted to aspects related to fisheries management. Before determining the development strategy, it is essential to first, define the IFE and EFE scores by multiplying the weights by the ratings. The weights and ratings are determined based on interviews with respondents. The total weight for internal and external factors is assigned a value of 1.00, with the most dominant subtotal having the higher value. The rating values are based on the levels of influence on fisheries management in West Aceh District.

Internal Factors

The internal factors that constitute strengths for developing an environmentally friendly fisheries management strategy based on the code of conduct

for responsible fisheries in West Aceh District are categorized into five elements: high demand for fish, use of non-destructive fishing gear, existence of the *Panglima Laot* institution, availability of supervisory agencies (PSDKP), and the safety of fishing gear for operators. These factors are detailed in Table 4 below.

Table 4. Internal Factor Evaluation (IFE) Matrix for Environmentally Friendly Fisheries Management

Internal Factor	Weight	Rating	Score
Strengths (S)			
1. High demand for fish	0.15	4	0.60
	0.13	4	0.52
2. Existence of the <i>Panglima Laot</i> institution	0.11	4	0.44
	0.14	4	0.56
	0.09	3	0.27
3. Availability of supervisory agencies (PSDKP)			
4. No capture of protected fish			
5. Safety of fishing gear for operators			
Total Strengths	0.62		2.39
Weaknesses (W)			
1. Relatively low education levels among fishermen	0.09	4	0.36
	0.07	4	0.28
	0.08	4	0.32
2. Low mastery of modern technology	0.07	3	0.21
	0.07	4	0.28
3. Lack of fisheries extension services			
4. Social conflicts among fishermen			
5. Low selectivity of fishing gear			
Total Weaknesses	0.43		1.45
Total Internal Factors	1.00		3.84

External Factors

The external factors that present opportunities for developing an environmentally friendly fisheries management strategy are categorized into five elements: the increasing growth of fishing fleets, the development of environmentally friendly fishing gear, the existence of regulations for managing fishing zones, local regulations governing fisheries management, and investor interest in fisheries development.

Conversely, the external factors that pose threats to improving the environmentally friendly fisheries management strategy are also divided into five elements: river siltation in shipping lanes, flood disasters (ROB), pollution around fish landing sites, scarcity of subsidized fuel for fishermen, and the use of destructive fishing gear by external fishermen.

The total score for the EFE (External Factor Evaluation) amounts to 3.28, reflecting the influence of both opportunities and threats. The external factors analysis reveals that opportunities are more dominant compared to threats affecting environmentally friendly fisheries management in West Aceh District. For clarity, the details of the external factors are presented in Table 6 below.

Table 5. External Factor Evaluation (EFE) Matrix for Environmentally Friendly Fisheries Management

Internal Factor	Weight	Rating	Score
Opportunities (O)			
1. Increasing growth of fishing fleets	0.15	3	0.45
	0.10	3	0.30
2. Development of environmentally friendly fishing gear	0.13	2	0.26
	0.12	2	0.24
	0.07	2	0.14
3. Existence of regulations for managing fishing zones			
4. Local regulations governing fisheries management			
5. Investor interest in fisheries development			
Total Opportunities	0.57		1.39
Threats (T)			
1. River siltation in shipping lanes	0.09	3	0.27
	0.08	1	0.08
2. Flood disasters (ROB)	0.10	2	0.20
	0.08	2	0.16
3. Pollution around fish landing sites	0.08	1	0.08
4. Scarcity of subsidized fuel for fishermen			
5. Use of destructive fishing gear by external fishermen			
Total Weaknesses	0.44		0.79
Total External Factors	1.00		2.18

Based on Table 4 and Table 5, the value obtained from the External Factor Evaluation matrix is 3.28. The value of internal and external factors is far above the average, namely 2.5, which means that the condition of environmentally friendly capture fisheries management in West Aceh District has provided a positive response to the development of environmentally friendly fishing equipment in West Aceh District. Existing opportunities can be exploited to minimize existing weaknesses.

The Internal Factor Evaluations matrix and the external Factor Evaluations matrix analysis show that the Cartesian diagram is in quadrant I (Figure 2), namely supporting efforts to develop environmentally friendly fishing equipment by increasing supervision of the use of fishing equipment for fishermen based on statutory regulations applicable.

