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The performance of traditional fishing technologies of narrow barred Spanish mackerel (*Scomberomorus commerson*) in Bone Bay waters, South Sulawesi, Indonesia

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Abstract. Narrow barred Spanish mackerel is a high-value pelagic fish and is mostly caught in Bone Bay waters. These fish can be caught using purse seines, drift gill nets, lift net and hand lines, but the most catches are in drift gill nets and hand lines. This study aims to compare the performance of drift gill nets and hand line technologies. Biological, technical, social, economic and legal data were collected from 2018 to 2020 through direct field observations and interviews. Performance according to the four aspects and the combination of all aspects of the two fishing gear were analyzed using the Mangkusubroto Scoring method. Based on the biological and technical aspects the performance of the hand line was better than the drift gill nets, while on the contrary, based on the economic and social aspects, the performance of gill nets was better than the hand lines. Based on legal and institutional aspects, the two technologies do not show any differences. Although there are differences in the performance of the biological, technical, social and economic aspects, the performance of the two technologies is classified as good.

1. Introduction

Indonesia is one of the countries that catches mackerel fish in the Indian Ocean waters. Based on average catches over the period 2012 - 2018 by country, Indonesia is in the first position with a production portion of ± 40,000 tons year^{-1} or 24% of the annual average production [1]. The annual production of Indonesian mackerel from the Indian Ocean is the catch of several fishing gears, however the three main fishing gears are gill net, hooks and line and purse seine. One of the waters in Indonesia that produces a lot of fish including mackerel fish is the Indonesian Fisheries Management Area 713 which includes the waters of Bone Bay, Makassar Strait, Flores Sea and Bali Sea. The Indonesian Fisheries Management Area 713 is the second highest fish producer (12.42%) of the total Indonesian fish production [2]. The high fish production in FMA 713, especially Bone Bay, is due to the presence of eddy water in these waters [3]. Although the waters that enter IFMA 713 are high fish producers, fishing business is still dominated by small-scale fisheries (> 90%) which is characterized by the use of small fishing vessels (<5 GT) and only a few (<10 %) which is categorized as a medium-scale fishing business and above, so it needs to be

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developed [4]. Narrow barred Spanish mackerel (*Scomberomorus commerson*) are one of the largest potential pelagic fish in Fisheries Management Area 713, especially Bone waters [5]. Based on statistical data, of the ten types of fish with high production in IFMA 713, narrow-barred Spanish mackerel are in seventh place with a production of 15,500 tons year^{-1}. In the waters of Bone Bay, narrow barred Spanish mackerel can be caught by fishermen using surface gill nets, trolling line, purse seine, traditional seine net, boat lift net and hand line, but most of the annual production is the catch of surface gill nets and hand lines [6]. Gill nets and hand line are also widely used as the main fishing gear for narrow barred Spanish mackerel fish in various waters in Indonesia. Including in the waters of Belitung Regency [7], in Bangka waters [8], in the waters of the Java Sea [9], in the waters of Lampung Bay [10]. Gill net and hand line are effective and efficient fishing gear for fishing Spanish mackerel [7,11], are economically feasible to develop [12], provide high income [10,13]. Gill nets are as effective as fishing gear for catching narrow barred Spanish mackerel in the waters of the North Persian Gulf but are less sustainable because they use small mesh sizes [14]. Research on mackerel in the waters of the Gulf of Bone is limited to biological aspects such as the relationship between length and weight, sex ratio and eating habits [6] and population dynamics [5].

This study aims to analyze the performance of the two main fishing gear for narrow barred Spanish mackerel in Bone Bay waters. The results of this research can be used as information in determining the management and utilization policies of mackerel fish, especially in the Bone Bay waters. In addition, the results of this study can provide scientific data and information for other mackerel fish researchers both in Indonesia and outside Indonesia.

