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Assessment of the Environmental Friendliness of Fixed Lift Net Fishing Gear in Rebo Waters, Bangka Belitung Islands Province

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Abstract: Lift net is a fishing gear widely used by coastal fishers in Rebo Waters, Bangka Belitung Province, Indonesia; therefore, its level of environmental friendliness needs to be assessed to support sustainable capture fisheries management. This study aimed to evaluate the environmental friendliness of bagan tancap based on technical and biological–environmental aspects. A descriptive approach with a scoring system was applied to several criteria, including operational safety, energy consumption, ghost fishing potential, catch selectivity, discard handling, interactions with protected species, and impacts on aquatic habitats. The results showed that bagan tancap obtained a total score of 26 out of a maximum score of 30, with an Environmental Friendliness Index (EFI) of 86.67%, indicating that this fishing gear is highly environmentally friendly. However, catch selectivity remained low due to the use of light attraction, which resulted in mixed catches.

Keywords: Capture Fisheries, Environmental Friendliness, Fixed Lift Net, Rebo Waters.

INTRODUCTION

The potential of fish resources in the waters of the Bangka Belitung Islands is very diverse and is the mainstay of the livelihoods of coastal communities, especially small-scale fishermen. One commonly used fishing gear is the fixed-net net (bagan tancap), which plays a significant role in catching small pelagic fish and other marine life, such as anchovies and squid. Fishing activities using fixed-net nets in coastal villages like Rebo not only affect marine productivity but also have implications for the environment and the sustainability of fisheries resources. Previous research has shown that technological innovations in fish-calling lights can increase fixed-net net catches by improving operational efficiency without directly increasing pressure on fish resources (Kurniawan & Farhaby, 2017).

However, the operation of fixed nets also raises questions regarding its ecological impact, such as the level of catch utilization, the number of*by-catch*, as well as interactions with non-target species and aquatic habitats. Studies in the waters of Bangka Belitung indicate that variations in fishing gear characteristics and the intensity of their use have the potential to impact the sustainability of fish stocks and catch composition, including the number of species that do not meet catchable sizes or are not fully utilized. This is reflected in the analysis of the efficiency level of lift net fishermen, which remains quite high but indicates the need to consider environmental aspects such as bycatch and the size of fish caught (Mardyani et al., 2021). Based on this background, a systematic assessment of the environmental friendliness of lift net fishing gear is needed, including aspects of catch utilization, impacts on non-target biota, and potential habitat damage. This study aims to determine the environmental friendliness of lift net fishing gear in the Rebo Waters,

Bangka Belitung, based on biological, technical, and environmental aspects, as a basis for developing recommendations for responsible and sustainable capture fisheries management.

RESEARCH METHODS

Time and Place

This research was conducted at the Sampur Fish Auction Place (TPI) for bagan tancap fishermen operating in Rebo waters. The research was conducted in July 2025.

Data Types and Sources

The data used includes primary and secondary data. Primary data was obtained through several methods, including interviews, direct field observations, and questionnaires. Meanwhile, secondary data came from fisheries reports, relevant scientific publications, and government documents as supporting materials for the analysis of fishing gear.chartwhich operates around the waters of Rebo.

Data Collection

Data collection on the analysis of the level of environmental friendliness of fishing gear was carried out on fishermen.chartwhich actively operates in the Rebo waters. Respondents were determined using the method*purposive sampling*with the criteria of fishermen who have been actively operating for at least two years and implementing an operational system*one day fishing*Data were collected through participant observation to record the duration and stages of each fishing trip, as well as interviews using semi-structured questionnaires to obtain information related to technical, biological, and environmental aspects.

Data analysis

The obtained data was analyzed using a scoring method. This method is used to evaluate the environmental friendliness of fishing gear based on indicators covering technical, biological, and environmental aspects. Details of the indicators and scoring criteria are presented in Table 1.