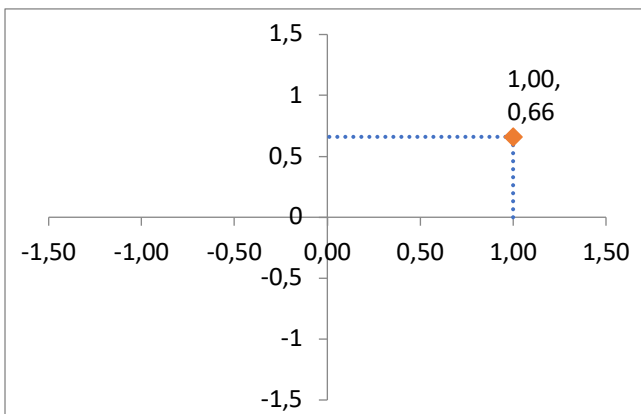


Figure 2. Cartesius SWOT chart

According to the Internal Factor Evaluation (IFE) and External Factor Evaluation (EFE) matrices, a formulation of environmentally friendly fisheries management strategies is developed. This formulation involves a combination of strengths with opportunities, strengths with threats, weaknesses with opportunities, and weaknesses with threats. Utilizing the strategic factors from Tables 5 and Tables 6, a SWOT interaction matrix is created as shown in Table 7. This matrix outlines alternative strategic concepts that can be implemented: Strengths and Opportunities (SO) strategies, Weakness and Opportunities (WO) strategies, Strengths Threats (ST) strategies, and Weakness and Threats (WT) strategies. Based on this matrix, priorities for sustainable environmentally friendly fisheries management strategies in West Aceh Regency can be established. The prioritization of policy development concepts is determined by the scores assigned to each strategy within the matrix.

Table 7. SWOT Matrices Illustrations

IFAS	Strengths (S)	Weaknesses (W)
	<ol style="list-style-type: none"> High demand for fish Use of non-destructive fishing gear Existence of the Panglima Laot institution Availability of monitoring agencies (PSDKP) 5. Fishing gear used does not endanger operators 	<ol style="list-style-type: none"> Relatively low education level of fishermen Low level of modern technology adoption Lack of fisheries extension services Social conflicts among fishermen Low selectivity of fishing gear
IFES	Opportunities (O)	SO Strategies
	<ol style="list-style-type: none"> Increasing growth of fishing fleets Development of environmentally friendly fishing gear Regulations for managing fishing zones Local regulations for fisheries management Investor interest in developing fisheries 	<ol style="list-style-type: none"> Increase monitoring of fishing gear usage. Implement strict sanctions for violating fishermen. Develop representative fisheries ports. Provide training to fishermen. Enhance fisheries extension services.
		WO Strategies
		<ol style="list-style-type: none"> Improve fishing infrastructure and facilities. Support the operation of environmentally friendly fishing gear. Ban all forms of non-environmentally friendly fishing gear.
	Threats (T)	ST Strategies
		WT Strategies

1. River siltation in navigation channels	1. Increase monitoring of fishing activities.	1. Educate fishermen on the importance of
2. Pollution around fish landing sites	2. Enhance the capacity of the Panglima Laot institution as an adat leader.	2. Implement technology in utilizing natural resources while maintainin g local wisdom.
3. Pollution from community activities	3. Improve skilled human resources.	2. Implement integrated managemen t to preserve and enhance aquatic ecosystems , particularly in maintainin g sustainable local wisdom values.
4. Shortage of subsidized fuel for fishermen	4. Develop efficient, effective, and environmentally friendly fishing vessels and gear.	3. Foster cooperatio n among stakeholder s to combat illegal, unreported , and unregulate d (IUU) fishing.
5. Use of destructive fishing gear by external fishermen		

Discussion

The development of environmentally friendly capture fisheries management strategies based on the code of conduct for responsible fisheries can be undertaken by considering both internal factors, such as strengths and weaknesses, and external factors, including opportunities and threats. This process is organized using a matrix format, which results in a general strategy (grand strategy) and is then integrated into a SWOT matrix (Triyani, 2023). The

integration of the Internal Factor Analysis Summary (IFAS) and External Factor Analysis Summary (EFAS) into a SWOT matrix produces four cells that serve as a guide for determining alternative strategies for sustainable fisheries management in the Aceh Barat waters area, reflecting its internal and external potentials.

Based on the analysis of internal and external environmental factors in the Aceh Barat waters area, a SWOT analysis (Strengths, Weaknesses, Opportunities, and Threats) is performed. The SWOT matrix results in four cells containing alternative strategies for developing sustainable fisheries management strategies in Aceh Barat. The combination of strategy classifications includes:

The Strengths-Opportunities (SO) Strategy

This strategy utilizes strengths to maximize opportunities. According to the IFAS and EFAS matrices, the internal factor score is 3.84, while the external factor score is 2.18. The strengths identified are the high demand for fish, the existence of the Panglima Laot institution, the monitoring of surveillance for marine and fisheries resources (PSDKP), the non-capture of protected fish, and the use of fishing gear that does not endanger operators. The opportunities include the growing fishing fleet, the development of environmentally friendly fishing gear, regulations for managing fishing zones, local regulations for fisheries management, and investor interest in fisheries development.

The strategy for implementing environmentally friendly capture fisheries management in West Aceh by leveraging strengths to exploit opportunities involves several key actions. These include increasing the monitoring of fishing gear usage, implementing strict penalties for fishermen who violate regulations, developing representative fisheries ports, providing training to fishermen, and enhancing fisheries extension services.