2. Research Method

2.1. Time and location of research

The study was conducted from April 2018 to August 2020. Data collection was carried out at four fish landing sites in the north Bone Bay, South Sulawesi Indonesia. The narrow barred Spanish mackerel fishing area is located between 2°30' north latitude and 6° south latitude, and between 120° west longitude and 122° east longitude with a water depth of 50-200 meters. The location of the research is presented in Figure 1.

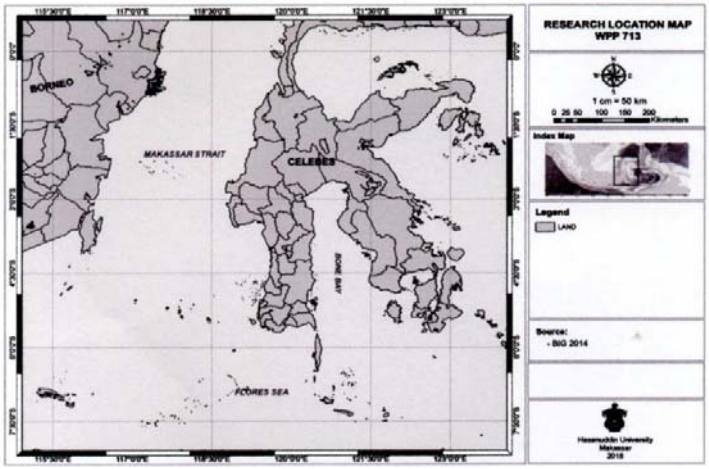

Figure 1. Location of the research

2.2 Materials and equipment

The materials and types of equipment have been used in this research, such as narrow-barred Spanish mackerel, labeling paper, measuring boards specifically designed for large pelagic fish and, a set of computers and software for data analysis.

2.3 Data collection

Biological aspects observed include fish size structure, fishing season duration, peak fishing season, and technology selectivity. Technical aspects include the influence of oceanographic factors on fishing gear operation, the difficulty level of fishing gear operation, the technology level of fishing gear, average production per trip, average production per worker per trip. Economic aspects include gross income per business unit per year, gross income per business unit per trip and gross income per worker per year and the B/C ratio. Social and institutional aspects include the acceptance of technology by the community, absorption of labor, business use for non-fishing communities, the level of community investment ability in fishing gear, the level of technology adaptability, the legal level of fishing gear. Data related to biological, technical, economic and social and institutional aspects were collected directly in the field during the activity and interviewed by a team of researchers and students. During the study, 1,237 specimens were measured using stratified random methods and conducted observations and interviews of drift gill net and hand line fishermen for 10 business units each.

2.4 Data analysis

2.4.1 Biological performance analysis

The size structure of the narrow barred Spanish mackerel caught by both technologies was analyzed descriptively and presented in the form of a column diagram. To distinguish the value of the two technologies based on the size structure, the catch is grouped according to the maturity level of mackerel, namely young fish, pre-adult fish and adult fish. Narrow barred Spanish mackerel that have a length of > 80 cm FL are classified as adult fish, > 60 cm - < 80 cm in length as pre-adult fish, and fish measuring <60 cm as young fish. If the catch is dominated by young fish with a score of 1.0, dominated by pre-adult fish with a score of 3.0, and dominated by adult fish with a score of 5.0 (Table 1).

Selectivity of fishing technology is analyzed using the parameter values of the Von Bertalanffy equation with the assumption that selectivity is a function of length. The logistic curve selectivity equation is as follows[15]:

$$S(t)=\frac{1}{1+\exp(T1-T2*t)}$$

Where :

$T1 = t50\%*\ln 3/ (t75\% - t50\%)$

$T2 = \ln 3/(t75\% - t50\%) = T1/t50\%.$

$t50\% = to - (1/K) \ln (1 - L50\% / L\infty)$

$t75\% = to - (1/K) \ln (1 - L75\% / L\infty)$

The percentage of eligible fish to catch is calculated using the equation Mallawa et al [16] as follows,

$$F_E = (F_S/F_T) \times 100\ \%$$

Where:

