Strategy to re-utilization shrimp resources in the Arafura Sea

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Abstract. Shrimp resources in FMA 718 have not been optimally utilized. This study aims to analyze the characteristics of shrimp use after the moratorium policy and formulate recommendations for the use of shrimp in the Arafura Sea that provide maximum benefits for the community. The research was conducted in 2020. The data used in this study are secondary data. The data analysis method used is multi-criteria analysis with the TOPSIS technique. The criteria used include ecological, economic and social aspects with nine criteria. These criteria are the catching range, the potential for shrimp, the effect of shrimp use on shrimp resources and the aquatic environment, the income of business actors, the value of shrimp, the benefits received by the central government, the benefits received by the local government, the possibility of conflict in the use of fishing gear and the area of fishing and labor recruitments. The policy options presented in this study are the option of using shrimp in existing conditions, the option of utilizing shrimp with the addition of a smallscale trawl, the option of utilizing shrimp using small scale trawl and large trawl, and the option of utilizing shrimp only using a large scale trawl. Recommended policy options using the Topsis method which gives the highest ci value, namely option 3.

1. Introduction

The Arafura Sea is a Fishery Management Area (FMA) 718, one of the waters that are the prima donna of Indonesian fisheries fishing, better known as 'The golden fishing ground.' This is evident from the number of fishing boats that have applied for permits to catch in WPP 718. The catch is the prawn commodity which is the best type of shrimp. These fishing vessels are dominated by trawlers, one of the most effective types of fishing gear for catching bottom fish and shrimp.

Intensive utilization of shrimp resources in Arafura waters has been carried out since 1970, which was started by a joint venture between Indonesia and Japan-based in Sorong and Ambon. Since that year, the intensive use of shrimp has continued to increase. The total catch of demersal fish and shrimp during the 2000s was 300,000 tonnes per year, with the number of vessels operating reaching 1,100 units [1]. Furthermore, Sumiono et al. in 2011 stated that the proportion of shrimp and bycatch in shrimp fisheries in the Arafura Sea seems to vary according to sub-area or time (annually) [2].

To protect shrimp resources and the environment in FMA 718, various regulations and technical arrangements have been established, such as Presidential Decree No.39 / 1980, followed by Presidential Decree No. 85 of 1982, mandatory use of BRD / TED (Kep. Dirjen Perikanan No. 868 / Kpts / IK.340 / II / 2000; Kep. Dirjen Perikanan No. IK.010 / S3.80.75 / 1982), and setting the size of the mesh (Kep. Dirjen Perikanan 340/1990). The various regulations imposed in FMA 718 are not followed by adequate law enforcement in their implementation. All these regulations are unable to reduce the negative
excesses of trawling operations. This condition is exacerbated by the increasing number of IUU fishing and vessel size markdown, distorts the licensing control system and mechanism (input control), plus suboptimal enforcement of regulations, making trawl fisheries area uncontrollable. So that there is more catch in stocks of various fish resource commodities [3,4].

Under these conditions, the government has imposed a Temporary Suspension (Moratorium) on Capture Fisheries Business Licensing in the Indonesian FMA through regulation No. 54 / Permen-KP / 2014, which has been revised into Permen KP No.10 / Permen-KP / 2015 and the Prohibition of Using Hela Trawls (Trawls) and Trawling Fishing Tools (SeineNets) in WPPN-RI through the Minister of Marine Affairs and Fisheries Regulation No. 2 / PERMEN-KP / 2015. This policy is expected to restore the condition of shrimp resource stocks and environmental damage in FMA 718 [5]. But on the other hand, this policy also led to an increase in unemployment, a decrease in Regional Original Income, a decrease in fish production, a decrease in foreign exchange due to a decrease in the number of shrimp exports. The reduction of 614 trawl vessels also reduced the operating vessels by 2.75%, production went down by 18.41% in the start of the period but increased by 8.84% in the end. Rent increased by 34.09% as well as biomass by 31.57%. This increase is caused by the reduced cost which was bigger than the reduced income calculated from multiplying production and selling price [6]. According to Haynes et al. in 1986 [7] and Charles in 2001 [8], the management of fishery resources can increase benefits for fisheries actors. Therefore it is necessary to have a fisheries management policy that provides benefits to fisheries actors and maintains the sustainability of these fishery resources.

