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## Environmental and Technical Approach In the Selection of Fishing Gear Featured in WPP 571 Aceh

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### Abstract

Fishery management area 571 (WPP 571) Aceh is fertile waters and become a major fishing ground for fishermen who settled along the north coast of Aceh. The research aimed to analyze the condition of the waters around fishing ground and fish production in WPP 571 Aceh, and to determine the fishing gear featured for environmental and technical aspects in WPP 571 Aceh. The methods used are water quality analysis, descriptive methods and the scoring method. The results showed that the condition of the waters around the fishing ground in WPP 571 Aceh is generally quite good. Fish production tends to increase in the last 11 years, with the highest production occurs in small pelagic fish. Fishing gears featured are each drift gill nets, trolling, fish traps, trammel net and fixed gill nets.

**Keywords:** environmental and technical approach; fishing gear; fishing ground; fish production.

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## **1. Introduction**

WPP 571 is adjacent directly to three provinces, namely Aceh Province, North Sumatra Province and Riau Province. But the widest parts of the WPP 571 are in Aceh Province. WPP 571 who entered the Aceh administration starts from the Andaman Sea (west), ZEE Indonesia-Thailand (north), the border sea of Aceh and North Sumatra (east) and mainland Aceh (south). WPP 571 Aceh is fertile waters and become a major fishing ground for fishermen who settled along the north coast of Aceh.

The support of good environmental conditions in the waters around the fishing ground will ensure the sustainability of fish production by the fishermen [1,8]. While the number of Aceh fishermen who depend on fishing activities in WPP 571 reached 9,577 people [14].

The level of utilization of fish resources in WPP 571 about 50-70%, and for certain species of fish is still lower. Meanwhile, the total allowable catch in the waters is approximately 80% [13,19]. This condition would provide an opportunity for the development of fishing gear and enhancement the contribution of the fisheries sector. To ensure sustainability of production, the fishing gear was developed to be excellent, that fits with the environment and good in operate technically.

Consideration of environmental aspect is essential to minimize the destructive impact of fishing operations for fish breeding, biodiversity and habitat protection [2,8]. Technical considerations are useful to improve the performance of fishing operations, because the fishing gear, vessel, engines, the number of crew, and supplies materials to support each other [6,8]. This research is focused to develop both approaches in the selection of fishing gear featured in WPP 571 Aceh. The research aimed to analyze the condition of the waters around fishing ground and fish production in WPP 571 Aceh, and to determine the fishing gear featured for environmental and technical aspects in WPP 571 Aceh.

## **2. Materials and Methods**

Materials and tools used in this research consisted of a sample of sea water around the fishing ground, questionnaires, checklists, stationery, calculators, cameras, test kits for water quality and satellite imagery. This research was conducted in Aceh Province, with the location of data collecting is districts that high-intensity of fishing in WPP 571 [4,6], namely Pidie District, Bireuen District and North Aceh District. The research timing is May-September 2016.

Data collected consist of sea water quality data, fish production, populations of fishing gears, environmental and technical data of fishing gears used in WPP 571 Aceh. The water samples taken at fishing ground in three locations selected.

Production data collected through literature review on reports or study documents in Marine and Fisheries Agency of Aceh Province. Environmental and technical data of fishing gears collected through questionnaires and interviews to fishery stakeholders, namely the fishermen, port management and staff of Marine and Fisheries Agency. Selection of respondents from groups of stakeholders was conducted by purposive sampling.

The methods used are water quality analysis, descriptive methods and the scoring method. Water quality analysis conducted using the test kit and the reading of satellite imagery. The parameters analyzed include pH, color, odor, garbage, turbidity, oil layer, dissolved oxygen (DO), the speed of water currents, sea surface temperature (SST), salinity and chlorophyll [5,15]. To determine the condition of the waters around the fishing ground, the results of the analysis are compared with sea water quality standards for fish / marine life according to the Decree of the State Minister of Environment No. 51 of 2004 [17]. Data of fish production and fishing gear were analyzed using descriptive method, where the results of the analysis presented in tables, graphs or image.

The scoring method used to develop environmental and technical analysis in the selection of fishing gear featured in WPP 571 who entered the Aceh administration. The criteria are used in the analysis of environmental and technical aspects of fishing gears refers to the Code of Conduct for Responsible Fisheries (CCRF) [8].