Table 1. Assessment of the environmental friendliness index of fishing gear

No.	Criteria	Score	Shoes Max	Shoes
I.	**TECHNICAL ASPECTS**			
1.	Do not endanger fishermen and other people at sea		3	
	● Endanger	1		
	● Quite dangerous	2		
	● No harm	3		
2.	Energy saving		3	
	● Not energy efficient	1		
	● Quite energy efficient	2		
	● Very energy efficient	3		
3.	Quantity Producing Pollution (Polluting Materials)		3	
	● Ships or boats that are used produce a lot of pollution	1		
	● Ships or boats used have moderate pollution	2		
	● Ships or boats used are low pollution	3		

4.	Materials for making fishing gear		3
	● Fishing gear is made from materials whose procurement is very damaging to the environment or protected ecosystems.	1	
	● Fishing gear is made from materials whose procurement is somewhat damaging to the environment or protected ecosystems.	2	
	● Fishing gear is made from materials that are not procureable to damage the environment or protected ecosystems.	3	
5	The level of vulnerability of a fishing gear		3
	● Fishing gear has a high potential for occurrence *"ghost fishing"*	1	
	● Fishing gear has a fairly high potential for occurrence *"ghost fishing"*	2	
	● Fishing gear has a low potential for occurrence *"ghost fishing"*	3	
II.	**BIOLOGICAL AND ENVIRONMENTAL ASPECTS**		
1.	Selectivity (Composition of fish caught)		3
	● The fish caught are not uniform, legal or*proper size*	1	
	● The fish caught were fairly uniform, legal or*proper size*	2	
	● Fish caught are uniform, legal or*proper size*	3	
2.	Proportion of catch utilized		3
	● The catch and by-catch are not utilized to their maximum potential.	1	
	● The catch and by-catch are not being utilized optimally.	2	
	● The catch and by-catch are utilized to the maximum.	3	
3.	Treatment of fish and marine biota returned to the sea (discard)		3
	● Fish and marine biota that are not suitable for catching are returned to the sea without guaranteeing their survival.	1	
	● Fish and marine biota that are not suitable for catching are returned to the sea with less guarantee of their survival.	2	
	● Fish and marine biota that are not suitable for catching are returned to the sea and their survival is guaranteed.	3	
4.	Cases of the capture of protected species of biota		3
	● Protected species are often caught/*biodiversity*	1	
	● Rarely caught protected species/*biodiversity*	2	
	● Never capture protected species/*biodiversity*	3	
5.	Potential damage to the aquatic environment and habitat		3
	● Fishing methods and operations are very destructive to the aquatic environment and habitats.	1	
	● Fishing methods and operations are quite damaging to the aquatic environment and habitat.	2	

● Fishing methods and operations do not damage the aquatic environment and habitat	3	
Shoes	ΣS_{max}	ΣAnd

Eco-Friendly Fishing Gear Index (IRF)

$$IRF = \frac{\sum_{i=1}^{n} Si}{\sum_{i=1}^{n} Smax} \times 100$$

IRF = environmentally friendly fishing gear index
Si = Score of criterion i
Smax = Maximum score
Environmentally friendly fishing gear categories
IRF ≤ 25% : fishing gear is not environmentally friendly
IRF >25% - 50% : fishing gear is less environmentally friendly
IRF >50% - 75% : fishing gear is quite environmentally friendly
IRF >75 % : very environmentally friendly fishing gear

RESULTS AND DISCUSSION

Characteristics of the Bagan Tancap Fishing Gear in Rebo Waters, Bangka Belitung

Bagan tancap is a fishing tool which is classified as a fixed fishing tool (*stationary fishing gear*), operated in one location without moving during fishing activities. In the waters of Rebo, Bangka Regency, Bangka Belitung Islands Province, the fixed lift net is generally operated for approximately 12 hours, from afternoon to morning. The operating system of this tool utilizes the positive phototactic properties of aquatic organisms by using lights as a fishing aid, thus effectively attracting fish and marine biota that are active at night. The relatively calm and productive conditions of the Rebo coastal waters support the sustainable operation of this fishing gear.

The main target of the catch from the fixed net in these waters is anchovies (*Stolephorus spp.*) and squid (*Loligo spp.*.), which includes small pelagic groups and nekton that live in the upper to middle water layers. The dominance of the catch indicates that the fixed lift net has quite good selectivity for small to medium-sized organisms. From the construction and operation aspects, the fixed lift net is considered relatively environmentally friendly because it is stationary and operates in shallow waters, however, the catch is greatly influenced by environmental conditions such as weather, tides, and moonlight intensity, so that proper management is needed to maintain the sustainability of fish resources (Brandt, 1984; Subani & Barus, 1989; Sudirman & Mallawa, 2012). Determining the level of environmental friendliness of the fixed lift net fishing gear operating in Rebo waters can be done through a scoring assessment based on technical aspects as well as biological and environmental aspects.