F_E = Number of eligible fish to catch (%)

F_S = Number of adult fish or have spawned
F_T = Number of fish samples observed

Fishing season and peak season duration were analyzed descriptively from the amount of monthly catch of each technology. The fishermen's catch data is confirmed by the narrow barred Spanish mackerel production data from the Fisheries Service Office. Fishing season and length of peak season are stated in number of months per year. The procedure for scoring the two technologies based on biological aspects per is presented in Table 2

2.4.2 Technical performance analysis

The influence of oceanographic factors on fishing gear operation uses the answers of 10 sample fishermen for each fishing gear. The oceanographic factors included in the analysis were current, brightness and waves. The level of difficulty in operating fishing gear is obtained from the answers of 10 sample fishermen of each fishing gear. The level of fishing gear technology used includes the use of GPS, fishing aids, net colors, and types of bait. Production per trip is calculated using annual production data and the number of trips during one year from fishermen's records, and expressed in kg trips^{-1}. Production trip-1 labor-1 is calculated using annual production data and the number of trips during one year from fishermen's records, and expressed in kg trips^{-1}. The procedure for scoring the two technologies based on technical aspects is presented in Table 2.

2.4.3 Economic performance analysis.

Gross income year^{-1}, gross income trip^{-1} and gross income trip^{-1} labor^{-1} of drift surface gill net and hand line obtain from the fishermen's revenue records for one year of data. The value of B / C is calculated using the income and expenditure records of 10 sample fishermen for one year of data using method of Kadariyah [17]. The procedure for scoring the two technology based on economic aspects is presented in Table 3.

2.4.4 Social and legal performance analysis.

The number of workers used by each technology was obtained through direct field observation of 10 surfaces gill net and hand line fishing units Information about the ability to invest was obtained through interviews. The benefits of the business unit for non-fishing gear users are obtained through interviews with 10 people around the fish landing sites. The legality of fishing gear includes the method of operation, location of installation, use of fishing aids, and not to catch protected fish as stated in international regulations, national and local policies. The scoring procedure for the two technologies based on the social and legal aspects is presented in Table 4.

To distinguish the two fishing technologies, the variables in each aspect are broken down into sub variables and then a scoring is carried out. The results of field observations, interviews and calculations, then matched the three sub variables in the analysis table (Table 1-4) developed by Mallawa et al [19].

2.4.5 Performance of fishing technology

The performance of fishing technology is calculated using the following equation:

$$F_P = (\sum V_O/V_F)* 100\%$$

Where:

F_P = fishing technology performance (%)
V_O = obtained value by fishing technology

V_F = the full value that should have been achieved (50)

If the F_P value is ≥ 80%, the performance of fishing technology is very good
If the F_P value is 60 - < 80%, the performance of fishing technology is good
If the F_P value < 60%, the performance of fishing technology is less good

Table 1. The table for analyzing the biological performance of a fishing technology.

No	Performance variables	Weighted	Sub Variable value	Score	Weighted*Score
1	Fish size structure in catch	2.0			
	1.1 Catch dominated by young fish		1		
	1.2 Cath dominated by pre adult fish		3	….	….
	1.3 Catch dominated by adult fish		5		
2	Percentage of eligible fish to catch	2.0			
	2.1 Eligible fish ≤ 10%		1		
	2.2 Eligible fish > 10 – 30%		3	….	….
	2.3 Eligible fish > 30%		5		
3	Fishing gear selectivity	2.0			
	3.1 Value of selectivity < 0.25		1		
	3.2 Value of selectivity 0.25 – 0.50		3	….	….
	3.3 Value of selectivity > 0.50		5		
4	Fishing season duration	2.0			
	4.1 Fishing season < 4 months		1		
	4.2 Fishing season 6 – 8 months		3	….	….
	4.3 Fishing season > 8 months		5		
5	Peak season duration	2.0			
	5.1 Peak season < 2 months		1		
	5.2 Peak season 3 – 6 months		3	….	….
	5.3 Peak season > 6 months		5		

Table 2. The table for analyzing the technical performance of a fishing technology.

