The impact of mini trawl (arad) fisheries based on fish and social resources in Cilincing, Jakarta Bay

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Abstract. Mini trawl fisheries is a fishing method typically used in small to medium-scale fisheries. It involves using a net with meshes large enough to prevent fish from getting trapped. However, using mini trawl can significantly impact the aquatic environment, including the waters in Cilincing, North Jakarta, Indonesia. This study has two objectives: (1) Determine the level of sustainability of mini trawl in Cilincing waters and (2) identify fishermen's perceptions of using mini trawl. The analysis method used in this research is by conducting interviews and the EAFM (*Ecosystem Approach to Fisheries Management*) approach. The ecosystem approach to fisheries management ensures the sustainability of fisheries. The results of this study show that the sustainability of mini trawl use in Cilincing is moderate. This result was obtained using the EAFM approach. The value obtained from the composite analysis of each domain in the EAFM indicator is 60.67, which is classified as moderate. Most (50%) of the set net fishermen in Cilincing waters showed a positive perception (in favor) of using set nets for fishing, and the remaining 40% were neutral, and 10% disagreed. The impact are fishing using mini trawls in Cilincing waters still maintains sustainable fish resources.

1 Introduction

One of the government's efforts to maintain the sustainability of marine resources is to issue Ministerial regulations governing the use of trawls as stipulated in the Minister of Marine Affairs and Fisheries Regulation No. 18 of 2021 [1]. The definition of *trawls* based on the Indonesian National Standard 01-7233-2006 is a fishing gear consisting of two trawl wing, the body, and the trawl bag.

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Various types of fishing gear, such as lift nets, set nets, traps, gillnets, seine nets, and mini trawls, are operated in Jakarta Bay [2]. In 2022, fish production landed at the Cilincing fish auction was 2,927,046kg and valued at Rp 88,218,904,500 [3]. Mini trawl fishing in Cilincing, North Jakarta, is one of the fishing activities commonly conducted by local fishermen. This fishing practice is primarily carried out to meet the daily needs of fishermen and local communities. However, as in many other places, the mini trawl in Cilincing also has the potential to cause negative impacts if not appropriately managed. The first aspect to consider regarding the mini trawl fishery in Cilincing is the sustainability of fish resources. Regarding this, the monitoring and management of fish resources are important to prevent overfishing. These measures include setting fishing quotas, minimum sizes for catchable fish, and appropriate fishing seasons. Selective nets can reduce the impact of bycatch or capture of non-target fish. Therefore, fishermen can optimize the net designs to reduce the capture of unwanted fish. The second aspect to be considered is marine habitat management. As mini trawling can damage seabed habitats, measures must be taken to minimize this damage, such as avoiding vulnerable areas and protecting coral reefs and seaweeds. This issue can be addressed by encouraging the diversification of local fishers' livelihoods, which could be a good solution. This could include training fishers in other sustainable fishing practices or developing sustainable marine resource-based economic ventures.

According to the latest Minister of Marine Affairs and Fisheries Regulation number 36 of 2023 [4] concerning the placement of fishing gear and fishing aids, mini trawls are not categorised as prohibited fishing gear in Indonesia. However, it was banned in 2015 through the Minister of Marine Affairs and Fisheries Regulation number 2 of 2015 [5], and starting in 2016, the fishing gear are again allowed in all fisheries management areas of the Republic of Indonesia. The permit to operate mini trawl is limited to the fishing vessel with a maximum tonnage of 5 GT.

The development of capture fisheries activities in the Cilincing area, characterized by the increasing number of fishermen, which give pressure on capture fisheries in Cilincing waters due to the large number of fishing operations in the Cilincing area [6]. Increased pressure on capture fisheries may have a negative impact on existing fisheries resources. If left unchecked, the sustainability of capture fisheries in the Cilincing area will be at risk. Therefore, assessing the sustainability of the existing capture fisheries activities in Cilincing waters is necessary before the fish resources are overfished. In addition, data limitations are also common in small-scale fisheries. The lack of data recording for small-scale fisheries statistics, due to the absence of enumerators in Cilincing, also warrants attention. Hence, the utilization of small-scale fisheries statistics has yet to be maximized as initial information in sustainable fisheries management. With the study of the sustainability of fisheries activities in the research location, it is expected that information related to the level of sustainability of capture fisheries activities in Cilincing waters will be obtained to be used as a reference in making policies for future fisheries management. This study aims to determine the sustainability level of mini trawl fishery activities in Cilincing waters and identify fishers' perceptions of using mini trawl.

