

The identification of sustainable fishing gear based on the code of conduct for responsible fisheries in West Aceh

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Abstract. This research examines the environmental friendliness of various fishing gear in the West Aceh District. The research method used is descriptive, data was collected by interviewing fishermen using questionnaires and direct observation of the research object. There are nine aspects of the assessment criteria namely; high selectivity, no damage to habitat, the safety of fishermen, high-quality production, no harm to consumers, low by-catch, no catch of protected or endangered species, minimal impact on biodiversity, and social acceptability. The type of fishing gear and quantity was collected as primary data meanwhile secondary data was obtained from official documents from the Maritime Affairs and Fisheries Service, websites, books, and journals. All fishermen who used nine types of fishing gear: trawls, boat seines, trolling lines, handlines, Purse seines, traps, millennium gillnet, trammel net, and bottom longline, were part of the population. The research shows that trolling lines and handlines are the highest level of environmental friendliness, and are categorised as "very environmentally friendly". Purse seines, traps, and boat seines also belong to this category. In contrast, trawls and trammel nets are categorised as "less environmentally friendly" due to their negative impact on marine habitats and high levels of by-catch

1 Introduction

Aceh with 1.660 km² of coastline, is a province in Indonesia that has potential resources in maritime and fisheries sectors [1]. Several districts in Aceh bordering the Indian Ocean (WPP 57), one of those is West Aceh District which has 4 sub-districts in coastal areas. West Aceh District has potential resources on fisheries and it is also a great opportunity, especially in

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the capture fisheries sector. The estimated potential for marine fisheries in West Aceh waters in 2024 will reach 20,331.74 tons [2].

Unfortunately, the fishing industry's growth, in West Aceh District, as one of the consequences of rapid population growth, also negatively impacts the sustainability of fish resources and the environment. This condition worsens because fishermen operate environmentally friendly fishing gear that significantly influences the decline in fish populations. The environmentally friendly fishing gear uses equipment that does not harm the environment, such as being more selective in catching fish [3]. Currently, several conditions for fishing activities are quite dangerous because some fishermen use fishing gear that is not environmentally friendly, without proper planning and management, this will potentially damage fishing resources in the future [4]. Also added that mounts of traditional fishing fleets around the coastal areas and the use of fishing equipment that is not environmentally friendly such as mini trawls are the causes of overfishing. Fishing equipment management that is not ecologically friendly can cause damage to fish habitat and resources. Still, on the other hand, it can benefit fishermen for a while because they get a little more catch and the fishermen's income will easily increase.

The Minister of Maritime Affairs and Fisheries Regulation *No. 2/PERMEN-KP/2015* has prohibited the operation of trawls in all Fisheries Management Areas of the Republic of Indonesia [5]. The diversity of using fishing gear is one of the strategic steps to overcome the threat of damage to marine ecosystems and anticipate the occurrence of destructive fishing. The Code of Conduct Responsible for Fisheries (CCRF) published by FAO in 1995, is one of the international instruments that contain rules and frameworks for promoting sustainable and environmentally friendly fisheries development. The Indonesian government has applied CCRF as a guideline for responsible and sustainable fishing activities. These guidelines establish international principles and standards for responsible practices to ensure the effectiveness of conservation, management, and development of aquatic biological resources, while the preservation of ecosystems and biodiversity is also part of the priorities.

Similar research has been conducted by writer in other part of Aceh, but none of those conducted in West Aceh. Based on the finding of those research and short term observation, there is a potential issues on sustainable fishing gear in West Aceh District So, this research aims to determine CCRF-based environmentally friendly fishing equipment that operated by fishermen in West Aceh District.