No	Performance variables	Weighted	Sub Variable value	Score	Weighted*Score
1	Influence of oceanographic factors on fishing gear operation	2.50			
	1.1 Stated influential ≥ 80 %		1		
	1.2 Stated influential 60-<80%		3	….	….
	1.3 stated influential < 60%		5		
2	The difficulty of operating fishing gear	2.50			
	2.1 Answer stated difficult ≥ 80%		1		
	2.2 Answer stated difficult 60 - < 80%		3	….	….
	2.3 Answer stated difficult < 60%		5		
3	Level of fishing gear technology	2.50			
	3.1 Using technology < 2 types		1		
	3.2 Using technology 2 – 4 types		3	….	….
	3.3 Using technology > 4 types		5		
4	Production (kg $trip^{-1}$)	2.50			

	4.1 If production < 100 kg trip^{-1}	1		
	4.2 If production 100 – 300 kg trip^{-1}	3	….	….
	4.3 If production > 300 kg trip^{-1}	5		

Table 3. The table for analyzing the economic performance of a fishing technology.

No	Performance variables	Weighted	Sub Variable value	Score	Weighted*Score
1	Gross income year^{-1} (IDR)	2.50			
	1.1 Gross income < 100 million		1		
	1.2 Gross income 100 – 200 million		3	….	….
	1.3 Gross income > 200 million		5		
2	Gross income trip^{-1} (IDR)	2.50			
	2.1 Gross income < 10 million		1		
	2.2 Gross income 10 – 20 million		3	….	….
	2.3 Gross income > 20 million		5		
3	Gross income trp^{-1} worker^{-1}(IDR)	3.00			
	3.1 gross income < 1 million		1		
	3.2 If gross income 1 – 2 million		3	….	….
	3.3 If gross income > 2 million		5		
4	B/C Ratio	2.00			
	4.1 Value of B/C ratio > 1.0 - 2.0		1		
	4.2 Value of B/C ratio >2.0 – 3.0		3	….	….
	4.3 Value of B/C ratio > 3.0		5		

Table 4. The table for analyzing the social and legal performance of a fishing technology.

No	Performance variables	Weighted	Sub Variable value	Score	Weighted*Score
1	Labor absorption	2.50			
	1.1 Worker used < 5 person		1		
	1.2 Worker used 5 – 10 person		3	….	….
	1.3 Worker used > 10 person		5		
2	Ability to invest	2.50			
	2.1 Ability to invest < 50%		1		
	2.2 Ability to invest 50 - 75 %		3		
	2.3 Ability to invest > 75 %		5		
3	Business benefits for non-fishing gear users	2.50			
	3.1 helpful < 50%		1		
	3.2 helpful 50 – 75 %		3		
	3.3 helpful > 75 %		5		
4	Legality of fishing gear	2.50			
	4.1 Contrary to > 3 regulations		1		
	4.2 Contrary 1 – 3 regulations		3	….	….
	4.3 No conflict with the regulation		5		

3. Result and discussion

3.1. Biological performance

The results of the mapping between the frequency according to the length class and the mean length class of mackerel fish caught by surface gill net and hand line produce a histogram as in Figure 2. Based on Figure 2, it can be described that the surface gill net catch are dominated by young fish, while the hand line catch are dominated by pre-adult fish.