2 Material and method

2.1 Research location and times

The research was conducted from January to May 2024 at the Cilincing fish auction site, North Jakarta (Figure 1). Data was collected covering two domains: the fish resource domain and the fishing technique domain.

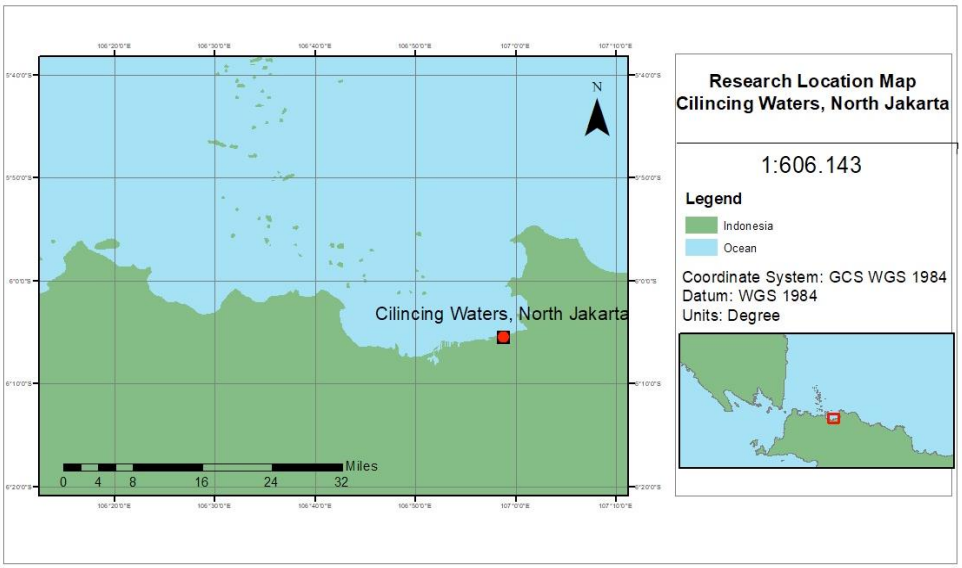

Fig. 1. Research Location in Cilincing, North Jakarta.

Each domain has indicators used to assess its sustainability level. Information collection through interviews was conducted using questionnaire. A total of 15 fishermen were selected as key informants in this study using a purposive sampling technique. Further data collection was obtained from the Marine and Fisheries Agency. The types of data used to assess the sustainability level of mini trawl fisheries in Cilincing using the EAFM approach can be seen in Table 1.

Table 1. Types of data and collection methods used to assess the sustainability of the mini trawl fishery in Cilincing.

Domain/Aspect Fish resources			
	Indicator	**Definition / Explanation**	**Data Collection**
1	CPUE	It is the catch per unit of fishing effort.	*Logbooks*, Observers for at least 2 years from the fishery unit under study.
2	Proportion of juvenile fish caught	The percentage of fish caught before reaching *maturity*.	Sampling
3	Species composition of the catch	Utilized and unutilized target species	*Logbook,* survey, and monitoring
4	*Range collapse of* fish resources	Increasingly distant fishing grounds	Survey and monitoring, *logbook*, observation,

			and interview
Domain/Aspect of Fishing Techniques			
	Indicator	**Explanation**	**Collection**
1	Effect of fishing gear operation on the environment	More than 50% of the water bottom is damaged 25-50% of the water bottom is damaged <25% water bottom is damaged	Interview
2	Modification of fishing gear and fishing aids	Use of fishing gear and aids that harm fish resources	Observer, sampling of target fish size/ dominant fish, Lm size based on literature study
3	Capture selectivity	Fishing activity is associated with a diversity of catches from the use of existing fishing gear.	Capture fisheries statistics, *logbooks*, and surveys