The criteria for the environmental aspect include the selectivity of fishing gear, the friendliness for the fish habitat, the quality of fish caught, the safety for fishermen, product safety for consumers, by-catch is low, positive impacts on biodiversity and security for protected fish. Whereas the criteria used for the technical aspect are the completeness of production equipment, the capacity of the hold (kg/trip), the load capacity of the ice (beams/trip), employment / crew (persons/unit), capacity of the engine (HP) and the size of the vessel (GT). The formulation of the scoring method used is as follows [2,16]:

$$V_{ij} = \frac{X_{ij} - X_{0j}}{X_{1j} - X_{0j}} \dots\dots\dots (1)$$

$$V_j = \sum_x V_{ij} \dots\dots\dots (2)$$

In these formulations,  $X_{ij}$  = value of criteria X of fishing gear i on aspect j,  $X_{0j}$  = lowest value of criteria X on aspect j,  $X_{1j}$  = highest value of criteria X on aspect j,  $V_{ij}$  = value function of criteria X of fishing gear i on aspect j,  $V_j$  = value function of aspect j, X = criteria, i = alternative fishing gear, j = aspects of assessment (environmental and technical). A total of gear 5 (five) fishing gears have the highest value function of a joint assessment of environmental and technical aspects ( $V_{Joint}$ ), defined as fishing gears featured.

**3. Results and Discussion**

**3.1. Water Conditions and Fish Production**

The waters which become a major fishing ground in WPP 571 Aceh generally found around Pidie District, Bireuen District and North Aceh District. The fishing intensity in the territorial waters of these districts is high and can last throughout the year [4,6]. The condition of the waters around the fishing ground in WPP 571 is presented in Table 1.

**Table 1:** The condition of the waters around the fishing ground in WPP 577 Aceh

Parameters	Quality Standards*	Water Environmental Condition			Reviews
		Fishing Ground 1	Fishing Ground 2	Fishing Ground 3	
pH	6-9	7.5	6.3	7.6	good
Color (CU)	natural	Natural	natural	natural	good
Odor	natural	Natural	natural	natural	good
Garbage	naught (-)	-	-	-	good
Turbidity (NTU)	< 5	4.3	4.1	3.8	good
Oil layer	naught (-)	-	-	-	good
DO (ppm)	> 4	6.5	7.2	6.8	good
Speed of water currents (m/sec)	< 2	1.82	2.14	1.64	warning
SST (°C)	28-32	28.5-29.7	28.2-29.4	28.2-30.2	good
Salinity (‰)	natural	26.3	29.4	31.2	good
Chlorophyll (mg/m <sup>3</sup> )	natural	0.42-0.65	0.47-0.52	0.35-0.82	good

Description: (1) \* Decree of the State Minister of Environment No. 51 of 2004 for fish / marine life, (2) Fishing Ground 1,2 and 3 are respectively the waters around Pidie District, Bireuen District and North Aceh District.

Based on Table 1, the condition of the waters around the fishing ground in WPP 571 is generally quite good. For some parameters which indicate pollution, such as color, odor, garbage and the oil layer are still in accordance with the sea water quality standards for fish / marine life according to the Decree of the State Minister of Environment No. 51 of 2004. As for the parameters that related directly to the growth and proliferation of fish, such as pH, DO, SST and chlorophyll are also in good condition. For example, DO levels in the range of 6.5 to 7.2 ppm for the entire fishing ground in WPP 571, while the required minimum 4 ppm. This shows that there is no disruption to the potential of fish resources in WPP 571. Good water conditions spurred the increase of the stock of fish resources, so that the fishing operations can be performed more freely [1,3].

Adverse conditions only occur on the parameters of currents speed, which is quite high around fishing ground in Bireuen District (2.14 m/sec). This is due to the topography of the coastal waters of Bireuen District in the form of the basin, causing clashes of the water currents from the west and north.

While the currents clash in large quantities can cause the release of the waves at high speed and temperature changes extremely, especially when the currents comes from the vast oceans in the west monsoon [3,7]. The speed of water currents can affect fishing operations and production quantities of fish each year. Figure 1 presents data of fish production for the period 2005-2015 in WPP 571 Aceh.

