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Analysis of Perception and Compliance of Sibolga Purse Seine Fishermen Based on Licensed Fishing Ground

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ABSTRACT

The purse seine fishery in Sibolga plays a vital role in fish production but faces challenges regarding compliance with licensed fishing ground regulations. Non-compliance, driven by economic pressure and declining fish stocks, threatens resource sustainability and fishermen's welfare. This study aimed to analyze fishermen's perceptions and compliance levels regarding the use of licensed fishing areas and their relationship to regulatory enforcement. The research was conducted from January-March 2024 at Sibolga Archipelago Fishing Port, North Sumatra, one of the main landing bases for purse seine vessels. Data were collected from 115 respondents, consisting of vessel captains and mates, using structured questionnaires and direct interviews. Observations and secondary data from fisheries institutions supported the primary data. Data were analyzed using descriptive statistics and the non-parametric Kruskal–Wallis test to determine differences in perceptions and compliance among fishing groups categorized by vessel tonnage and fishing zones. The results showed that fishermen's perceptions of potential fishing grounds and fish resource availability were relatively uniform across groups, indicating a shared view that fishing effort continues to expand to secure catches. In contrast, perceptions of VMS usage differed significantly, with the 30–100 GT small pelagic purse seine group acknowledging its role in detecting violations. Compliance levels also varied, with the 30–100 GT small pelagic purse seine operating in <12-mile zones showing the lowest compliance. It is concluded that stricter enforcement, effective monitoring, and targeted empowerment programs are necessary to enhance compliance and ensure sustainable fisheries management in Sibolga.

INTRODUCTION

Purse seine fisheries play an important role in supporting fish production in Indonesia, particularly in Sibolga, which is known as one of the main fishing ports on the west coast of Sumatra. This fishing gear is highly effective for catching pelagic fish species with high economic value. However, the increasing fishing effort and competition among fishermen have raised concerns regarding compliance with regulations, especially those related to the use of licensed fishing areas. The government has designated specific fishing zones through a licensing system to ensure the sustainability of fishery resources and minimize conflicts at sea. Nevertheless, indications of non-compliance, such as fishing outside the permitted areas, still frequently occur and may threaten resource sustainability as well as the welfare of fishing communities.

The main issue lies in the gap between policy implementation and fishermen's behavior. Some purse seine fishermen in Sibolga are suspected of fishing outside licensed areas due to declining fish stocks in permitted zones or economic pressures to obtain higher catches. This situation indicates that fishermen's perceptions of licensing policies, their level of understanding of the regulations, and socio-economic factors have a significant influence on their compliance. Furthermore, weak monitoring and limited law enforcement exacerbate this problem, making it essential to understand the factors affecting fishermen's adherence to regulations.

Previous studies have examined fishermen's compliance with fishery regulations from various perspectives. Sutanto (2019) found that compliance is greatly influenced by fishermen's understanding of the regulations as well as the effectiveness of monitoring and enforcement. Meanwhile, Rahmawati *et al*. (2021) emphasized that fishermen's perceptions of the benefits of regulations play an important role, where those with positive perceptions tend to be more compliant. However, studies that specifically link fishermen's perceptions with compliance in the context of licensed fishing areas for purse seine fisheries, particularly in Sibolga, remain very limited. Therefore, this research aims to fill the knowledge gap in small-scale fisheries management.

Based on the above description, the objective of this study is to analyze the perceptions and compliance levels of purse seine fishermen in Sibolga regarding the use of licensed fishing areas. The findings of this research are expected to provide valuable input for policymakers and stakeholders in formulating more effective strategies to enhance regulatory compliance, ensure sustainable fisheries management, and improve the welfare of fishing communities in Sibolga.

METHODS

Type of Research

This research is conducted from January-March 2024 at Sibolga Archypelago Fishing Port (Figure 1), North Sumatra Province, which serves as one of the main landing bases for purse seine vessels with high fishing activity. The selection of Sibolga Archypelago Fishing Port as the research location is based on the fact that every fishing vessel departing for and returning from fishing operations must report its arrival to the harbor master and fisheries supervisors at Sibolga Archypelago Fishing Port for inspection of the types and quantities of fish landed. Additionally, this location allows the researcher easier access to data related to the research problem.

This study is quantitative in nature and uses a descriptive method to determine the perceptions and factors influencing the compliance of purse seine vessels with licensed fishing areas. According to Whitney (1960) in Moleong & Lexy (2012), descriptive research is a fact-finding approach with accurate interpretation to understand attitudes, views, ongoing processes, and the effects of certain phenomena. The quantitative approach is carried out through a survey method. The survey method is a data collection technique conducted by asking questions to respondents in order to obtain information related to the research topic. Surveys are commonly used in social, economic, educational, and other research fields to understand opinions, behaviors, or characteristics of a population (Katsaras & Beto, 2024).