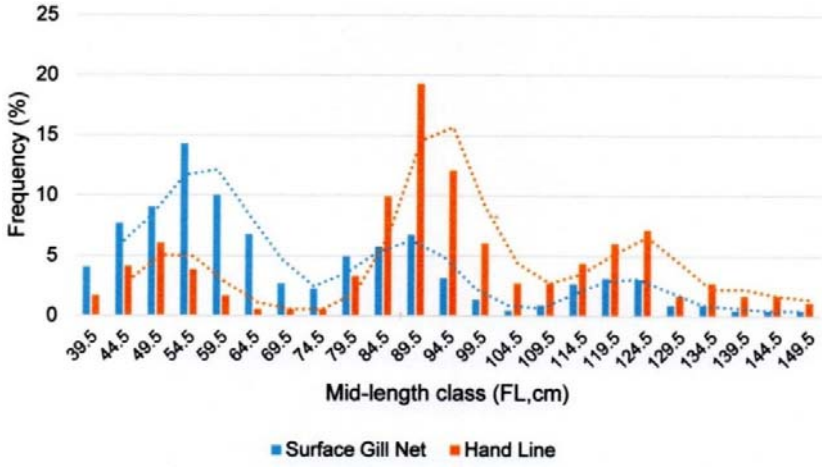

Figure 2. Size structure and age group of yellowfin tuna, according to fishing gear in Bone Bay waters.

The calculation of the selectivity of the two fishing technologies uses a logistic curve method by entering the values of L∞ 322.5 cm, L50% 39.44 cm, L75% 42.45 cm (Figure 3a) , K 0.15 year^{-1} and to -0.59 years for the surface gill net. Then L∞ 207.5 cm, L50% 85.93 cm, L75% 89.94 cm (Figure 3b), K 0.35 year^{-1} and to -0.28 years for the hand line, the selectivity values of each of these fishing technologies were obtained (Table 5).

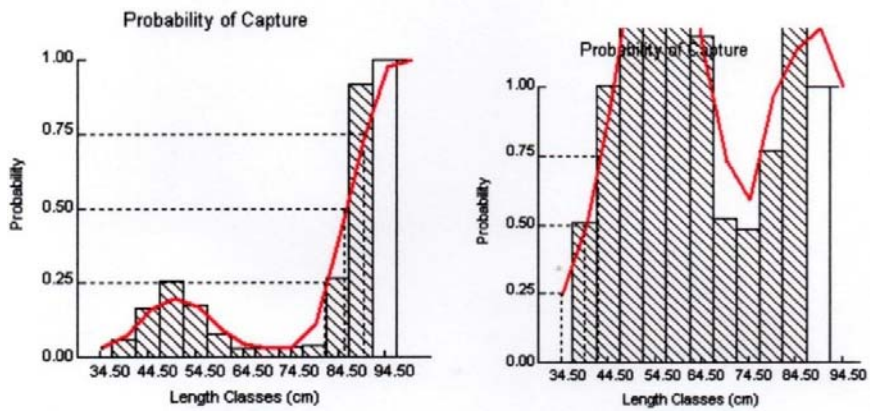

Figure 3. Probability of catch of narrow barred Spanish mackerel by fishing gear in Bone Bay waters.

Table 5. The performance biology of narrow barred Spanish mackerel fishing technologies at Bone Bay.

No	Variables	Surface Gill Net	Hand Line
1	Size structure of catch	Catch dominated by young fish	Catch dominated by pre adult fish
2	Selectivity	0.54	0.71
3	Number of eligible fish to catch (%)	27.81	79.0
4	Fishing season duration (months)	10	10
5	Peak fishing season duration (months)	5	6

3.2. Technical performance

The results of observations, interviews and data analysis obtained variable values related to the technical performance of the two fishing technologies for narrow barred Spanish mackerel in Bone Bay waters as presented in Table 6.

Table 6. The technical performance of the two narrow barred Spanish mackerel fishing technologies.

No	Variables	Surface Gill Net	Hand Line
1	Influence of oceanographic factors on fishing gear operation (%)	90	80
2	The level of difficulty of operating fishing gear (%)	50	40
3	Level of fishing gear technology (item)	2	< 2
4	Production (kg trip^{-1})	1.140 ± 117.04	239 ± 125.12
5	Production (kg trip^{-1} labor^{-1})	360 ± 28.75	118 ± 60.85

3.3. Economic performance

The results of observations, interviews and data analysis obtained variable values related to the economic performance of the two fishing technologies in the Bone Bay waters as presented in Table 7.