Analysis of the Environmental Friendliness of Floating Bagan Fishing Gear

This study assesses the environmental impact of the fixed-net fishing gear. The assessment was conducted using relevant indices to measure the gear's environmental friendliness. The results of the index calculations are presented in Table 2.

Table 2. Assessment of the environmental friendliness index of the Bagan Tancap fishing gear

No.	Criteria	Score	Shoes Max	Shoes

I.	**TECHNICAL ASPECTS**		
1.	Do not endanger fishermen and other people at sea	3	3
2.	Energy saving	3	2
3.	Quantity Producing Pollution (Polluting Materials)	3	3
4.	Materials for making fishing gear	3	3
5	The level of vulnerability of a fishing gear	3	3
II.	**BIOLOGICAL AND ENVIRONMENTAL ASPECTS**		
1.	Selectivity (Composition of fish caught)	3	1
2.	Proportion of catch utilized	3	2
3.	Treatment of fish and marine biota returned to the sea (discard)	3	3
4.	Cases of the capture of protected species of biota	3	3
5.	Potential damage to the aquatic environment and habitat	3	3
	Shoes	**30**	**26**
	IRF	**86,67 %**	

Source: processed research data

Based on the assessment results of the technical and biological-environmental aspects, the fixed lift net fishing gear operated in Rebo Waters, Bangka Belitung Islands Province, obtained a total score of 26 out of a maximum score of 30 with an Environmentally Friendly Index (IRF) value of 86.67%, thus being categorized as a very environmentally friendly fishing gear. These results are in line with various studies in Indonesian coastal waters which state that passive and fixed fishing gear have a relatively lower ecological impact than active fishing gear. Yusfiandayani et al. (2017) and Fitri et al. (2019) explain that fixed lift nets do not cause physical disturbance to the waterbed, have a low energy consumption level, and have a low risk of causing fish damage.*ghost fishing*. In addition, the high score on the criteria*discard*The absence of cases of capture of protected biota supports the findings of Lestari and Nugroho (2021), who stated that passive fishing gear allows non-target biota to be returned to the waters alive. However, the low selectivity of the catch, as reflected in the assessment results, is also in line with Baskoro et al. (2016), who stated that the use of light on lift nets tends to result in mixed catches. Overall, the results of this study confirm that lift nets are environmentally friendly fishing gear and support the principles of sustainable capture fisheries, although management efforts are still needed to increase catch selectivity. This assessment was obtained based on an evaluation of criteria covering technical aspects, biological aspects, and environmental aspects.

TECHNICAL ASPECT ANALYSIS

Do Not Endanger Fishermen And Other People At Sea

The criterion of not endangering fishermen and other water users during the operation of fixed lift nets in Rebo Waters, Bangka Belitung Islands Province, received a score of 3 (Table 2). This indicates a good level of operational safety. Regarding crew safety sub-criteria, fishermen generally have adequate work experience and skills, supported by good physical condition and the ability to*self rescue*as initial mitigation of emergencies at sea. The availability of safety equipment and the implementation of routine maintenance of

propulsion engines before and after operations reflect the application of occupational safety principles in line with responsible small-scale fisheries (FAO, 2019).

In the sub-criteria for fishing gear safety, fixed nets are managed through regular maintenance, equipped with fishing gear markers, and have a risk*ghost fishing*Low risk of fishing gear loss is achieved because the gear is not left damaged or uncontrolled. Post-operational gear security also reduces the potential for disruption to shipping and other water users. This practice aligns with the principles of safe and sustainable fishing gear management (Gilman et al., 2016; FAO, 2021).

Energy saving (Fuel Consumption)

The energy-saving criteria for operating fixed lift net fishing gear in the Rebo Waters, Bangka Belitung Islands Province, demonstrate a relatively good level of environmental friendliness. In the fuel consumption sub-indicator, fixed lift net fishing gear is classified as energy-efficient because in one operating trip it only consumes approximately 10 liters of diesel fuel with an operating duration of approximately 12 hours. This low fuel consumption is due to the fixed nature of fixed lift net fishing gear, so energy requirements are only used for supporting activities, such as lighting and limited engine operation. This condition indicates that fixed lift net fishing gear is higher in energy efficiency than active fishing gear that requires intensive vessel movement (Iskandar et al., 2017; Rahmat et al., 2020). However, the final energy-saving score was 2 (Table 2) because the use of alternative energy, fixed lift net fishing gear in the Rebo Waters, has not implemented renewable energy sources. All operational energy needs still rely on fossil fuels, although various studies have shown that the use of solar panels in small-scale fisheries has the potential to increase energy efficiency and support sustainable capture fisheries (Putra et al., 2019; Suryanto & Nugroho, 2022).