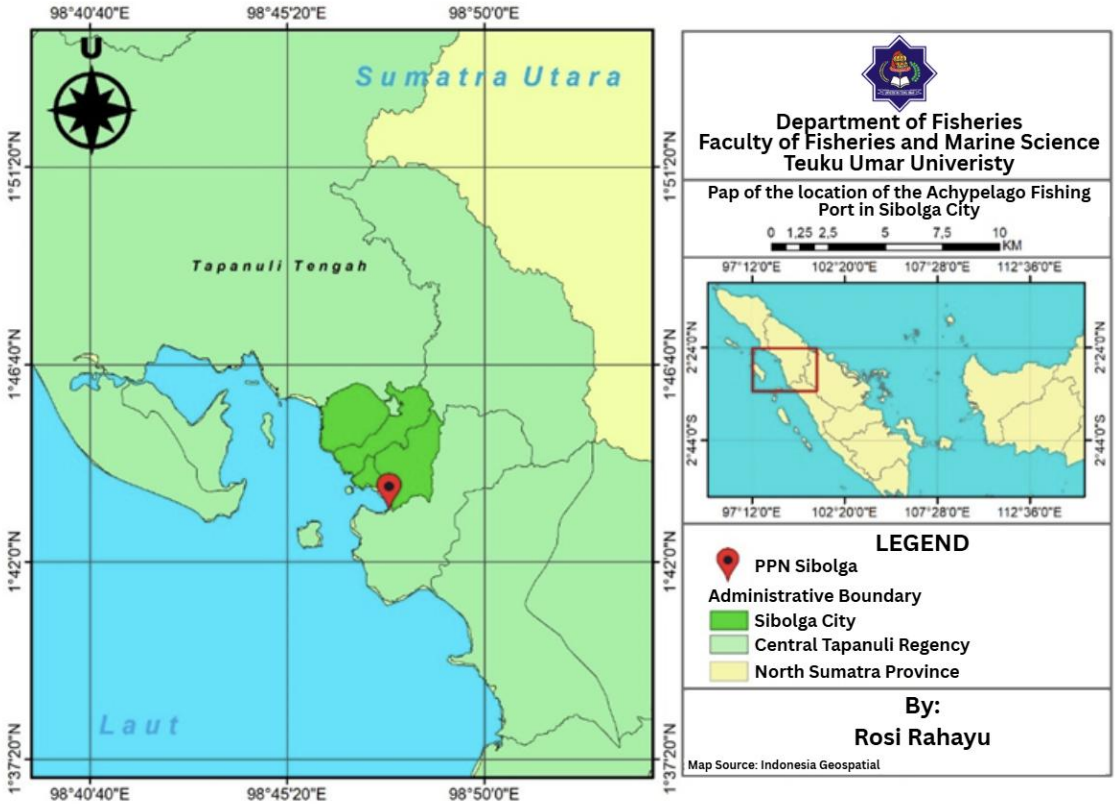

Figure 1. Research Location Map

Sources of Information

The data collected in this research consists of primary and secondary data. Primary data are collected from questionnaires distributed to respondents, who are purse seine fishermen at Sibolga Archypelago Fishing Port. The study population consists of purse seine vessels over 30 GT, which are required to use and install VMS onboard. In 2022, there were 190 fishing vessels over 30 GT based at Sibolga Archypelago Fishing Port (PSDKP Sibolga, 2022). Secondary data include literature studies on regulations governing fishing areas and data obtained from relevant institutions. These data consist of the number of purse seine vessels based at Sibolga Archypelago Fishing Port and productivity data of purse seine catches over the last five years.

The respondents sampled in this study are the captains (skippers) and vice-captains (mates) of purse seine vessels in Sibolga City. Captains were chosen as respondents because they are primarily responsible for fishing operations, including determining fishing areas. The mates were also included as respondents because they serve as the captain's deputies during fishing activities.

The sampling technique used is incidental sampling, targeting captains and mates encountered at the research site. The sample size was determined based on sample size requirements, where the minimum number of samples is 100 or approximately five times the number of indicators (Santoso, 2018). With 23 indicators in the structural model, the number of respondents interviewed is 115.

Research Instruments

The research instrument is a tool or facility used by the researcher to collect data in a way that makes the work easier, more accurate, complete, and systematic, thus simplifying data processing (Arikunto, 2010). Data collection is carried out through interviews supported by a survey instrument in the form of a written questionnaire with pre-provided alternative answers. The questionnaire is distributed to 115 respondents consisting of captains and mates of purse seine vessels in Sibolga City.

The measurement scale used in this study is the Likert scale**,** which is applied to measure attitudes, opinions, and perceptions of individuals regarding predetermined social phenomena. The questions or statements in the questionnaire are answered using two methods: a Likert scale ranging from 1 to 5 (from “strongly disagree” to “strongly agree”) and a weighting system from the lowest to the highest score.