2.2 Data Analysis

Analysis of the level of sustainability of mini trawl fisheries activities in Cilincing waters was conducted using the EAFM (*Ecosystem Approach to Fisheries Management*) approach. The composite approach to be used is a simple composite approach using the MCA (*multi-criteria analysis*) approach in which a criterion is developed to analyse the behavior of fisheries management through the development of a composite index with several stages referring to Budiarto [7]. The assessment of the fish resource domain includes four indicators: CPUE, the proportion of juvenile fish caught, species composition of the catch, and *range collapse of* fish resources. The fishing technique domain assessment includes three indicators: operation of fishing gear against the environment, modification of fishing gear, and selectivity of fishing [8]. The assessment criteria and weights for each indicator can be seen in Table 2.

Table 2. Assessment criteria, scores, and weights of fish resource and fishing technique domain indicators [9].

Domain of Fisheries resource				
No	Indicator	Criteria	Score	Weight
1.	CPUE	Sharp decline (average decline >25% per month	1	
		Slight decline (average decline <25% per month)	2	40
		Stable or increasing	3	
2.	Proportion of juvenile fish caught	A lot (>60%)	1	
		Many (30-60%)	2	15
		Little (<30%)	3	
3.	Species composition of the catch	Less proportion target (< 15% of total volume)	1	
		Proportion of targets equal to non-targets (16-30% of total volume)	2	10
		Greater proportion	3	
4.	*Range collapse* of fish resources	Increasingly difficult depending on the target species	1	
		Relatively fixed depending on target species	2	10
		Getting easier depending on the target species	3	
Domain of fishing techniques				

Domain of Fisheries resource				
1.	Operation of fishing gear on the environment	More than 50% of the water bottom is damaged 25-50% of the water bottom is damaged <25% water bottom damaged	1 2 3	30
2.	Modification of fishing gear ang fishing aids	More than 50% of the target species size <Lm 25-50% target species size <Lm <25% target species size <Lm	1 2 3	25
3.	Capture selectivity	Low (75% of fish caught are non-target) Medium (50-70% of fish caught are non-target) High (<50% of fish caught are non-target)	1 2 3	15

The value is obtained by multiplying the score by the weight. The indicator with the highest weight indicates that it is the *main indicator* in a domain. In contrast, the indicator with the smallest weight indicates that it has a low level of importance in assessing a domain. Indicator values are divided into five categories that describe the level of fisheries management in each domain (Table 3).

Tabel 3. Domain value score boundaries.

Value Range			Description
≥ 33.33	-	≤ 46,17	Bad
≥ 46.67	-	≤ 59.5	Less
≥ 6	-	≤ 72.83	Medium
≥ 73,33	-	≤ 86.17	Good
≥ 86,67	-	≤ 100	Very

2.3 Perception analysis

Information on fishermen's perceptions of mini trawl was collected through several questions covering productivity, sustainability, and conflict (Table 4). Response options for perception were agreed (A), neutral (N), and disagree (DS). The score for agree (A) is 3, neutral (N) is 2, and disagree (DS) is 1.

Table 4. Fishermen's perception questions on the use of mini trawl.

No	Question
1	Use of mini trawl nets to catch fish
2	Fishermen's perception of mini trawl nets as environmentally friendly fishing gear
3	Fishermen's perceptions of catch productivity are influenced by the availability of fisheries resources in a body of water.
4	Fishermen's perception of continuous fishing of undersized fish, which will reduce the fish population in a body of water.
5	Fishermen's perception of continuous fishing of undersized fish, which will reduce the fish population in a body of water.
6	Fishermen's perception of the use of non-selective mini trawl will affect the number (volume) of catches.
7	Fishermen's perception of undersized fish, which should be released, because they may reduce the fish population.
8	Fishermen's perceptions of differences in catchability between mini trawl fishermen and other fishermen will lead to social conflicts between fishermen.

3 Results

3.1 Sustainability level of mini trawl fishery in Cilincing waters

The type of vessel is a typical 10 GT wooden boat with an *inboard* engine. The size of the vessels is generally the same, between 7-9 meters long, 2.5-3 meters wide, and 1-2 meters deep. The vessels are typically powered by a Dongfeng 24 HP motor. Each of them has one fish hold, with a capacity of 1 ton.