This study aims to analyze the characteristics of shrimp use after the moratorium policy and formulate recommendations for the use of shrimp in the Arafura Sea that provide maximum benefits for the community. The data analysis method used is multi-criteria analysis with the TOPSIS technique. Multi-Criteria Decision Making is a method that helps the decision-making process that has many criteria. According to Mulliner et al in 2016, Multi-Criteria Decision Making is a set of methods that deals with evaluating a series of alternatives that are many, often contradictory, and have various criteria [9]. The purpose of the Multi-Criteria Decision Making is to provide choices, ratings, descriptions, classifications, groupings, and to sort alternatives from the most preferred to the least preferred option. The TOPSIS method is a multi-criteria decision-making method that was first introduced by Yoon and Hwang in 1981 [10].

2. Characteristics of existing shrimp utilization in the Arafura Sea
In 1980, Presidential Decree No. 39 of 1980 concerning the elimination of trawling operations in all Indonesian waters. With this policy, the number of fishing vessels with trawlers continues to decline. However, in 1982 Presidential Decree No. 85 of 1985 was issued, which allowed trawlers equipped with bycatch filter equipment to operate only in the time area of Indonesia, namely the Arafura Sea and its surroundings.

The operational bases for shrimp fishing vessels are mainly in Sorong, Tual, Bintuni, Benjina, Merauke, and Kendari. Many industrial shrimp trawlers are operated in the Eastern Indonesia Region (KTI), especially in the waters around Papua Island, such as in the waters of Arafura, Sele Strait, and Bintuni Bay. Some of the water areas built for the trawl fleet operating in the Arafura Sea are Benjina, Wannam, Agats, Avona (Maparpe), and Merauke. Among these fishing, bases are being built by shrimp fishing companies, such as PT Daya Guna Samudera, a subsidiary of PT. Djajanti Group. The fishing trawl area in L. Arafura can also be monitored from the monitor screen Vessel Monitoring System (VMS). DKP has only operated since 2004, where vessels with VMS transmitters can be monitored for 24 hours. The latest data (February 2005) at the Directorate General of Capture Fisheries shows that the number of shrimp trawlers licensed in L. Arafura is 355 vessels ranging in size from 31 GT to 515 GT.

Since the issuance of Permen KP Number 02 of 2015 concerning the Prohibition of Fishing with Hela Trawls and Trawl Trawls, there is no longer fishing for penaeid shrimp using shrimp trawl fishing gear throughout WPP-RI. An alternative to trawling for catching penaeid shrimp is using a gillnet with the active operation or what is known as a "coker." The catch of shrimp using trammel net and monofilament shrimp nets by fishers is increasing. This has attracted the interest of other fishers to seek
luck catching banana prawns in coastal waters, adding fishing gear. The Kaimana fishermen are increasingly feeling the impact of the ban on shrimp trawling. Some shrimp-catching areas are also felt to be expanding. In Kaimana bay, now the spread of penaeid shrimp has entered the waters of Sarlota Island, Mandais, Tj. Simora, Karang Galampa, Tj. Besari, Pasar Baru Kaimana Waters, Arguni Waters, Coa Waters, Lombo Sand, Kampung Baru, Air Merah, Pasar Baru, Kaki Air and Arguni and the surrounding waters.

Based on the research of Misbah et al. in 2017, shrimp fishing activities in Kaimana only range from the coastal area 1-4 miles to the sea with a depth of 1 - 5 meters for monofilament shrimp nets and 5-20 meters for trammel nets with mud and sandy mud bottoms [11]. In general, shrimp fishing in Kaimana is divided into two main fishing grounds, namely.

1. The estuary waters in the Arguni area above, Arguni below, and the surrounding coastal waters close to rivers such as Burumi, Bahamia, Ubia, Wamesa, Warahuta, Rauna, Tawera and their surroundings with a depth of 1 - 5 meters. This area is commonly referred to as village waters and most of those who catch our local fishermen. Fishing gear that is commonly used is monofilament shrimp nets with mesh sizes 1.75” and 2”. Catching by fishers is carried out almost all year round. It can damage the net, so fishers do not catch shrimp at that location but instead catch fishing ground 2, namely around the Coa area, Tanjung Simora, and Kaimana Bay.