Data Collection Procedures

Data collection is conducted over three months at PPN Sibolga and the PSDKP Sibolga office. Both primary and secondary data are collected through interviews and observations. Primary data collection through interviews is conducted directly with respondents using pre-prepared questionnaires. These interviews take place when purse seine vessels undergo inspections upon arrival from fishing operations or prior to departure at PPN Sibolga’s pier. The interviews aim to gather data on the socio-economic characteristics of purse seine fishermen, their perceptions of potential fishing areas, perceptions of fish resource availability, perceptions of VMS use, compliance with fishing area regulations, and factors influencing compliance with these regulations. Additional relevant information is also collected through these interviews.

Primary data from observations are collected by monitoring the distribution of purse seine vessels operating in the waters off the west coast of Sumatra and landing their catches at PPN Sibolga. This includes recording vessels suspected of violating fishing area regulations and identifying the types of violations committed. Secondary data are collected through literature studies and institutional surveys, covering: a) The number of purse seine vessels based at Sibolga Archypelago Fishing Port; b) The fish production landed by purse seine vessels at Sibolga Archypelago Fishing Port over the last five years.

Data Analysis

The data analysis to be used in this study will be adjusted to the research objectives. The objectives, types of data, data collection methods, and data analysis are presented in Table 1 below.

Table 1 Objectives, Types of Data, Data Collection Methods, and Data Analysis

Objective	Types of Data	Data Collection Methods	Data Analysis
To analyze the perceptions and compliance of purse seine fishermen	Primary Data: • Fishermen’s perceptions of	Conducted through interviews using a structured questionnaire with	Comparative analysis.

Objective	Types of Data	Data Collection Methods	Data Analysis
based on Fishing Grounds in accordance with business licensing.	potential fishing grounds • Fishermen's perceptions of the availability of fishery resources • Fishermen's perceptions of the use of VMS • Fishermen's compliance with regulations	115 respondents consisting of purse seine vessel captains and mates. Data collection employed a questionnaire with two measurement methods: a Likert scale (interval 1–5) ranging from "strongly disagree" to "strongly agree," and weighting from the lowest to highest score.	

Data Analysis of Fishermen's Perceptions and Compliance with Regulations

The data analysis used for fishermen's perceptions involves a comparative analysis of perceptions regarding the criteria for potential fishing grounds, perceptions of fishery resources, perceptions of VMS usage, and fishermen's compliance with fishing area regulations. If the collected data is not normally distributed, the comparative analysis will use the non-parametric Kruskal-Wallis test (Walpole, 2005). This test will be conducted on the average scores of perceptions and compliance of purse seine fishermen in each fishing area.

Data processing and testing using the Kruskal-Wallis test will be carried out with Microsoft Office Excel and IBM SPSS Statistics 26. The decision-making is based on comparing the probability value (p-value) with a significance level of 0.05; if the p-value is less than 0.05, the null hypothesis is rejected.

Hypothesis testing:

H_0 : There is no difference in perception or compliance among groups of fishermen based on licensed fishing grounds (DPI).

H_1 : At least one pair of fishermen groups based on DPI has different perceptions or compliance levels.

RESULTS

Data Analysis of Fishermen's Perceptions and Compliance with Regulations

a. Perceptions of Purse Seine Fishermen on Potential Fishing Grounds (DPI)

The analysis of perception data regarding the criteria for potential fishing grounds (DPI) was measured through interviews using a structured questionnaire administered to 115 respondents, all of whom were purse seine vessel captains based at PPN Sibolga. The distribution of respondents according to their perceptions of potential fishing grounds can be seen in Figure 2.

Based on Figure 2, there are two (2) out of six (6) criteria for potential fishing grounds with the highest scores. A total of 61 respondents rated the criterion of species composition or catch composition at weight 2, indicating that the catch consisted of three species with

significantly different sizes. Furthermore, 50 respondents rated the criterion of accessibility to fishing spots at weight 2, indicating that it is often difficult to reach the fishing spots.

Jatmiko *et al*. (2020) explained that skipjack tuna caught by large and small pelagic purse seine vessels in WPP 572 were mostly immature, with a proportion of 80%. Even more striking, yellowfin tuna caught in WPP 572 were 99% immature. Purse seine fisheries have now expanded their fishing grounds beyond archipelagic and territorial waters, reaching the Exclusive Economic Zone (EEZ) and even the high seas (Atmaja *et al*., 2014).