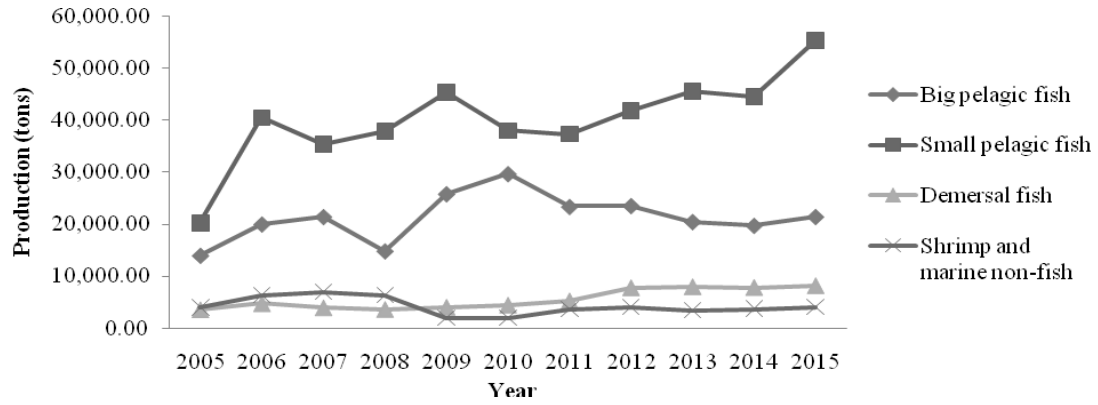


Figure 1: Fish production in WPP 571 Aceh

Based on Figure 1, fish production in Aceh WPP 571, tends to increase in the last 11 years. A drastic increase occurred in 2005 to 2006, allegedly due to the procurement of fishing gears in large quantities through the Aceh reconstruction program following the tsunami in 2004. In addition to improving road infrastructure and housing, procurement of fishing gears is a main priority of the Aceh reconstruction program, because most of the people affected worked as a fisherman [4]. Of the four groups of fish (Figure 1), the production in large quantities occurs in small pelagic fish. This is because the potential of this fish is the biggest in WPP 571, reaching 147,300 tons/year [13], and fishing gears developed by many fishermen are also intended to catch this fish group.

### 3.2. Selection of Fishing Gear Featured

#### 3.2.1. Assessment of Environmental and Technical Aspects

There are about 22 types of fishing gear used to catch fish in WPP 571 Aceh, but developed intensively only 12 types of fishing gear [14] (Figure 2).

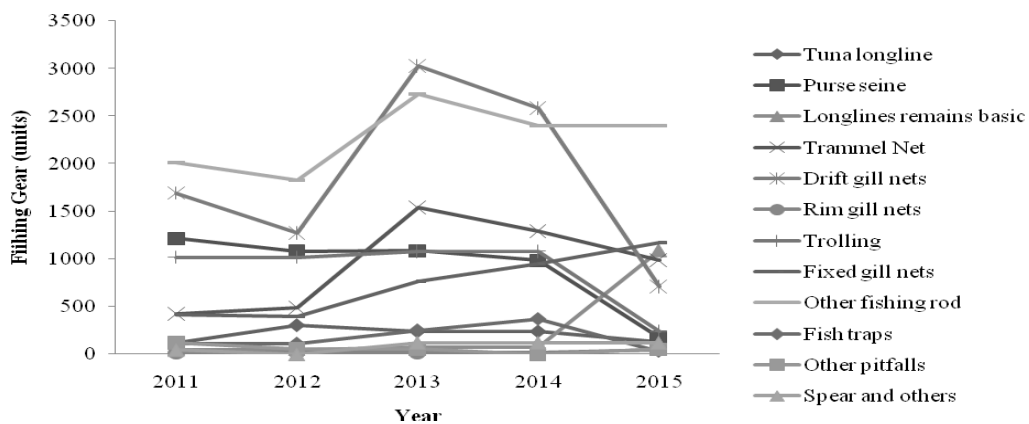


Figure 2: Fishing gears in WPP 571 Aceh

Based on Figure 1, some fishing gears developed by Aceh fishermen in WPP 571 are a drift gill nets, longlines remains basic, trammel net, purse seine, trolling and fixed gill nets. Development of the fishing gears has been carried across generations to catch certain fish groups, without regard to the carrying capacity of the condition of the environmental and technical existing. By using the scoring method, for 12 different types of fishing gear will be determined which fishing gear featured from the joint of environmental and technical aspects to be developed in the future. Consideration of the various aspects of management will ensure sustainability of fish resources and the survival of fishing [1,8,10]. Table 2 presents the results of the assessment of environmental aspects of fishing gears in WPP 571.