2. The waters of Kaimana Bay and its surroundings. In June-November, also known as the eastern season, shrimp start to migrate from the estuary to the coast and then to deeper waters around Kaimana Bay, starting from Tawera Beach, Sarlota Island, Coa Waters, Mandais, Tanjung Simora, Karang Galampa, Tanjung Besari, Pasar Baru, Red Light and its surroundings with a water depth of about 5-20 meters. In these waters, shrimp are caught using trammel net fishing gear by Kaimana fishers. At the same time, shallow coastal areas caught by local fishermen (Arguni) using monofilament shrimp nets. In the eastern monsoon, the Kaimana waters are characterized by wavy waters, strong winds and currents, and turbid waters. The peak of arrests occurred in July-August. In this season, the conditions of these choppy waters, the shrimp swim in the current so that the shrimp are evenly distributed in the water layer, which causes many shrimp to be caught. Meanwhile, in the shady season (west), the condition of the waters is bright, the currents and waves are relatively small, the shrimps start to be caught a little by the trammel net and the monofilament nets. The low season starts from November to May. At this time, Arguni fishers returned to enjoy the catch of shrimp in the Ground 1 fishing area, while only a small portion of the Kaimana fishermen and its surroundings (FG 2 fishers) were still looking for luck operating the trammel net. Most of them operated other fishing tools such as fishing nets, trolling lines, basic fishing lines, and mackerel fishing lines.

There are many types of fishing gear operating in FMA 718 such as squid jigging, oceanic gill net, small pelagic purse seine, seabed longlines, lion bun, cash net etc. The largest number of vessels is vessels with squid jigging. There are 706 vessels with squid jigging in FMA 718 (based on licensing data as of September 7, 2020). The accumulation of GTs of squid jigging catching in FMA 718 reached 75,659 GT or an average of 107 GT per vessel. The number of fishing boats in FMA 718 can be seen in table 1.

| Fishing gear type          | Number of fleet (unit) | Number of tonase (GT) |
|----------------------------|------------------------|------------------------|
| Squit Jigging              | 706                    | 75,659                 |
| Oceanic gill net           | 469                    | 46,648                 |
| Small pelagis purse seine  | 285                    | 42,319                 |
| Seabed longlines           | 167                    | 13,133                 |
| Lion bun                   | 22                     | 1,171                  |
| Bouke ami                  | 8                      | 942                    |
| Cast nets                  | 8                      | 981                    |
| Hand lines                 | 7                      | 682                    |

Table 1. Central fleet licensing at WPP 718 as of September 7, 2020.
Technically, the dominant fishing gear operating in the Arafura Sea is not aimed at catching shrimp but for catching squid, demersal fish, and small pelagic fish. In terms of the number of ships operating in the Arafura Sea, in 2020, more than the number of ships in 2011. However, in terms of capacity, as seen from the number of GTs, it has decreased compared to 2011.

Based on the Decree of the Minister of Marine Affairs No. 50 of 2017 concerning the estimated potential, the amount of catch allowed, and the utilization rate of fish resources in FMA 718, the total fish potential is 2.64 million tons. The biggest potential is demersal fish, namely 876,722 tons, and shrimp potential 62,842 tons. The highest utilization rates are for squid and reef fish, namely 1.28 and 1.07, which means that the number of fish catches has exceeded the allowable catch. The lowest utilization rate is small pelagic fish, namely 0.51%. The types of fish groups that have experienced overfishing are squid, reef fish, large pelagic fish, and lobsters. In more detail, the size of the potential, the amount of catch allowed, and the level of use for fisheries in the Arafura Sea is presented in Table 2.

### Table 2. Potential, total allowable catch and utilization rate of fish in FMA 718.

| Resources             | Small pelagic | Large pelagic | Demersal | Reef fish | Shrimp | Lobster | Crab | Blue swimming crab | Squid | Total       |
|-----------------------|---------------|---------------|----------|-----------|--------|---------|------|-------------------|-------|-------------|
| Potential             | 836,973       | 818,870       | 876,722  | 29,485    | 62,842 | 1,187   | 1,498| 775               | 9,212 | 2,637,564   |
| TAC                   | 669,579       | 655,096       | 701,378  | 23,588    | 50,274 | 950     | 1,198| 620               | 7,370 | 1,108,053   |
| Production (2018)     | 58,380        | 23,524        | 110,276  | 36,399    | 3,465  | 1       | 5,049| 3,142             | 17,140| 818,870     |
| f-opt (unit)          | 2,583         | 5,028         | 2,741    | 5,430     | 178,571| 9,860   | 6,119| 11,904            | 1,058 | 1,954,185   |
| f-actual (unit)       | 1,316         | 4,963         | 1,828    | 5,822     | 153,206| 9,313   | 5,226| 9,169             | 1,354 | 836,973     |
| Utilization rate      | 0.51          | 0.99          | 0.67     | 1.07      | 0.86   | 0.97    | 0.85 | 0.77              | 1.30  | 0.65        |
| Standart gear         | Pure          | Purse         | Gill net | Hand lines| Trammel | Gill net| Trap  | Gill net          | Squid | jiggng      |
|                       | Seine         | Seine         | Gill net | Gill net  | Trap    | Gill net|      |                  |       |             |