Quantity Producing Pollution (Polluting Materials)

Subindicatornoise pollution And air pollution (engine exhaust)getscore 3(Table 2) which shows a relatively low level of environmental disturbance. The low noise level is reflected in operational conditions where the crew (ABK) can still communicate normally at a distance of less than 2 meters without increasing the volume of their voices, which is influenced by the characteristics of the fixed lift net which does not require continuous engine operation. In addition, the air pollution produced is also very minimal because the propulsion engine is only used in the preparation and post-operation stages, while during the main fishing process the engine is in an inoperative condition, so that smoke exposure to the crew and the aquatic environment is relatively low. These conditions indicate that the lift net meetsnoise and air pollution control criteriaas an indicator of environmentally friendly fishing gear and supports the implementation of sustainable capture fisheries (Pratama et al., 2018; Wibowo & Yusfiandayani, 2021; Kurniawan et al., 2019; Lestari et al., 2023).

Materials for Making Fishing Gear

The materials used to make fixed lift net fishing gear in the Rebo Waters, Bangka Belitung Islands Province, consist of natural and synthetic materials, with natural materials dominating by more than 50%, while synthetic materials are used in a proportion of 25–50%. The dominance of natural materials, such as wood and bamboo, indicates that the construction of fixed lift nets relies on local materials that are relatively environmentally friendly and have a lower ecological impact than synthetic materials, as long as they are procured in a controlled manner and do not originate from protected areas. The use of

synthetic materials, such as synthetic nets and other supporting components, is limited to increase the efficiency and durability of the fishing gear, thereby minimizing the potential for pollution and disruption to the aquatic ecosystem. Considering the composition of these materials, fixed lift nets in the Rebo Waters meet the criteria for environmentally friendly fishing gear in terms of manufacturing materials.**,**namely using materials with procurement that does not damage the environment or protected ecosystems, thus obtaining a final score of 3 (Table 2) (Fitri et al., 2017; Yusfiandayani et al., 2020; Kurnia et al., 2019; Lestari & Boesono, 2022).

Vulnerability Level of Fishing Gear

The fixed-net fishing gear operated in Rebo Waters, Bangka Belitung Islands Province, on the fishing gear vulnerability criteria obtained a score of 3 (Table 2) which indicates the potential for...*ghost fishing*The potential for fishing gear is relatively low. This low potential is due to the fixed nature of fixed nets (bagan tancap), which are permanently installed on the waterbed. Therefore, the likelihood of the gear coming loose, drifting, or being lost during operation is relatively small. This is supported by routine management, supervision, and post-operational security of the gear by fishermen. This condition aligns with research findings in Indonesia over the past ten years, which indicate that passive and fixed fishing gear have a high level of vulnerability.*ghost fishing*Lower than active fishing gear or fishing gear that is prone to drifting, due to the permanent construction of the gear, the use of location markers, and the high maintenance intensity (Yusfiandayani et al., 2016; Kurnia et al., 2019; Lestari & Nugroho, 2021). Thus, the fixed lift nets in Rebo Waters meet the criteria for environmentally friendly fishing gear in terms of vulnerability.*ghost fishing*and support responsible and sustainable capture fisheries.

ANALYSIS OF BIOLOGICAL AND ENVIRONMENTAL ASPECTS

Selectivity: Composition of Fish Caught

Based on biological and environmental aspects, the selectivity criteria for fishing gear showed low performance with a final score of 1 (Table 2), thus not meeting the criteria for environmentally friendly fishing gear in terms of catch selectivity. Fixed lift nets produced diverse and mixed catches because the use of light as a fishing aid attracted various types of fish and aquatic biota that exhibit a positive phototactic response. Furthermore, the sub-indicator for catchable size (*legal size*), most of the fish caught do not meet the recommended biological size, thus potentially increasing the risk*growth overfishing*if it continues. Low selectivity is also indicated by the continued capture of non-target species alongside the main target species. This condition confirms that lift nets in Rebo Waters require further management, particularly through regulating mesh size and fishing operation times, to increase selectivity and support the sustainability of fish resources (Baskoro et al., 2016; Yusfiandayani & Wibowo, 2020; Fitri et al., 2019; Kurnia et al., 2022; Lestari & Boesono, 2023).