2 Material and methods

2.1 Time and place

This research was conducted in June 2024, located in West Aceh District including Samatiga, Johan Pahlawan, and Meureubo Districts. The complete research location is presented in Fig. 1 below :

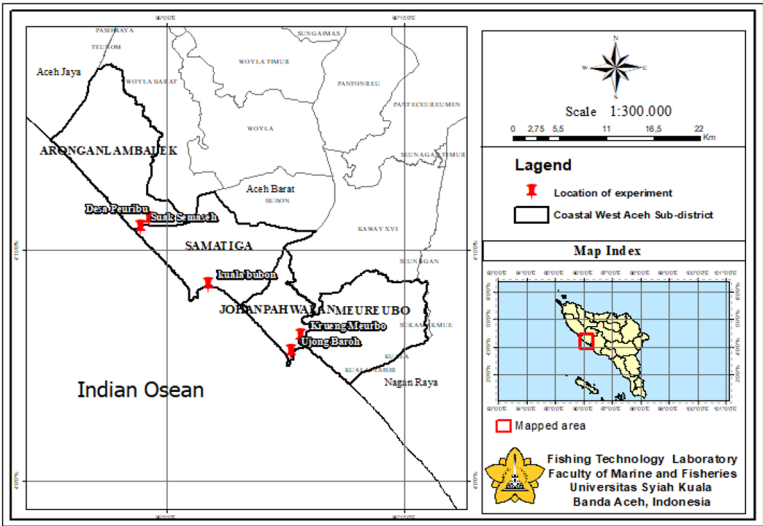


Fig. 1. Maps showing the location of the experiment.

2.2 Data and monitoring methods

A descriptive method with survey techniques was conducted in this research. A survey was applied to collect information about the research object by interviewing fishermen (Nazir, 2014). There were 5 fishermen form each fishing gear category in several locations. In addition, several pieces of informants from the Department of Maritime Affairs and Fisheries in West Aceh were also included in this research as policy maker perspectives.

Research on the level of eco-friendly fishing gear was carried out based on the Code of Conduct for Responsible Fisheries [6]. Consisting of 9 criteria, namely high selectivity, safety for the habitat of fish breed, not endangering fishermen, the quality of production, the product is safe consumers, minimise fish waste, safe for endangered species, and minimum impact on biodiversity and is socially acceptable, which is assessed by a weighting system [7].

2.3 Data analysis

Data analysis of the criteria was carried out through reference points, dividing the total number of scores from respondents and the number of respondents. Reference points are applied to determine the final weighting results for each environmentally friendly fishing gear criterion [6]. Calculated using the following formula.

Table 1. Weighting of criteria for environmentally friendly fishing gear.

No	Criteria	Sub-criteria	Scores
1	High selectivity	Catching more than three species of fish with a diversity of sizes.	1
		Catching three species of fish or less with a diversity of sizes.	2
		Catching less than three species of relatively similar size	3
		Catching a species of fish with a relatively similar size	4
2	Prevent habitat destruction	Causes widespread damage	1
		Causes habitat destruction in a narrower area	2
		Causes damage to every habitat in a narrow area	3

		Safe for Habitat	4
3	Producing of fish high-quality	Dead and rotting fish	1
		Dead, fresh, and disabled fish	2
		Dead and fresh fish	3
		Living Fishes	4
4	Safety for fishermen	Possibility for fishermen's death	1
		Possibility of permanent disability for fishermen	2
		Only a temporary safety disturbance	3
		Save for fishermen	4
5	Safe production for consumers	High possibility of causing death to consumers	1
		Potential for consumer's health problems	2
		Relatively save for consumers	3
		Save for consumers	4
6	Low by-catch	Several bycatch species which is unsellable	1
		Less than three species of bycatch and sold out	2
		Less than three species of bycatch with high prices	3
		Less than three species of bycatch with high prices	4
7	Diversity's impact	Death of all living creatures and destroys the habitat	1
		Death of several species but save for habitat	2
		Death of several species but save for habitat	3
		Save for diversity	4
8	Save for protected fishes	Protected fish that are often caught	1
		Protected fish that are caught several times	2
		Protected fish that were caught	3
		Protected fish have never been caught	4
9	Socially Acceptable	Low investment costs	
		Profitable	
		Does not conflict with local culture	
		Does not conflict with existing regulations	
		Fishing gear that meets 1 of 4 those criteria	1
		Fishing gear that meets 2 of 4 those criteria	2
		Fishing gear that meets 3 of 4 those criteria	3
		Fishing gear that meets 4 of 4 those criteria	4
Total scores			36

After all the interview scores are obtained, reference points are made by dividing the total scores from respondents and respondents. Reference points are used to determine the final weighting results for each environmentally friendly fishing gear criterion, calculated using the following formula [8].

$$X = \frac{\sum x_n}{N} \quad (1)$$

Notes: X = Total of environmentally friendly; X_n = Total score ; N = Respondents

After the score or value has been obtained, reference points are created, which can be used to determine ranking [9]. The environmental friendliness categories can be seen in the following table.