Source: MMAF (2017)

Shrimp resources in the Arafura Sea in 2018 were only utilized for 5.09% of its sustainable potential. Utilization is carried out by the community only on a small scale using trammel net and gillnet monofilament (small-scale fishing gear) with an average catch of 10-15 kg/trip and only operating in coastal waters <4 miles. The stock assessment results indicate that the shrimp resources in FMA 718 have not been optimally utilized.

3. Strategy to re-utilization of shrimp resources in Arafura sea

The formulation of a strategy to re-utilise shrimp resources in the Arafura Sea is reviewed from the ecological, economic, and social aspects. In the ecological aspect, the criteria are the catch range, shrimp potential and the effect of fishing on the aquatic environment. In the economic aspect, the criteria used are the business actor's income, the value of the shrimp caught, the benefits of the central government, and the benefits of the provincial government. In the social aspect, the criteria included are potential conflicts in the use of fishing gears (API) and fishing grounds (DPI) and labour recruitment. These three aspects are used to measure the possible impact on the use of four scenarios, namely the existing scenario (1), the addition of small scale trawling (2), addition small scale trawling and large scale trawl (3) and addition large scale trawl (4) according to the weights that have been determined. (Table 3).

The criterion of catch range is the area of fishing location in the Arafura Sea that is used to catch shrimp. In the option 1, the area of the shrimp fishing location are very small, the score is 1. In option 2, the area of the shrimp fishing location is greater than option 1, but it is still less than the other options, the score is 1. In option 3, the area of fishing locations is almost all over the Arafura Sea, the score is 3. In Option 4, the fishing location is only in the EEZ, the score is 2.
The criterion for potential shrimp is the availability of potential shrimp after the catching of shrimp using the four scenarios. The potential for shrimp is very high when used in option 1; the score is 3. In option 2, by utilizing the potential of shrimp in an area less than 12 miles, it is suspected that the shrimp stock is in optimal condition; the score is 3. In option 3, shrimp are catching in areas less than 12 miles, and in the EEZ area, the score is 1. In option 4, the utilization was carried out in the EEZ, and it is suspected that shrimp stocks are still available in areas less than 12 miles; the score is 2.

The fishing impact criteria are the negative effects that may occur on shrimp resources and the aquatic environment using each fishing scenario. Option 1, gillnet fishing gear and squid fishing rod and trammel net, which are environmentally friendly fishing gear, do not harm shrimp resources and the environment, the score is 3. Option 2, this option does not harm shrimp resources and the aquatic environment, the score is 3. Option 3, catching shrimp using small scale trawl and large scale trawl, it is suspected that the use of shrimp exceeds the optimal utilization level and disruption of the aquatic environment, the score is 1. Option 4, the use of shrimp using a large-scale trawl carried out in the EEZ, has a slight negative impact on shrimp resources, aquatic environment, fishing location; the score is 2.

The business actor's income criteria is the total income or total benefits received by all fish business actors. In option 1, the economic benefits received by the business actor are minimal from the use of shrimp; the score is 1. In option 2, the benefits received by the business actor are higher than in option 1; the score is 2. In option 3, the economic benefits received by the business actor very high, both small-scale and large-scale fishers; the score is 3. In option 4, the benefits received by large-scale business actors are very high, but it does not provide benefits for small-scale business actors; the score is 2.

The value of shrimp criteria is the value of shrimp caught from each policy scenario. In option 1, the value of the shrimp produced is deficient; the quality of the shrimp is not following the export standard, the score is 1. Option 2, catching shrimp using a small-scale trawl, is expected that post-fishing technology is found so that the quality of the shrimp be accorded export standards; the score is 2. Option 3, the volume of the catch of shrimp is the highest amount in this option, and the quality of the shrimp can also accord the export standard; the score is 3. Option 4, the volume of the catch is lower than the volume of the catch in option 3, but the quality of the shrimp produced is the best; the score is 2.