Table 7. The economic performance of the two narrow barred Spanish mackerel fishing technologies.

No	Variables	Surface Gill Net	Hand Line
1	Gross income (IDR million year^{-1})	271 ± 54.05	145 ± 49.89
2	Gross income (IDR million trip^{-1})	2.71 ± 0.54	1.45 ± 0.50
3	Gross income (IDR million trip^{-1} labor^{-1})	0.68 ± 0.14	0.73 ± 0.25
4	B/C ratio	2.45 ± 0.69	3.50 ± 0.80

3.4. Social, institutional and legal performance

The results of observations, interviews and data analysis obtained variable values related to the social, institutional and legal performance of the two fishing technologies in the Bone Bay waters as presented in Table 8.

Table 8. Social, institutional and legal performance of both narrow barred Spanish mackerel fishing technologies.

No	Variables	Surface Gill Net	Hand Line
1	Number of labor used	4	2
2	Ability to invest	80%	100%
3	Business benefits for non-fishing gear	80%	80%
4	Legality of fishing technologies	Does not conflict with existing	Does not conflict with existing

				regulations		regulations

Based on the results of observations, interviews and data analysis in Tables 5 - 8, an analysis of the performance of the surface gill net and the hand line used in catching narrow barred Spanish mackerel in Bone Bay waters was carried out as presented in Tables 9 - 12.

Table 9. Biological performance of two technologies of narrow barred mackerel in Bone Bay waters.

No	Performance variables	Weighted	Score		Weighted*Score	
			Surface gill net	Hand line	Surface gill net	Hand line
1	Fish size structure in catch	2.50	1	3	2.50	7.50
2	Percentage of eligible fish to catch	2.50	3	5	7.50	12.50
3	Fishing gear selectivity	2.00	5	5	10.00	10.00
4	Fishing season duration	1.50	3	3	4.50	4.50
5	Peak season duration	1.50	5	5	7.50	7.50
	∑weighted*score				32.00	42.00

Table 10. Technical performance of two technologies of narrow barred mackerel in Bone Bay waters.

No	Performance variables	Weighted	Score		Weighted*Score	
			Surface gill net	Hand line	Surface gill net	Hand line
1	Influence of oceanographic factors on fishing gear operation	1.50	1	3	1.50	4.50
2	The level of difficulty of operating fishing gear	1.50	5	5	7.50	7.50
3	Level of fishing gear technology	2.00	3	1	6.00	2.00
4	Production $trip^{-1}$	2.50	5	3	12.50	7.50
5	Production $trip^{-1}$ $labor^{-1}$	2.50	5	3	12.50	7.50
	∑weighted*score				35.00	29.00

Table 11. Economical performance of two technologies of narrow barred mackerel in Bone Bay waters.

No	Performance variables	Weighted	Score		Weighted*Score	
			Surface gill net	Hand line	Surface gill net	Hand line
1	Gross income (IDR million $year^{-1}$)	2.50	5	5	12.50	12.50
2	Gross income (IDR million $trip^{-1}$)	2.50	5	5	12.50	12.50
3	Gross income (IDR million $trip^{-1}$ $labor^{-1}$)	2.50	3	3	7.50	7.50
4	B/C ratio	2.50	5	5	12.50	12.50
	∑weighted*score				45.00	45.00

Table 12. Social, and legal performance of two technologies of narrow barred mackerel in Bone Bay waters.