Proportion of Catch Utilized

Based on the criteriaproportion of catch utilization, the fixed net in Rebo Waters, Bangka Belitung Islands Province, is classified asquite environmentally friendly with score 2 (Table 2)**.**In the sub-indicator of primary catch utilization, most of the catch is optimally utilized for consumption and marketing, resulting in a relatively low level of discarded catch. However, in the sub-indicator of bycatch (*by-catch*), fixed nets received lower scores because bycatch consisted of several types and only some of them had economic value and were utilized optimally. This condition indicates that although the utilization of the main

catch has met the criteria for environmentally friendly fishing gear, increasing utilization*by-catch*is still needed to reduce the potential for resource waste and support responsible and sustainable capture fisheries (Yusfiandayani et al., 2017; Kurnia et al., 2019; Lestari et al., 2022).

Treatment of Fish and Marine Biota Returned to the Sea (*Discard*)

Level assessmentenvironmental friendlinessfixed-line fishing gear based on criteriaproportion of catch utilizationshow performancequite environmentally friendly with final score 2 (Table 2). In the sub-indicator of primary catch utilization, most of the catch is optimally utilized for consumption and marketing, so that the level of catch discard is relatively low. However, in the sub-indicator of bycatch (*by-catch*), its utilization is still limited because bycatch consists of several types and only some of them have economic value and are utilized optimally. This condition shows that although the utilization of the main catch has met the criteria for environmentally friendly fishing gear, the increase in utilization*by-catch*is still needed to reduce the potential for resource waste and support responsible and sustainable capture fisheries (Yusfiandayani et al., 2017; Kurnia et al., 2019; Lestari et al., 2022).

Cases of Capture of Protected Biota Species

The environmental friendliness of the fixed lift net fishing gear operated in the Rebo Waters of the Bangka Belitung Islands Province, based on the criteria for the capture of protected species, obtained a score of 3, indicating no cases of protected species being captured during fishing activities. This condition reflects the low risk of interaction of fixed lift nets with marine biodiversity, which is related to the characteristics of fishing gear that is passive, stationary, and has a limited operating range. This finding is consistent with the results of various studies in Indonesian waters over the past ten years that state that passive fishing gear has a lower potential to capture protected biota than active fishing gear. Thus, the fixed lift net in the Rebo Waters meets the criteria for environmentally friendly fishing gear in terms of protecting protected biota and supporting the sustainability of marine biodiversity (Yusfiandayani et al., 2017; Fitri et al., 2019; Lestari & Nugroho, 2021).

Potential for Damage to the Aquatic Environment and Habitat

Level assessmentenvironmental friendlinessfixed-net fishing gear operated in Rebo Waters, Bangka Belitung Islands Province, based on criteriapotential damage to aquatic environments and habitats, getscore 3 (Table 2)which indicates that fishing methods and operations do not cause damage to the aquatic ecosystem. This condition is influenced by the characteristics of fixed lift nets (bagan tancap), which are stationary, not actively operated, and do not come into direct contact with the waters bottom, resulting in relatively low pressure on aquatic habitats and the environment. This finding aligns with research in Indonesia, which states that passive fishing gear has minimal ecological impacts and supports the sustainability of coastal aquatic ecosystems. Therefore, the lift nets in Rebo Waters meetcriteria for environmentally friendly fishing gearfrom the aspect of habitat and aquatic environment protection (Yusfiandayani et al., 2017; Fitri et al., 2019; Lestari & Boesono, 2023).

CONCLUSION

Based on the results of the assessment of technical aspects as well as biological and environmental aspects, the fixed net fishing gear operated in Rebo Waters, Bangka Belitung Islands Province, is included in the category of fishing gear.very environmentally

friendlywith an Environmentally Friendly Index (IRF) value of 86.67%. The characteristics of the passive and fixed bagan tancap, relatively low energy use, minimal potential*ghost fishing*, and the absence of cases of the capture of protected biota indicates that this fishing gear has a low ecological impact on the aquatic environment. In addition, the treatment of the catch returned to the sea (*discard*) is considered good because most of the non-target biota are still alive. However, catch selectivity is relatively low due to the use of light, which results in a mixed catch, so further management is needed, particularly through adjusting mesh size and operating times. Overall, lift nets have the potential to support responsible and sustainable capture fisheries management in the Rebo Waters.

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