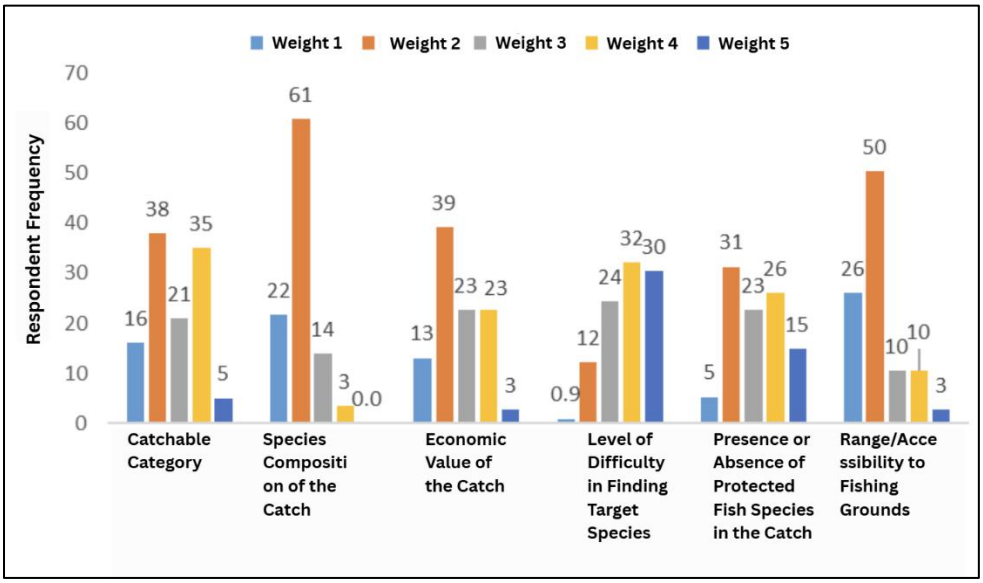

Figure 2. Distribution of Fishermen's Perceptions of Potential Fishing Grounds (DPI)

The fishing grounds for small pelagic purse seines based in Sibolga are located in the waters off the west coast of Sumatra, Mentawai Island, Nias Island, and Sinabang Island. The travel time from the base to the fishing spots for small pelagic purse seines is estimated to be between 7 and 13 hours, with fishing trips lasting 7 to 15 days. The target catch of small pelagic purse seines is small pelagic fish resources. Simbolon (2011) stated that small pelagic fish inhabit coastal waters where environmental conditions are more dynamic compared to oceanic waters. Fishing pressure affects the dynamics of small pelagic fisheries because their habitat is in coastal areas that are relatively easy to access by fishing fleets.

Small pelagic purse seine vessels targeting mackerel with a size of 98 GT based in Sibolga have fishing grounds as far as 70 miles from the outer coast of Sumatra. Meanwhile, large pelagic purse seine vessels ranging from 131 to 149 GT based in Sibolga have fishing grounds predominantly in the EEZ and high seas (Jatmiko *et al*., 2020). Currently, most fishermen frequently face difficulties in reaching fishing spots due to the increasingly expanded fishing areas. Simbolon (2011) explained that large pelagic fish generally live in offshore waters and are capable of year-round long-distance migrations. Groups of large pelagic fish such as tuna, skipjack, and mackerel are categorized as highly migratory species.

Based on the results of the Kruskal-Wallis test, the chi-square value was 5.30 with a degree of freedom (df) of 2 and an asymptotic significance (p-value) of 0.07. The p-value is greater than the significance level of 0.05, thus the decision is to accept the null hypothesis (H0) and reject the alternative hypothesis (H1). The conclusion is that there is no difference in perceptions among fishermen groups based on the criteria of potential fishing grounds.

Table 2. Fishermen's Perceptions of Potential Fishing Grounds (DPI)

Tonnage (GT)	Type of Fishing Ground (TPI)	Number of Respondents	Perception Scores						Average	Remarks
			Y1.1	Y1.2	Y1.3	Y1.4	Y1.5	Y1.6		
30-100 (Pukat rapat)	Zone < 12 miles	25	3.12	1.92	2.84	4.36	2.88	1.84	2.83	b
30-100 (Pukat tongkol)	Zone > 12 miles	45	2.82	2.16	2.8	3.78	3.17	2.51	2.88	a
100-300 (Pukat tongkol)	ZEE & high seas	43	2.56	1.87	2.31	3.49	3.24	1.91	2.56	a

Notes: Based on the scale range, Y1.1: Catchable Category; Y1.2: Species Composition of the Catch; Y1.3: Economic Value of the Catch; Y1.4: Level of Difficulty in Finding Target Species; Y1.5: Presence or Absence of Protected Species in the Catch; Y1.6: Range/Accessibility to Fishing Grounds

The results of the fishermen's perception test on potential fishing grounds (DPI) in Table 4.2 show that none of the groups exhibited differences in their perceptions regarding potential fishing grounds. The similarity in perceptions among the fishermen groups toward potential fishing grounds is based on the understanding that fishermen will continuously search for the presence of fish resources that can be harvested. Fishing grounds are strongly influenced by the dynamics of aquatic environments, which generally vary across regions and different periods (Simbolon, 2011).

Currently, the majority of both large and small pelagic purse seine fishermen have expanded their fishing grounds. This expansion aims to increase the number of fish caught, thereby boosting fishermen's income. Simbolon *et al*. (2009) explained that fishermen are expanding their fishing grounds to maintain the sustainability of fish resources, particularly in coastal areas, which requires the use of larger fishing vessels.

b. Fishermen's Perceptions of Fish Resources

The analysis of perception data on the criteria for the presence of fish resources was measured through the assessment of 115 fishermen based on four (4) criteria for fish resources. The distribution of respondents according to their perceptions of the presence of fish resources can be seen in Figure 3.