Indicators of the fish resources domain consist of CPUE, the proportion of juvenile fish caught, species composition of catches, and range collapses of fish resources. In contrast, the fish resources domain consists of the effects of fishing gear operation on the environment, modifications to fishing gear and fishing aids, and selectivity in fishing. The indicator values for each domain are shown in Table 5.

Table 5. Criteria for assessing indicators in the fish resource domain.

Domain of Fisheries resource					
No	Indicator	Criteria	Score	Weight	Indicator Value (score x weight)
1.	CPUE	Sharp decline (average decline >25% per month Slight decline (average decline <25% per month) Stable or increasing	1 2 3	40	40
2.	Proportion of juvenile fish caught	A lot (>60%) Many (30-60%) Little (<30%)	1 2 3	15	45
3.	Species composition of the catch	Less proportion target (< 15% of total volume) Proportion of targets equal to non-targets (16-30% of total volume) Greater proportion	1 2 3	10	10
4.	*Range collapse* of fish resources	Increasingly difficult, depending on the target species Relatively fixed, depending on the target species Getting easier depending on the target species	1 2 3	10	10
Domain of fishing techniques					
No	Indicator	Criteria	Score	Weight	Indicator Value (score x weight)
1.	Operation of fishing gear on the environment	More than 50% of the water bottom is damaged 25-50% of the water bottom is damaged <25% water bottom damaged	1 2 3	30	90
2.	Modification of fishing gear and	More than 50% of the target species size <Lm 25-50% target species size <Lm	1 2 3	25	50

	fishing aids	<25% target species size <Lm			
3.	Capture selectivity	Low (75% of fish caught are non-target) Medium (50-70% of fish caught are non-target) High (<50% of fish caught are non-target)	1 2 3	15	50

Overall, the sustainability level of mini trawl fisheries in Cilincing waters was moderate, with a composite analysis score of 60.67 across the two existing domains using an ecosystem approach (Table 6). The average value of each domain is in the medium category (60.67).

Table 6. Value of each domain of EAFM of mini trawl in Cilincing waters.

Domain	Domain value	Description
Fish resources	51,11	Less
Fishing techniques	70,24	Medium
Average aggregate	60,67	Medium

3.2 Perceptions of mini trawl fishermen in Cilincing waters

Small-scale fisheries in Jakarta Bay generally use mini trawls. One of the main problems in mini trawl fisheries is the low level of selectivity, which results in catches dominated by bycatch rather than targeted fish. This will undoubtedly have an impact on fish resources. Fishermen, who are the main stakeholders, need to understand the various aspects related to the use of mini trawl. For this reason, fishermen's perceptions were identified through eight questions covering the effectiveness of the mini trawl, resource sustainability, and social conflicts among fishermen (Figure 2).

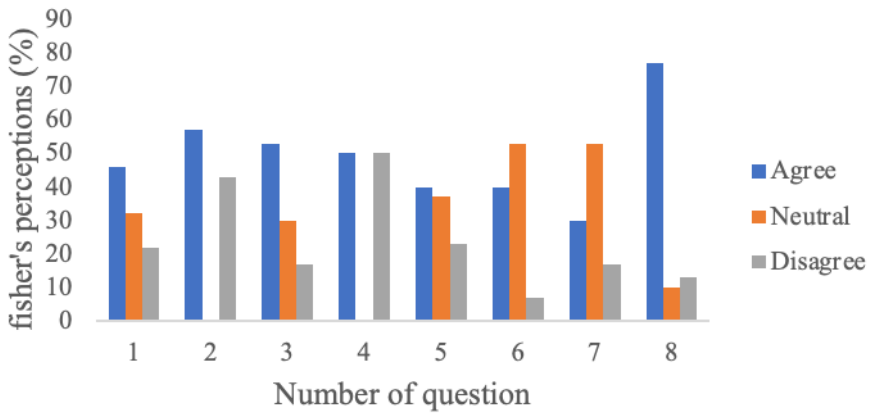

Fig. 2. Cilincing fishermen's perception of the mini trawl fishery in Cilincing waters, North Jakarta.