Table 2. Classification of environmentally friendly categories

No	Environmentally friendly categories	Score (X)
1	Very Environmentally friendly	28 – 36
2	Less environmentally friendly	19 – 27
3	Not environmentally friendly	10 – 18
4	Harmful to the environment	1 – 9

3 Result and Discussion

3.1 Result

Based on interviews with *Panglima Laot* and several fishermen, several kinds of fishing gear are commonly operated in West Aceh District, namely:

Trawls. Trawls are that consist of nets with pockets, bodies, and wings, and they are equipped with net openers (otter boards). This is the most favourite fishing gear in West Aceh District which is operated by 489 ships. Trawl operated by <6 GT ship with 2-3 ships crew. Trawl catches various types of shrimp, sea bream, mackerel, snapper, and other fish. The results of the environmental friendliness level analysis obtained a score of 26 which shows that this fishing gear is the environmentally unfriendly category.

Boat Seine. Boat seines includes circle bag seines with a bag and wings. The number of boat seines operated in West Aceh District by 10 ships with 12-15 crews. This kind of fishing gear consists of a net body, net bag, wings, upper ris rope, lower ris rope, and also a piece of wing/net leg rope, which is the longest part of the net and is located at the front end of the boat seines. The net wing consists of an upper wing and a lower wing. This fishing gear catches fish that live in groups on the water's surface, for example, tuna, scallops, mackerel, trevally, and other small pelagic fish. The results of the environmental friendliness level analysis received a score of 30 and this fishing gear is included in the environmentally friendly category.

Trolling lines. Trolling lines is a in the longline category which consists of a main line, rope reel, weights, and hook. The trolling lines is also part of the fishing gear that is most widely used in West Aceh District, 382 ships are operating this fishing gear. The main catches of the Trolling lines are tuna, tuna, sardines, and others. The analysis of the level of environmental friendliness obtained a score of 36 shows that this fishing gear is included in the very environmentally friendly category.

Handlines. Handlines is one of the used in West Aceh District that consists of winding roll which made of cylindrical plastic with a diameter of 15-20 cm. The main rope is a monofilament nylon rope with the length of the main rope around 15-20 m. Sailfish, marlin, and snapper are usually caught by this fishing gear. The environmental friendliness level analysis obtained a score of 36, which means that this fishing gear is included in the very environmentally friendly category.

Purse seines. Purse seines are rectangular nets equipped with rings and crimped ropes. There are 14 Purse seines used in West Aceh District, operating using vessels with an average size of 15 GT and 12 - 18 crew members. The environmental friendliness level analysis results obtained a score of 34, meaning this fishing gear is included in the environmentally friendly category.

Traps. Traps are installed permanently underwater for a certain period and the purpose of making it easier for fish to enter but difficult to run away. There are 10 traps used in West Aceh District, which are made from nets, iron, wood, bamboo, cylindrical, trapezoidal, and other shapes, operated passively on the bottom or surface of the water, either with bait or not.

The environmental friendliness level analysis results score of 31, meaning this fishing gear is included in the environmentally friendly category.

Millennium Gillnets. The Millennium Gillnet is a modification form of the gillnet. The net is nylon monofilament (mono twist) consisting of several soft twisted fibers (not spun) while gill nets are generally made of spun multifilament nylon. There are 17 Millennium Gillnet operated in West Aceh District with the targets of catch in millennium gillnets are pelagic fish, such as mackerel, tuna, *sailing*, skipjack, and demersal fish such as snapper, *Talang-Talang*, and others. The results of the environmental friendliness level analysis obtained a score of 33, meaning that this fishing gear is included in the very environmentally friendly category.

Trammel nets. A Trammel net is a operated on the bottom of the waters. Main catch targets are various types of demersal organisms, such as shrimp, demersal fish, crabs, and crabs. Trammel net operates by sweeping the bottom of the water, by dragging or drifting. The environmental friendliness level analysis results obtained a score of 27, meaning that this fishing gear is included in the less environmentally friendly category.