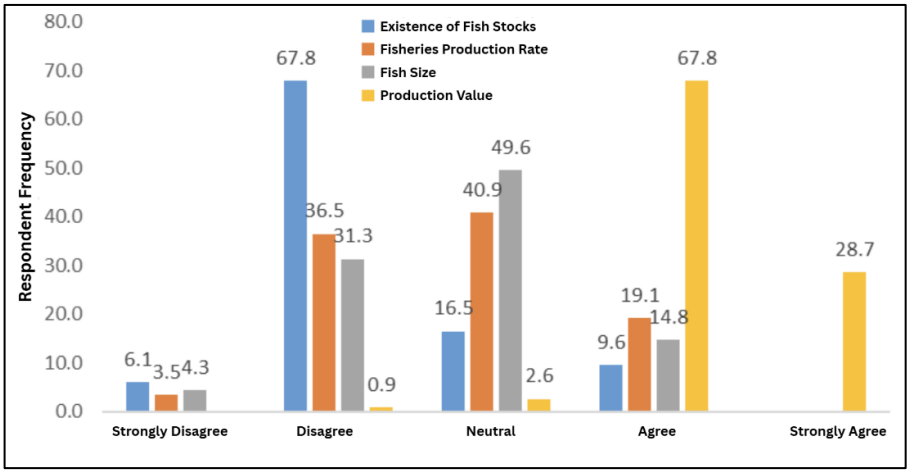

Figure 3. Distribution of Fishermen's Perceptions of Fish Resources

Based on Figure 3, it is known that the highest perception regarding fish resources is found in the sub-criterion of fisheries production value, where 67.8% of respondents answered "agree." Furthermore, 67.8% responded "disagree" to the sub-criterion of fish stock availability, and 49.6% responded "neutral" to the sub-criterion of fish size. The distribution of fishermen's perceptions of fish resource criteria shows that the majority of respondents agreed with the sub-criterion of fisheries production value. In contrast, the majority of respondents disagreed with the sub-criterion of fish stock availability.

The dominant assessment of respondents who agreed with the fisheries production value sub-criterion indicates that the catch obtained with high selling value is able to increase fishermen's income. On the other hand, the dominant perception of respondents who disagreed with the fish stock availability sub-criterion indicates that fishermen are currently fishing in more distant areas, requiring greater fishing effort. To ensure the presence of fish, detection efforts for fishing grounds are needed to support the success of fishing operations (Simbolon *et al*., 2009). Information on the presence of fish resources is one of the determining factors for successful fishing, in addition to other factors such as fishing vessels, fishing technology used, and the reliability of human resources.

One of the current difficulties experienced by purse seine fishermen is the constantly changing current conditions during fishing operations. Currents also influence the presence and abundance of fish in a particular water area. Based on the results of the Kruskal-Wallis test, the chi-square value was 3.55 with a degree of freedom (df) of 2 and an asymptotic significance (p-value) of 0.16. This p-value is greater than the significance level of 0.05, therefore the decision is to accept the null hypothesis (H0) and reject the alternative hypothesis (H_1). The conclusion drawn is that there is no difference in perceptions among fishermen groups based on the criteria of fish resource availability.

Table 3. Fishermen's Perceptions of Fish Resources

Tonnage (GT)	Type of Fishing Ground (TPI)	Number of Respondents	Perception Scores				Average	Remarks
			Y2.1	Y2.2	Y2.3	Y2.4		
30-100 (Pukat rapat)	Zone < 12 miles	25	2.12	2.08	2.76	2.48	2.36	a
30-100 (Pukat tongkol)	Zone > 12 miles	45	2.29	2.22	2.78	2.80	2.52	a
100-300 (Pukat tongkol)	ZEE & high seas	43	2.42	2.49	2.73	2.84	2.62	a

Notes: Based on the scale range, Y2.1: Existence of Fish Stocks; Y2.2: Fisheries Production Rate; Y2.3: Fish Size; Y2.4: Production Value

The results of the fishermen's perception test in Table 3 indicate that none of the fishermen groups exhibited differences in perceptions regarding the availability of fish resources. The average perception scores of the three fishermen groups ranged between 2.36 and 2.62. According to Suman *et al*. (2016), the presence of small pelagic fish resources in WPP 572 covers the waters around Banyak Island to Simeulue Island and the waters west of Sibolga to the region of West Sumatra. Meanwhile, large pelagic fish resources are distributed across various water areas, especially offshore at depths of more than 100 meters.

Based on the Decree of the Minister of Marine Affairs and Fisheries Number 19 of 2022, the potential of small pelagic fish in the Indian Ocean off the west coast of Sumatra is 479,503 tons, with an allowable catch of 431,553 tons and a utilization rate of 0.2. Meanwhile, the potential of large pelagic fish in the Indian Ocean off the west coast of Sumatra is 438,877 tons, with an allowable catch of 219,439 tons and a utilization rate of 1.1.

c. Fishermen's Perceptions of the Use of VMS

The analysis of perception data regarding the use of VMS (Vessel Monitoring System) was measured through the assessment of 115 fishermen on three (3) criteria for VMS usage. The distribution of respondents according to their perceptions of VMS usage can be seen in Figure 4.