In total, 46% of 15 respondents stated that mini trawl are effective to catch the fish in Cilincing water, 32% stated that they are neutral towards the use of mini trawl for catching

fish, and the remaining 22% disagreed that the use of mini trawl is effective for catching fish (Question 1). As many as 57% of fishermen stated that mini trawl are environmentally friendly fishing gear, as long as it is not operated near the coast. The rest (43%) disagreed that using mini trawl is environmentally friendly because the gear can damage the habitat (Question 2). According to productivity (Question 3), 53% of fishermen reported that using mini trawls can produce more catches, thereby increasing catch productivity. Meanwhile, the other 30% of fishermen believe that the catch fluctuation is influenced by fish stock condition, which is highly dependent on weather and seasons. Good weather conditions (conducive) make it possible to catch fish in large quantities, while bad weather can make it difficult to catch fish in small quantities. The remaining 17% of fishermen did not agree that using mini trawls could increase catch productivity because the catches obtained so far could not be determined in size or quantity. Question 4 collected fishermen's perceptions regarding the effect of continuous catch of undersized catch on fish populations. Approximately, 50% of fishermen agree that mini trawl fishing gear affects fish population when undersized fish are found. Meanwhile, another 50% of respondents disagreed. Those who disagree believe that there are still many fish in a body of water because fish will never run out in the sea. Question 5 addressed fishers' perceptions of the effect of mini trawl use on catch volume. Results show that 40% of fishers perceived mini trawls as very effective in increasing catch volume, as a large number of fish can be captured in a single haul. In contrast, 37% of respondents expressed a neutral perception, acknowledging that catch volume is not determined solely by the operation of mini trawls but is also influenced by fish availability, weather conditions, and seasonal factors. Meanwhile, 23% of fishers disagreed that the use of non-selective mini trawls significantly affects catch volume. These respondents emphasized that different fish species exhibit distinct behavioral patterns; under certain conditions, fish may only pass through a fishing area or remain briefly, reducing the likelihood of being caught and, consequently, affecting total catch volume. Question 6 explored fishers' perceptions of government regulations on mesh size in mini trawl fisheries and their role in achieving sustainable fisheries management. The results indicate that 40% of fishers agreed that larger mesh sizes are necessary to reduce conflicts among fishers and to support the conservation of fish resources by allowing fish to grow and reproduce. More than half of the respondents (53%) expressed a neutral perception, reflecting uncertainty about the effectiveness of mesh size regulations in promoting sustainability. The remaining 7% disagreed that mesh size regulations contribute to sustainable fisheries management. Question 7 examined fishers' perceptions of releasing catches that do not meet the minimum catchable size. A proportion of fishers (30%) agreed with releasing undersized fish, as they believed this practice supports sustainable fisheries management and helps maintain fish stocks with higher economic value, which may ultimately increase fishers' income. However, the majority of respondents (53%) expressed a neutral perception, primarily due to limited knowledge and information regarding size regulations, which makes it difficult for them to determine whether a caught fish meets the legal catch size. The remaining 17% of fishers disagreed with the practice of releasing undersized catches. Question 8 focused on fishers' perceptions of whether differences in catchability between mini trawl fishers and other fishers could lead to social conflict. Most respondents (77%) believed that differences in catch levels caused by varying catchability between mini trawls and other fishing gears could potentially lead to social conflict among fishers. Meanwhile, 10% of fishers expressed a neutral perception, suggesting that conflict

may arise from social jealousy toward fishers using more advanced technology, depending on how individual fishers respond to declining catches. If such situations are managed appropriately and in accordance with existing regulations, conflicts may be avoided. The remaining 13% disagreed with the likelihood of social conflict, arguing that fishers generally accept technological differences as long as fishing practices comply with established rules and that catch levels largely depend on individual fishing effort.

The categorical value of perceptions regarding the use of mini trawl was obtained from respondents' responses using three categories (agree, neutral, and disagree). The qualitative answers were then quantified by giving a score value. Respondents who answered agree, neutral, and disagree were given a score of 3, 2, and 1, respectively. All answers were summed up based on each respondent. The fishermen's perception of the use of mini trawl based on the grouping of scores concluded that most of the fishermen respondents had a high level of perception with a percentage of 50% with nine respondents, a medium level of 5 people (40%) and a low level of 2 people (10%). The medium category is in the interval 20-22. Perception categories based on respondents' answers can be seen in Table 7.