No	Performance variables	Weighted	Score		Weighted*Score	
			Surface gill net	Hand line	Surface gill net	Hand line
1	Labor absorption	2.50	1	1	2.50	2.50
2	Ability to invest	2.50	5	5	12.50	12.50
3	Business benefits for non-fishing gear	2.00	5	5	10.00	10.00
4	Legality of fishing gear	3.00	5	5	15.00	15.00
	∑weighted*score				40.00	40.00

Based on the values in Table 9-12, the performance values of the surface gill net and hand line for narrow barred Spanish mackerel in Bone Bay waters are shown in Figure 3.

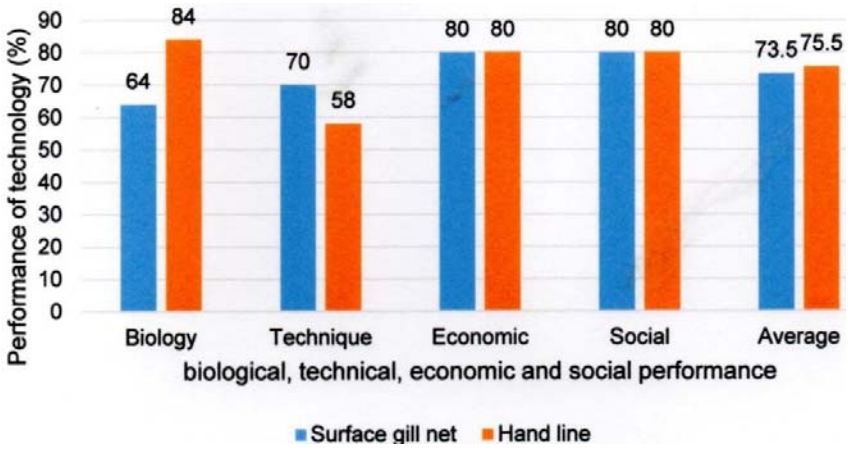

Figure 3. Biological, technical, economic and social institutional performance surface gill net and hand line for narrow barred Spanish mackerel in the Bone Bay waters.

Based on Figure 3 it can be explained that biologically, the performance of the surface gill net is less good. This is because the catch is dominated by small fish or young fish, while the performance of hand line is good. Based on the technical aspects, the performance of the surface gill nets are classified as good, while hand lines are classified as less good. The cause of the less good performance of the hand line based on technical aspects is the low use of technology in the fishing gear. Based on the economic aspect, the performance of both technologies is very good. Likewise, from the social, legal and institutional aspects, the performance of surface gill nets and hand lines for mackerel fishing is very good. Based on the average value of the four aspects, surface gill net and hand line for catching narrow barred Spanish mackerel in Bone Bay waters are classified as good. The cause of the surface gill net performance is not in the very good category is the dominance of small fish in the catch, the percentage of fish that is fit to be caught is low, the gross income $trip^{-1}$ $labor^{-1}$ is low, and the influence of high oceanographic factors. While on the hand line the causes are low technology use, low labor use, the low gross income trp^{-1} $labor^{-1}$.

Both mackerel fishing technologies in the waters of the Bone Bay have good performance. The good performance of the two technologies is contributed by the high selectivity of the two fishing gears, can be operated throughout and the long peak season of fishing, ease of operation of fishing gear, high productivity of fishing gear, high gross income and B/C ratio, low prices good social feasibility. These things are in accordance with the conditions of mackerel fishing in several Indonesian waters. The fishing activity of mackerel using gill nets and hand line in the waters of Belitung Regency can take place throughout the year, the peak season of fishing occurs in March - May and is very effective and efficient [7]. Mackerel fishing in the Java Sea can be done throughout the year with two peak seasons, March - June and November - December [18]. In Bangka waters, fishing can be carried out throughout the year with peak seasons March - April and October - November [19]. In Lampung waters, fishing activities take place throughout the year and peak seasons occur in March - May and July – September and productivity range 8.91 – 39.42 kg trip^{-1} [29] and in Belitung waters occur in March – May [7]. In the waters of Lampung Bay, the productivity of mackerel gill nets is 165 kg trip^{-1} in the peak season, 148 kg trip^{-1} in the normal season, and 68 kg trip^{-1} in the famine season [10]. In Indramayu waters, West Java, the productivity of gill nets is 347.7 kg trip^{-1} in the peak season and 51 kg trip^{-1} in the dry season. In Jambi waters, the productivity ranges from 61 - 381 kg trip^{-1} [11]. The mackerel gill nets in the waters of West Tanjung Jabung, Jambi Province, have an income ranging from IDR 302 - 352 million year^{-1}[13]