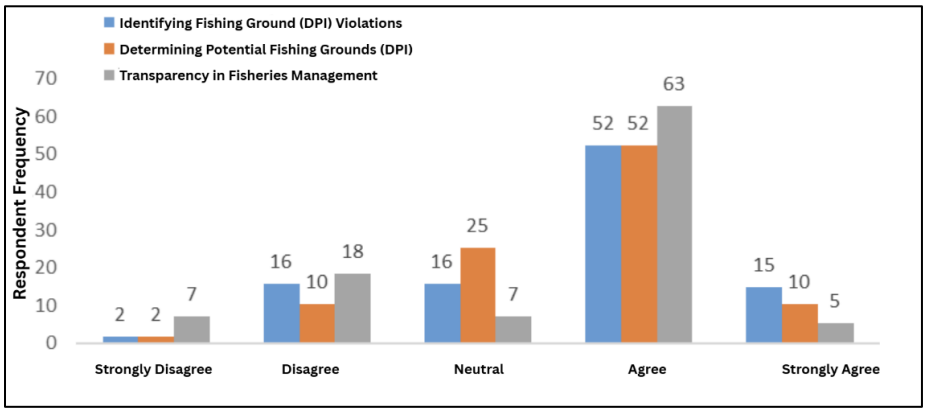

Figure 4. Distribution of Fishermen's Perceptions on the Use of VMS

Based on Figure 4, it is known that the majority of respondents gave an "agree" assessment toward the criteria for the use of VMS. An "agree" response was given by 63% of respondents for the sub-criterion of transparency in fisheries management, followed by 52% for the sub-criterion of identifying fishing ground (DPI) violations, and 52% for determining potential fishing grounds (DPI).

Tawaqal (2020) stated that the use of VMS can identify potential fishing grounds by analyzing the intensity of vessels operating in specific waters. Based on the results of the Kruskal-Wallis test, the chi-square value was 8.63 with a degree of freedom (df) of 2 and an asymptotic significance (p-value) of 0.01. This p-value is smaller than the specified significance level of 0.05, thus the decision is to reject the null hypothesis (H0) and accept the alternative hypothesis (H1). The conclusion drawn is that at least one group of fishermen has different perceptions based on the criteria for VMS usage.

Table 4. Distribution of Purse Seine Fishermen's Perceptions on the Use of VMS

Tonnage (GT)	Type of Fishing Ground (TPI)	Number of Respondents	Perception Scores			Average	Remarks
			Y3.1	Y3.2	Y3.3		
30-100 (Pukat rapat)	Zone < 12 miles	25	4.12	1.88	3.6	3.20	a
30-100 (Pukat tongkol)	Zone > 12 miles	45	4.27	2.78	3.69	3.58	b
100-300 (Pukat tongkol)	ZEE & high seas	43	4.29	2.42	3.58	3.43	a

Notes: Based on the scale range, Y3.1: Identifying Fishing Ground (DPI) Violations; Y3.2: Determining Potential Fishing Grounds (DPI); Y3.3: Transparency in Fisheries Management

The results of the fishermen's perception test in Table 4.13 indicate that there are two (2) groups of fishermen who have different perceptions regarding the criteria for VMS usage. The first group consists of small pelagic purse seine vessels (pukat rapat) sized 30 GT – 100 GT with fishing grounds in zones < 12 miles, and mackerel purse seine vessels (pukat tongkol) sized 100 GT – 300 GT with fishing grounds in the EEZ and high seas. This group has an average score range of 3.20 – 3.43.

The second group consists of mackerel purse seine vessels (pukat tongkol) sized 30 GT – 100 GT with fishing grounds in zones > 12 miles. This group has a perception score range of 3.43 – 3.48. This group believes that VMS is capable of detecting any violations in fishing activities and serves as one of the monitoring instruments in fisheries management.

According to Soemarmi et al. (2020), VMS, as one of the monitoring technologies in Indonesia, aims to oversee the utilization and management of fishery resources and to demonstrate transparency in the exploitation of fishery resources by fishermen in a country. Achieving transparency in the management and utilization of fishery resources is expected to reduce the number of violations committed by fishermen in fishing activities.

d. Fishermen's Compliance with Regulations

The analysis of fishermen's perception data regarding fishing ground regulations was measured through the assessment of 115 fishermen on three (3) criteria of fishermen's compliance with fishing ground regulations. The distribution of respondents according to their perceptions of regulatory compliance can be seen in Figure 5.