Table 7. Perception categories based on respondents' answers.

Perception categories	Number of respondents	Interval	Percentage (%)
Low	2	<20	10%
Medium	5	20-22	40%
High	8	>22	50%
Total	15		100%

4 Discussion

Jakarta bay waters are included in the state fisheries management area of the Republic of Indonesia 712. Most of the main fish resource commodities in WPPNRI 712 are in fully exploited status (reef fish, panaeid shrimp, lobster, crab, and squid), some fish groups are at overexploited (large pelagic fish and demersal fish) and moderate (small pelagic fish) utilization levels [10]. Fishery management focuses solely on the target species, without considering interactions or relationships among the various aspects of the ecosystem.

The perception of fishermen towards fisheries sustainability needs special attention because most fishermen feel that the existence of fish in the ocean is a gift from God that will not run out as long as the ocean still exists. This perception needs to be changed gradually through community leaders' approaches and education for fishermen and their descendants. In addition, fishermen also need to learn the size of fish that is worth catching and not worth catching so that fish obtained in a dead condition is impossible to throw into the sea so that it is used for sale and daily consumption.

For this reason, it is necessary to conduct education by related parties so that fishermen know the size of catchable and non-catchable fish. Fishermen generally agree with government regulations regarding the size of mini trawls. However, there are still fishermen who need to learn the regulations on this matter, so the regulations need to be applied more effectively through education for fishermen. This activity will give insight into the science for fishermen so that the possibility of problems in fisheries management can be overcome and the condition of the aquatic environment is well maintained. This socialization activity is expected to increase fishermen's compliance with regulations. The application of this regulation is also an evaluation material for the government and related stakeholders in improving sustainable fisheries management. Concerning sustainable small-scale fisheries,

we should provide more evidence on the direction of the causal arrows: from nature to resource to the individual to culture to community, or in the opposite direction [11]. The government's lack of an education program will affect the pattern of community life, making it prone to social conflict. Weak government supervision ultimately leads to a lack of trust in the fishing community in government performance.

Counseling related to sustainable fisheries needs to be provided to build fishermen's knowledge and awareness and to ensure that fishery resources are available and well-maintained. Fishermen must know that undersized fish should not be caught and, if caught, must be released into the water. Therefore, the government should provide information on fishing seasons. Policy strategies for managing legal-size fishing can be implemented by regulating the fishing season based on the emergence of legal-size category fish and setting size quotas for legal-size category fish in each fishing area [7]. Based on these strategies, fishermen's skills and awareness level in conducting fishing operations can also be built. This can help fishermen conduct fishing operations so that the time used is effective and efficient. Increased coaching and counseling will increase the insight and knowledge of fishermen so that the quality of fishermen's human resources is improving, which in turn can increase income and get out of poverty.

Conflict between fishermen can occur due to strong social jealousy; for example, differences in the use of fishing technology between traditional and modern fishermen. This difference in the use of fishing gear can significantly affect catch rates. This is consistent with the findings that stated that disparities in fishing technology often trigger social conflicts between fishermen [12]. Traditional fishers usually want access to more advanced fishing technology but are limited by their limited capital compared to modern fishers. Based on this, traditional and modern fishermen compete to obtain fish resources, triggering social jealousy and stress due to decreased catches, creating social conflict between fishermen. Differences in fishing technology have the opportunity for social conflict between fishermen [13]. This is caused by social jealousy over the number of catches that eventually leads to protests manifested in physical attacks and the destruction of fishing boats. Therefore, the government must manage conflict with relevant parties, including the fisheries agency, fishing communities, community leaders, religious leaders, and local area managers.

5 Conclusion

The sustainability level of mini trawl fisheries activities in the Cilincing area was rated as moderate, with a score of 60.67. Most mini trawl fishers in this area (50%) support using mini trawl for fishing, while 40% are neutral, and 10% disagree. The impact are fishing using mini trawls in Cilincing waters still maintains sustainable fish resources.

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