Bottom Longlines. Bottom longlines is also a type of fishing gear that is included in the longline classification and passive. There are 22 longline fishing equipment operated in West Aceh waters with a vessel size < 7 GT. Demersal fish are the target of bottom longlines, such as red snapper, *remang*, *mayung*, shark, and others. The environmental friendliness level analysis results obtained a score of 34, meaning this fishing gear is included in the environmentally friendly category. Based on the code of conduct for responsible fisheries, data analysis, fishing gear in West Aceh District has an average score for environmental friendliness as presented in Table 3 and 4.

Tabel 3. CCRF criteria values for fishing gear in West Aceh District.

No	Criteria	Fishing Gear								
		A1	A2	A3	A4	A5	A6	A7	A8	A9
1	High selectivity	1	1	4	3	3	1	2	1	3
2	Save for the habitat	4	4	4	4	4	4	3	4	4
3	Producing high-quality fisheries	3	3	4	4	3	4	3	3	4
4	Save for the fishermen	4	4	4	4	4	4	4	4	4
5	Save for the consumers.	4	4	4	4	4	4	4	4	4
6	Low Numbers of by-catch	1	2	4	4	4	3	3	2	3
7	Diversity impact	3	3	4	4	4	3	4	3	4
8	Protected fish-friendly	4	4	4	4	4	4	2	2	4
9	Socially acceptable	2	3	4	4	3	4	4	4	4
Total		26	28	36	35	33	31	29	27	34

A1: Trawls; A2: Boat seines; A3: Trolling lines; A4: Handlines; A5: Purse seines; A6: Traps; A7: Millenium Gillnet ; A8: Trammel net; A9: Bottom Long lines

Table 4. Fishing equipment category status.

No	Fishing Gear Equipment	Score (X)	Status
1	Troling lines	36	Very Environmentally Friendly
2	Handlines	35	Very Environmentally Friendly
3	Bottom Long line	34	Very Environmentally Friendly
4	Millenium Gillnet	33	Very Environmentally Friendly
5	Purse seines	33	Very Environmentally Friendly
6	Traps	31	Environmentally Friendly
7	Boat seines	30	Not environmentally friendly
8	Trammel net	27	Not environmentally friendly
9	Trawls	26	Not environmentally friendly

3.2 Discussion

The assessment for environmentally friendly fishing gear based on the CCRF (*Code of Conduct for Responsible Fisheries*), initiated by FAO (1995), shows a significant variation in the environmental impacts and sustainability of the nine fishing gears used. The assessment criteria include not destroying habitat, low by-catch, producing high-quality fish, not endangering fishermen, production not endangering consumers, having high selectivity, not endangering protected fish, being socially acceptable, as well as efficiency and productivity. Each fishing gear is given a score from 1 to 4 for each of these criteria, providing a comprehensive picture of the impact and sustainability of the fishing gear. An assessment of the level of environmental friendliness of fishing gear in West Aceh based on the CCRF initiated by FAO in 1995 shows variations in the environmental impact and sustainability of the nine-fishing gear used.

The assessment results show that the trawls, with a score of 26, is in the "Less environmentally friendly" category. This is due to the destructive impact of these tools on seabed habitats and high levels of by-catch involving non-target species. Trawling is often in the spotlight in fisheries sustainability issues because its catch method is not selective and has the potential to damage marine ecosystems. This assessment reflects the destructive impacts of these tools on seabed habitats and the high levels of by-catch, which often include non-target species. Although trawling is effective in catching a variety of commercial species in large numbers, its impact on the marine environment is significant. Research shows that fishing gear such as trawls can damage seabed ecosystems, disturb important habitats, and reduce biodiversity [10-11]. Therefore, although trawling has high efficiency in productivity, its destructive impact makes it less environmentally friendly.

In contrast, fishing gear such as boat seines, Trolling lines, hand lines, Purse seines, traps, millennium gill nets, and Bottom longline s received higher scores, with some of them falling into the "Very environmentally friendly" category. Boat seines, with a score of 30, shows good performance in almost all assessment criteria, especially in the aspects of safety for fishermen and high quality of the catch. The Trolling lines, with a perfect score of 36, is the most environmentally friendly thanks to its high selectivity and low by-catch. This method is very effective in catching target species without destroying habitats or catching protected fish and is well accepted by the fishing community [13, 14].