The SO strategy involves leveraging strengths to take advantage of available opportunities (Wibowo et al., 2021). The presence of numerous fishing fleets must align with existing regulations, necessitating enhanced monitoring and law enforcement of non-selective and potentially destructive fishing gear. This approach aims to prevent violations that may occur among those who are aware of the regulations as well as those who do not fully understand them. Additionally, optimizing human resources, supported by adequate infrastructure, can improve the management of environmentally friendly fishing gear throughout its entire lifecycle, from pre-production to post-production (Saptiona, 2021).

Strength-Threat (ST) Strategy

The Strength-Threat (ST) strategy focuses on leveraging strengths to address threats. The identified strengths include the high demand for fish, the presence of the *Panglima Laot* institution, the Surveillance for marine and fisheries resources (PSDKP), adherence to regulations on protected species, and the use of non-harmful fishing gear. On the other hand, the threats consist of river sedimentation in navigation channels, pollution around fish landing sites, pollution from community activities in surrounding waters, scarcity of subsidized fuel for fishermen, and the use of destructive fishing gear by external fishermen.

The strategy for managing environmentally friendly capture fisheries based on the code of conduct for responsible fisheries in West Aceh, utilizing strengths to mitigate threats, includes enhancing monitoring of fishing activities, increasing the capacity of the *Panglima Laot* institution as the local wisdom authority, improving the skill levels of human resources, and developing efficient, effective, and environmentally friendly fishing vessels and equipment (Nugraha et al., 2021). The ST strategy aims to use internal strengths to minimize external threats. External threats can easily undermine existing strengths (Setyawan, 2020; Azisyah & Hariyanto, 2023). Therefore, it is essential to strengthen the monitoring of fishing activities and pollution around ports to preserve environmental quality.

Weakness-Opportunity (WO) Strategy

The Weakness-Opportunity (WO) strategy aims to minimize weaknesses while exploiting opportunities. The identified weaknesses include low levels of education among fishermen, limited mastery of modern technology, insufficient fisheries extension services, social conflicts among fishermen, and low selectivity of fishing gear. Opportunities include the growth of the fishing fleet, the development of environmentally friendly fishing gear, regulations for managing fishing zones, local regulations governing fisheries management, and investor interest in fisheries development.

The strategy for implementing environmentally friendly capture fisheries management in West Aceh, using opportunities to address weaknesses, involves increasing the capacity of fishing infrastructure, supporting the operation of environmentally friendly fishing gear, and prohibiting non-environmentally friendly fishing gear. The WO strategy aims to address weaknesses by leveraging available

opportunities (Arafat & Amin, 2023). The profitability of fishing enterprises requires attention, including handling catch and ensuring hygienic processing of fish products. Enhancing infrastructure and resources supports environmentally friendly operations, ensuring optimal utilization by fishermen and other human resources (Usman, 2023).

Weakness-Threat (WT) Strategy

The Weakness-Threat (WT) strategy seeks to minimize internal weaknesses and avoid external threats. The internal weaknesses include low educational levels among fishermen, limited mastery of modern technology, insufficient fisheries extension, social conflicts among fishermen, and low selectivity of fishing gear. The threats include river sedimentation in navigation channels, pollution around fish landing sites due to fishing activities, pollution from community activities in surrounding waters, scarcity of subsidized fuel for fishermen, and the use of destructive fishing gear by external fishermen.

The strategy for managing environmentally friendly capture fisheries in West Aceh, using weaknesses to minimize threats, involves providing education to fishermen on the importance of technology for sustainable resource utilization without neglecting local wisdom, implementing integrated management to maintain and enhance aquatic ecosystem functions while preserving local wisdom, and fostering cooperation among various stakeholders to combat illegal, unreported, and unregulated (IUU) fishing. The WT strategy focuses on using weaknesses to mitigate threats. External threats can significantly impact management efforts. Hence, socialization and guidance on the use of modern, environmentally friendly technologies are crucial. Effective communication with stakeholders is necessary to ensure coordination and minimize issues arising from poor communication and coordination (Chaliluddin et al., 2021d).

Conclusion

The environmental-friendly fisheries management strategy based on the Code of Conduct for Responsible Fisheries (CCRF) in West Aceh District includes several important measures. First, increasing supervision of fishing gear usage ensures that all equipment meets environmentally friendly standards. Second, imposing strict penalties on violators is intended to enforce regulations and prevent damaging practices. Third, constructing representative fishing ports is necessary to support

efficient and environmentally friendly fishing activities. Fourth, providing enough information through training will enhance fishermen's knowledge and skills in sustainable fisheries management. Finally, improving fisheries outreach will broaden understanding of responsible fishing practices and the importance of environmental conservation.

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