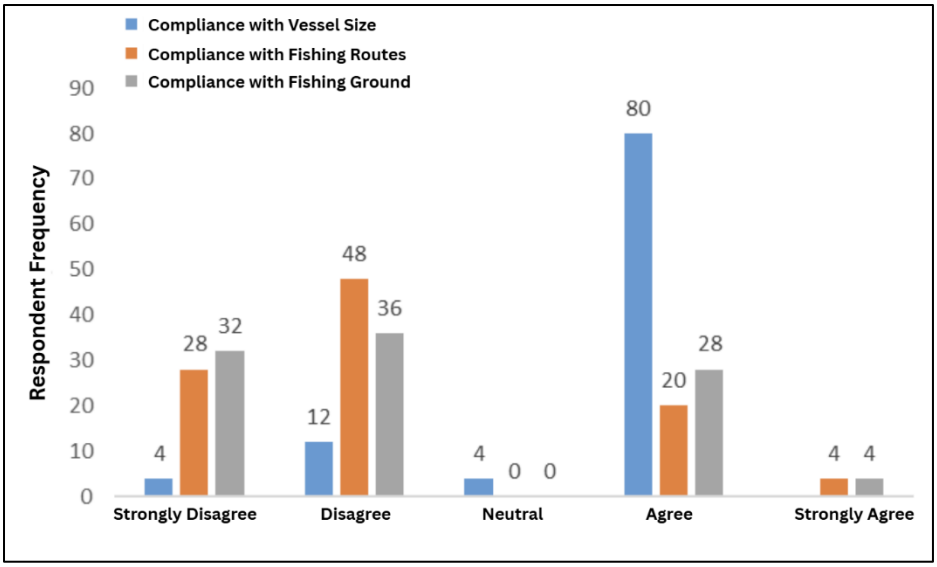

Figure 5. Distribution of Fishermen's Perceptions Regarding Compliance with Regulations

Based on Figure 5, it is shown that the highest perception of fishermen on each criterion is as follows: 72% answered "agree" on compliance with vessel size, 48% answered "disagree" on compliance with fishing routes, and 32% answered "strongly disagree" on compliance with fishing areas. The differences in perceptions regarding regulations are influenced by fishermen's experiences in searching for fish resources in areas they consider to be potential fishing grounds.

Thomas *et al*. (2023) reported that the compliance level of the purse seine fleet at PPS Belawan was very high, with a value of 85.42%. Meanwhile, Hawati (2018) stated that most

purse seine vessels based in Teluk Bone operated in fishing grounds that were not in accordance with regulations because the productivity obtained was higher than if they operated in accordance with the regulations. The primary reason fishermen engage in fishing in non-compliant areas is economic pressure. Fishermen also believe that violating existing regulations is preferable to not gaining profit from fishing activities. If fishermen fail to obtain a sufficient catch in the permitted fishing grounds, they tend to expand into other fishing areas.

Based on the results of the Kruskal-Wallis test, the chi-square value was 22.098 with a degree of freedom (df) of 2 and an asymptotic significance (p-value) of 0.00. This p-value is smaller than the specified significance level of 0.05, thus the decision is to reject the null hypothesis (H0) and accept the alternative hypothesis (H1). The conclusion is that at least one group of fishermen has different perceptions regarding compliance with fishing ground regulations.

Table 5. Distribution of Purse Seine Fishermen's Perceptions Regarding Regulations

Tonnage (GT)	Type of Fishing Ground (TPI)	Number of Respondents	Perception Scores			Average	Remarks
			Y4.1	Y4.2	Y4.3		
30-100 (Pukat rapat)	Zone < 12 miles	25	3.00	2.24	2.36	2.53	a
30-100 (Pukat tongkol)	Zone > 12 miles	45	3.78	3.69	3.73	3.73	b
100-300 (Pukat tongkol)	ZEE & high seas	43	3.73	3.78	3.73	3.75	b

Notes: Based on the scale range, Y4.1: Compliance with Vessel Size; Y4.2: Compliance with Fishing Routes; Y4.3: Compliance with Fishing Areas

The results of the fishermen's perception test in Table 4.14 show that there are two (2) groups of fishermen with different perceptions regarding compliance with regulations. The first group consists of small pelagic purse seine vessels (pukat rapat) sized 30 GT – 100 GT with fishing grounds in zones < 12 miles. This group gave the lowest assessment, with an average score range of 2.53 – 3.73.

The second group consists of mackerel purse seine vessels (pukat tongkol) sized 30 GT – 100 GT with fishing grounds in zones > 12 miles, as well as purse seine vessels sized 100 GT – 300 GT with fishing grounds in the EEZ and high seas. This group provided assessments with an average score range of 3.73 – 3.75.

Based on these results, it is evident that the small pelagic purse seine (pukat rapat) group has lower compliance with fishing regulations, particularly in the sub-criteria of fishing routes and fishing areas. According to information from fisheries inspectors at Satwas SDKP Sibolga (2023), violations of fishing regulations are predominantly committed by small pelagic purse seine vessels operating in zones < 12 miles.