The four things that cause the surface gill net performance to not be categorized as very good are the dominance of small narrow barred Spanish mackerel in the catch, fishing gear operation is strongly influenced by oceanographic factors, gross income trip^{-1} labor^{-1} is low, and the amount of labor used is low. There are three things on the hand line, namely the use of low technology, low gross income trip^{-1} labor^{-1}, and a small amount of labor.

Being caught and the dominance of small narrow barred Spanish mackerel fish is one of the causes of the decline in the performance of surface gill nets in the Bone Bay waters based on the biological aspects. The dominance of narrow barred small Spanish mackerel or young fish in the catch in the waters of Bone Bay is thought to have occurred due to the condition of the waters in the form of a bay and shallow waters, not because of the low selectivity of the fishing gear. Gill nets have high selectivity in narrow barred Spanish mackerel fish [20,21]. Another thing is that narrow barred Spanish mackerel schools, like other pelagic fish, use the Bone Bay waters as a nursery area and feeding area. The phenomenon of the dominance of small mackerel fish in the catch also occurs in several coastal waters and other bays. The mackerel caught in Kwandang Bay waters Sulawesi Sea throughout the year has a size of 25 - 138 cm and is dominated by small fish (mode 43 - 48 cm to 61 - 66 cm) except in March and August with a mode of 85 - 90 cm [22]. The narrow barred Spanish mackerels caught in the Persian Gulf of Iran is dominated by fish having a relative age of 1.43 years and 2.50 years with an average length of 53.88 cm and 85.83 cm respectively [23]. The narrow barred Spanish mackerel caught in the coastal waters of Mozambique and KwaZulu Natal,,South Africa is dominated by fish aged one to three years with a length interval of 75 - 95 cm [24]. The narrow barred Spanish mackerel caught in the northern Persian Gulf has a length range of 17 - 152 cm and is dominated by young fish, which are smaller than 70 cm [20].

The influence of oceanographic factors, especially currents, on fishing gear operation and the amount of the gill net mackerel catch is reported to have occurred in the waters of North Maluku [25]. Current velocity can affect the stability of the gill nets in the waters [26]. The successful operation of gill nets is not only influenced by technical factors such as mesh size, hang-in ratio, and color of the net as well as oceanographic conditions such as brightness related to seeing sensibility of fish and current speed which can cause changes from perfectly stretched to coiled [27]. The suitability of gill nets in Batam is greatly influenced by weather and currents [12].

In general, the use of labor in the surface gill net and hand lines mackerel business units is not as much as the use of labor in the purse seine Spanish mackerel. The use of labor on the gill net and mackerel hand line ranges from 2 - 4 people per business unit. [28].

4. Conclusion

The surface gill net used by fishermen to catch narrow barred Spanish mackerel in the Bone Bay waters has a good performance from a technical aspect, very good from an economic and social, legal and institutional aspect but has a less good performance from a biological aspect. The low performance of the surface gill net from biological aspects is due to the dominant small size fish or young fish in the catch. The hand line used by fishermen to catch narrow barred Spanish mackerel fish in the waters of the Bone Bay has a good performance from a biological aspect, very good from an economic and social aspect, legal and institutional aspects but has a less good performance from a technical aspect. The low performance of the hand line from a technical aspect is due to the lack of technology use in this fishing gear.

Based on the combined assessment of the four aspects, surface gill net and hand line for fishing narrow barred Spanish mackerel in Bone Bay waters has a good category performance so that its use is maintained.

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