**Table 2:** Results of the assessment of environmental aspects of fishing gears in WPP 571

	X	OP	X	OP	X	OP	X	OP	X	OP	X	OP	X	OP	X	OP
<b>Fishing Gears</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>4</b>	<b>4</b>	<b>5</b>	<b>5</b>	<b>6</b>	<b>6</b>	<b>7</b>	<b>7</b>	<b>8</b>	<b>8</b>
Tuna longline	4	1	3	1	3	2	1	3	3	2	3	1	3	2	3	1
Purse seine	1	4	1	4	2	3	2	2	2	3	1	4	1	4	2	3
Longlines	3	2	3	1	3	2	3	1	3	2	3	1	3	2	3	2
remains basic																
Trammel Net	1	4	2	3	3	3	3	1	3	2	3	2	2	3	2	3
Drift gill nets	3	2	3	2	3	2	3	1	4	1	3	2	3	2	3	2
Rim gill nets	2	3	2	3	2	3	2	2	4	1	3	2	3	2	2	3
Trolling	4	1	4	1	3	2	2	2	4	1	4	1	4	1	4	1
Fixed gill nets	3	2	2	3	3	2	2	2	4	1	2	3	3	2	2	3
Other fishing rod	4	1	3	2	3	2	3	1	3	2	3	2	3	2	3	2
Fish traps	4	1	4	1	4	1	3	1	4	1	4	1	4	1	4	1
Other pitfalls	3	2	3	2	3	2	3	1	4	1	3	2	3	2	3	2
Spear and others	3	2	2	3	1	4	1	3	2	3	3	2	3	2	3	2

Description : X1 = the selectivity of fishing gear, X2 = the friendliness for the fish habitat, X3 = the quality of fish caught, X4 = the safety for fishermen, X5 = product safety for consumers, X6 = by-catch is low, X7 = positive impacts on biodiversity, X8 = security for protected fish, and OP = order of priority

For selectivity criteria, tuna longline, trolling, other fishing rod and fish traps are the most selective (Table 2). This is because the fishing gears operated with hook system or trap using a particular bait, so that only the target fish that can be caught. Especially for fish traps and other fishing rod, it is useful to support the management of the potential of demersal fish in WPP 571. For the friendliness of the habitat, trolling and fish traps are the best fishing gear, for minimum interaction with the fishery resources and other components of the fishing ground. Spear also has little interaction, but because its operation by means speared so that potentially damaging to other components of the fishing ground when the target fish is not affected [6].

For criteria of the safety for fishermen and product safety for consumers, traps and other traps are the best. Spear is considered less friendly for fishermen because to operate the fishing gear, fishermen have to dive. Tuna longline is also considered less friendly, because the target fish have a large size (tuna fish), so it needs a great power and prudence in the catch. Operation of trolling, other fishing rod and fish traps are considered more able to maintain the security of the protected fish. Selection of the hook size and bait types can minimize the chances of non-target fish caught, including from protected species [18]. Draft wake of fish traps and the location of its operations also can prevent protected fish caught, especially species of sea eel. Table 3 presents the results of the assessment of technical aspects of fishing gears in WPP 571.

**Table 3:** Results of the assessment of technical aspects of fishing gears in WPP 571

<b>Fishing Gears</b>	<b>X1</b>	<b>OP1</b>	<b>X2</b>	<b>OP2</b>	<b>X3</b>	<b>OP3</b>	<b>X4</b>	<b>OP4</b>	<b>X5</b>	<b>OP5</b>	<b>X6</b>	<b>OP6</b>
Tuna longline	3	2	6,500	5	30	4	9	4	20	5	15	6
Purse seine	3	2	15,000	1	70	1	15	2	40	2	65	2
Longlines remains basic	3	2	6,000	6	30	4	8	5	15	6	10	7
Trammel Net	4	1	8,500	4	40	3	16	1	40	1	25	5
Drift gill nets	4	1	15,000	1	70	1	15	2	40	2	75	1
Rim gill nets	3	2	11,500	3	50	2	12	3	25	4	30	4
Trolling	3	2	5000	7	22	5	8	5	25	4	15	6
Fixed gill nets	2	3	13,000	2	30	4	12	3	35	3	35	3
Other fishing rod	2	3	850	9	5	7	1	8	10	7	3	9
Fish traps	3	2	1,000	8	8	6	3	6	15	6	5	8
Other pitfalls	2	3	500	10	3	8	2	7	8	8	2	10
Spear and others	1	4	500	10	2	9	2	7	8	8	2	10

Description : X1 = the completeness of production equipment, X2 = the capacity of the hold (kg/trip), X3 = the load capacity of the ice (beams/trip), X4 = employment / crew (persons/unit), X5 = capacity of the engine (HP), X6 = the size of the vessel (GT), and OP = order of priority