DISCUSSION

a. Perceptions of Purse Seine Fishermen on Potential Fishing Grounds (DPI)

Based on the analysis, it was found that there is no significant relationship between fishermen's perceptions of potential fishing grounds (DPI) and compliance with regulations. This situation can occur when fishermen, not obtaining abundant catches in certain areas, tend to expand their fishing areas even if it means violating regulations. Fishermen with positive perceptions of potential DPI tend to view these areas as valuable fishery resources that need to be preserved, leading to greater compliance with regulations. They may feel that by following regulations, they can maintain fishery resources and ensure the sustainability of fishing in the future. Conversely, fishermen with negative perceptions of potential DPI may be more likely to ignore or violate regulations, believing that the fishery resources in those areas do not provide maximum benefits.

According to Nababan *et al*. (2017), fishermen who fish in zone 1A admitted that they were forced to do so because the target fish were located there. Furthermore, their vessels are relatively small, preventing them from sailing to more distant waters. The decision to determine fishing grounds is influenced by various factors such as weather, knowledge of water conditions, resource availability, and previous catch results (Sudarmo *et al*., 2013).

b. Fishermen's Perceptions of Fish Resources

Based on the analysis, there is no significant relationship between fishermen's perceptions of fish resource availability (SDI) and compliance with regulations. The relationship between fishermen's perceptions of SDI and regulatory compliance is an important aspect in fisheries management. Fishermen's perception of SDI refers to their views and assessments of fish distribution patterns and availability in a given water area and their compliance with regulations.

Simbolon *et al*. (2019) explained that in order to maintain the presence and sustainability of fish resources, especially in coastal areas, and to obtain abundant catches with high economic value, it is necessary to expand fishing grounds. Fishermen's perceptions of fish resource availability in a water area strongly influence their fishing strategies, including gear type, fishing ground selection, and target species.

Triyanti *et al*. (2021) noted that fishermen's perceptions of fish resource availability can affect their compliance with regulations and policies for sustainable fishery resource management. Even when fishermen perceive fish stocks to be decreasing, they continue striving to maximize their catches. Branch *et al*. (2006) stated that fishermen's behavior is naturally competitive, as they always aim to maximize catches to improve family welfare. Consequently, fishermen will make any decision necessary to secure the largest possible catch.

c. Fishermen's Perceptions of the Use of VMS

The analysis also revealed no significant relationship between fishermen's perceptions of VMS (Vessel Monitoring System) usage and compliance with regulations. Fishermen's perceptions of VMS refer to their views and evaluations of the benefits and consequences of using this technology in fishing activities.

Hartono (2007) highlighted differences in perception between the government and fishery business operators regarding the VMS policy, with some operators believing that VMS provides no benefit in fishing operations. Fishermen with positive perceptions of VMS tend to see it as an effective tool for enhancing transparency and monitoring fishing activities.

Through VMS, fishermen can ensure compliance with DPI regulations and reduce regulatory violations.

On the other hand, some fishermen have negative perceptions of VMS, feeling uncomfortable with this technological instrument. They consider VMS an intrusion or limitation on their freedom to search for fish at sea. Hadinata (2010) reported that most vessel captains perceive the costs of purchasing VMS units, airtime fees, and repair expenses borne by the vessel owners as burdensome operational costs. Furthermore, despite VMS being intended to increase fishing vessel compliance with regulations, in practice, many fishing ground violations still occur as vessels attempt to evade monitoring through VMS surveillance.

d. Fishermen's Compliance with Regulations

In the model, there is an indirect relationship between fishermen's socio-economic characteristics and compliance with regulations through intermediary variables: fishermen's perceptions of potential DPI, perceptions of SDI, and perceptions of VMS usage. The results indicate no significant relationship between fishermen's socio-economic characteristics and regulatory compliance through these intermediary variables.

According to Imron (2008), to maintain fishery resource sustainability, fisheries management must emphasize or even reduce fishing effort. Fishing activities must consider the biological and economic sustainability of fish resources. Therefore, management of fishing grounds should be oriented toward resource sustainability, water quality, and the development of more efficient capture fisheries (Simbolon, 2019).

Sustainable fisheries management aims to prevent overfishing, maintain fish stock levels, and enhance productivity, income, and the welfare of fishery operators. Such management inevitably involves fishermen and considers the socio-economic impacts on them. To achieve these goals, commitment is required in training and empowering fishermen to improve their quality, including skills in determining potential DPI, understanding SDI, and using information technology. Enhanced empowerment efforts will change fishermen's mindsets, enabling them to escape poverty, improve perceptions, and ultimately increase compliance with regulations.

CONCLUSION

Based on the analysis of fishermen's perceptions and compliance, the results are as follows; a) There is no difference in perceptions among fishermen groups based on the criteria of potential fishing grounds (DPI) and availability of fish resources; b) There is a difference in perceptions among fishermen groups based on the criteria of VMS usage, where the small pelagic purse seine (pukat tongkol) group sized 30 GT – 100 GT perceives VMS as capable of detecting every violation in fishing activities; and c) There is a difference in perceptions among fishermen groups based on compliance with regulations, where the small pelagic purse seine (pukat rapat) group sized 30 GT – 100 GT demonstrates the lowest compliance, as this group most frequently operates in fishing zones that do not comply with their permits.

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