Boat seines with a score of 30 falls into the "Very environmentally friendly" category. Payang shows good performance in almost all criteria, especially in the aspect of safety for fishermen and the quality of the catch. This is a safe method, does not significantly damage marine habitats, and is socially accepted by the local fishing community. More selective fishing gear such as Trolling lines and hand lines, with scores of 36 and 35 respectively, are considered very environmentally friendly. Both methods are highly selective, with minimal bycatch, do not damage marine habitats, and are safe for fishermen and protected species. This superiority in selectivity means that the fishing gear is highly effective in capturing target species without disrupting the marine ecosystem as a whole [15].

Purse seines, with a score of 33, it also falls into the "Very environmentally friendly" category. Despite the risk of bycatch, this method is still very environmentally friendly and effective in catching large quantities of fish without significantly damaging marine habitats. Almost similar to Purse seines, traps with a score of 31, are known as highly selective fishing gear that does not damage marine habitats, is safe for fishermen, and produces high-quality fish without catching protected species [16, 17].

Millennium Gillnet with a score of 33, produces high-quality fish and is safe for fishermen, although this method may have higher levels of bycatch compared to more selective fishing gear. Meanwhile, the three-layer gill net, with a score of 27, is on the border between "Very environmentally friendly" and "Less environmentally friendly. The tool

scored less than optimal on several criteria, especially in terms of bycatch and impact on protected species, but was still socially acceptable and produced high-quality fish.

A bottom long line with a value of 34, it is highly selective and has minimal impact on marine habitats. This tool is safe for fishermen, and produces high-. Quality fish, and is well received by the local fishing community [18]. Recent research supports the importance of using more selective and environmentally friendly fishing gear. Less environmentally friendly fishing gear, such as trawls, although efficient in catching large numbers of fish, often cause damage to seabed habitats and catch many non-target species, which has the potential to disrupt the balance of marine ecosystems [19].

The use of environmentally friendly fishing gear has a significant impact on increasing the sustainability of fisheries and protecting marine biodiversity. This assessment is important to support responsible fisheries policies and assist fishermen and policymakers in selecting fishing gear that minimizes negative impacts on the environment while ensuring the safety and welfare of fishermen. Fishing gear that scores high on criteria such as "Does not harm protected fish" and "Socially acceptable" tends to be more sustainable and have long-term positive impacts on fishing communities and marine ecosystems [12]. Other research shows that implementing environmentally friendly fishing gear not only protects the environment but can also increase catches and fishermen's welfare in the long term.

Overall, this assessment provides valuable guidance for efforts to improve responsible and sustainable fishing practices in West Aceh and other areas that depend on the fisheries sector. Adopting environmentally friendly fishing gear is not only a step towards sustainability but also an investment in the future of fishing communities and a healthy and productive marine ecosystem.

Recently, research has supported the importance of using more selective and environmentally friendly fishing gear. Tools such as Trolling liness and hand lines not only reduce negative impacts on marine ecosystems but are also safer for fishermen. Less environmentally friendly fishing gear, such as trawls, although efficient in catching large numbers of fish, often cause damage to seabed habitats and catch many non-target species, which has the potential to disrupt the balance of marine ecosystems. Therefore, there is a strong push to adopt more responsible and sustainable fishing practices. This overall assessment guides efforts to improve responsible and sustainable fishing practices in West Aceh and other areas that depend on the fisheries sector.

4 Conclusion

The research conducted in West Aceh District found 9 (nine) types of fishing gear operated by local fishermen, 7 fishing gear fall into the very environmentally friendly category, namely trolling, hand line, Bottom longline, Purse seines, millennium gill net, trap, and Boat seines, while trawls and three-layer gill nets fall into the less environmentally friendly category. The expectation of eradicating fishing gear that is not environmentally friendly will shortly achieved, in a way to prevent social conflicts between fishermen. It is also hoped that there will be progressive action taken by the government and other local authorities in monitoring environmentally friendly fishing equipment in West Aceh waters, considering this is one of the important matters either for the better life of fishermen as a local community or the government itself.

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