Based on Table 3, trammel net and drift gill nets have the most complete production equipment. But to hold capacity, purse seine and drift gill nets are the greatest, that each of about 15,000 tons. For the loading capacity of the ice, purse seine, drift gill nets, rim gill nets and trammel net are the greatest. This condition is affected by the number of days at sea longer for the fishing gears (2-3 weeks each trip) and location of fishing grounds reach ZEE [1,12]. For employment criteria, trammel net, purse seine and fixed gill nets are a lot of recruiting, wherein each around 16 persons, 15 persons and 15 persons. Employment is less frequent in other fishing rod, other pitfalls, spear and others, because of the relatively small scale of activities [6].

For criteria of engine capacity, purse seine, trammel net and drift gill nets using a large capacity (40 HP). But for the size of the vessel, only purse seine and drift gill net that have a large size (each 65 GT and 75 GT), whereas trammel net only 25 GT. Operation of trammel net by sweeping the ocean floor is the main reason the

use of a large capacity engine, although the fishing gear and vessel used are not too large [12]. While in drift gill nets, the use of engine and large vessel needed for the mobilization of fishing gear is generally large and ease of operation in the fishing ground [3,9,11]. It is also to anticipate adverse weather conditions, such as high speed of water currents in WPP 571 (Table 1).

**3.2.2. Joint Assessment of Aspects**

Results of a joint assessment of environmental and technical aspects are the basis for the selection of fishing gear featured in 571 WPP Aceh. Fishing gear featured will be expected to ensure the fish production in Aceh Province, without causing any destructive effects on the waters environment, the location of fishing grounds. Table 4 presents the standardization results of a joint assessment of the environmental and technical aspects in WPP 571.

**Table 4:** Standardization results of a joint assessment of technical aspects of the environment

<b>Fishing Gears</b>	<b>V1</b>	<b>V2</b>	<b>V<sub>Joint</sub></b>	<b>OP</b>
Tuna longline	0.535	0.428	0.963	8
Purse seine	0.000	0.920	0.920	9
Longlines remains basic	0.628	0.373	1.001	7
Trammel Net	0.372	0.743	1.115	4
Drift gill nets	0.698	1.000	1.698	1
Rim gill nets	0.419	0.633	1.051	6
Trolling	0.884	0.406	1.289	2
Fixed gill nets	0.465	0.608	1.074	5
Other fishing rod	0.674	0.070	0.744	11
Fish traps	1.000	0.190	1.190	3
Other pitfalls	0.698	0.059	0.757	10
Spear and others	0.279	0.000	0.279	12

Description: V1 = value function of the environmental aspect, V2 = value function of the technical aspect, V<sub>Joint</sub> = value function of a joint assessment of aspects, and OP = order of priority

Based on Table 4, drift gill nets was selected as the most featured (first priority) to be developed in WPP 571 Aceh. The fishing gear has value function of a joint assessment of environmental and technical aspects (V<sub>Joint</sub>) about 1,698. Trolling and fish traps are second and third of fishing gear featured to be developed in WPP 571. Trammel net and fixed gill nets are fourth and fifth of fishing gear featured to be developed in WPP 571, with value function of a joint assessment of aspects (V<sub>Joint</sub>) each 1.115 and 1.074.

To support the production of fish groups, trolling can be relied upon to catch big pelagic fish, while the drift gill nets and fixed gill nets reliable for small pelagic fish. The availability of two options of fishing gear to catch small pelagic fish is very appropriate, because this fish group has highest potential in WPP 571, reaching 147,300 tons/year [13]. In addition, its production is also high in the last 11 years (Figure 1). Fish traps and



trammel net as featured to catch demersal fish and shrimp and marine non-fish. For fish traps, has started to be developed to catch demersal fish in WPP 571 Aceh, for example in Sabang and Pidie waters to replace spear [6, 10].

#### **4. Conclusion**

The condition of the waters around the fishing ground in WPP 571 Aceh is generally quite good. Fish production in WPP 571 Aceh tends to increase in the last 11 years, with the highest production occurs in small pelagic fish. Based on the priority, fishing gear featured are each drift gill nets ( $V_{\text{Joint}} = 1.698$ ), trolling ( $V_{\text{Joint}} = 1.289$ ), fish traps ( $V_{\text{Joint}} = 1.190$ ), trammel net ( $V_{\text{Joint}} = 1.115$ ) and fixed gill nets ( $V_{\text{Joint}} = 1.074$ ).

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