The benefits of the central government criteria are the benefits received by the central government in the use of shrimp in FMA 718. In this study, the benefits received were seen from the amount of PNBP paid by fisheries business actors with more than 30 GT vessels. In option 1, fishing vessels using gillnet fishing gear, squid fishing rod, purse seine provide high benefits for the central government because all vessels have central government permits; the score is 3. In option 2, the addition of small-scale trawlers and existing vessels still catching fish, the score is 3. Option 3 is mostly by trawling shrimp, and there is a possibility of reducing the existing vessels; the score is 2. Option 4, all trawlers have a central license, giving high PNBP to the central government, the score is 3.

The local government benefits criteria are the provincial government revenue from fisheries levies. In option 1, most or all fishing vessels in the Arafura Sea are vessels with central government permits, so the benefits received by the local government are minimal; the score is 1. In option 2, there is an increase in the benefits received by the local government due to the addition of small-scale trawls; the score is 2. Option 3 provides high benefits for the local government because the number of trawlers operating in the Arafura Sea is high; the score is 3. In option 4, with ship permits, most of the time is a permit from the central government, but the landing of shrimp or catch is carried out in the area. Thus providing little benefit to local governments, the score is 2.

The conflict criteria are conflicts that can occur because of using the same fishing gear and fishing area. In option 1, there is no conflict in fishing gears and fishing grounds; the score is 3. In option 2, there is no conflict in fishing gears, but there is a possibility of conflict in the same fishing area; the score is 2. Option 3, there is a possibility of conflict in fishing gears, and the fishing area is very high; the score is 1. Option 4, there may be a conflict in fishing gears, but there is no conflict in the fishing area; the score is 2. The strategy for resolving conflicts over shrimp resources in the Arafura Sea is with sufficient supervision and policy [12].
Labor recruitment criteria are the number of workers required for the implementation of each policy option. The highest number of workers occurs in option 3, the score is 3, and the lowest in option 1, the score is 1. Options 2 and 4 require almost the same labor; the score is 2.

Table 3. Scores of criteria in the use of shrimp resources in FMA 718.

| Aspects     | Criteria                          | Option 1 | Option 2 | Option 3 | Option 4 |
|-------------|-----------------------------------|----------|----------|----------|----------|
| Ecology     | Catch range                       | 1        | 1        | 3        | 2        |
|             | Shrimp potential                  | 3        | 3        | 1        | 2        |
|             | Fishing impact                    | 3        | 3        | 1        | 2        |
| Economic    | Business actor's income           | 1        | 2        | 3        | 2        |
|             | Value of shrimp                   | 1        | 2        | 3        | 2        |
|             | The benefits of the central government | 3        | 3        | 2        | 3        |
|             | The benefits of the local government | 1        | 2        | 3        | 2        |
| Social      | Conflict                          | 3        | 2        | 1        | 2        |
|             | Labor recruitment                 | 1        | 2        | 3        | 2        |

Using the TOPSIS technique, the best policy is the policy or option that gives the highest ci value, namely option 3 (shrimp catching uses small scale trawl and large scale trawl with few existing vessels to catch squid and other fish). Policies that provide the lowest benefits are those with the lowest ci value (Option 1). Table 4 shows The value of ci for each option.

Table 4. TOPSIS output of shrimp resource utilization in FMA 718.

| Opsi                        | TOPSIS       |
|-----------------------------|--------------|
|                            | di+          | di-          | ci           |
| Zero Trawl (1)              | 0.1194       | 0.0862       | 0.4193       |
| Small scale trawl (2)       | 0.0820       | 0.0901       | 0.5236       |
| Small scale trawl and Large scale trawl (3) | 0.0862 | 0.1194 | 0.5807 |
| Large scale trawl (4)       | 0.0730       | 0.0757       | 0.5090       |

4. Conclusion
The Temporary Termination Policy (Moratorium) on Capture Fisheries Business Licensing at Indonesian FMA has caused the use of shrimp in FMA 718 not to be optimal (under fishing). The strategy to re-utilization shrimp resources in FMA 718 is providing opportunities for small and large-scale fishers to use trawlers to catch shrimp.

Policy Implications
1. Comprehensive research to determine shrimp stocks that can utilize while maintaining the sustainability of shrimp resources so that fishing vessel licensing can be determined precisely
2. Ease of capital for business actors wishing to start or develop shrimp fishing businesses in FMA 718. Maritime and fisheries business capital management institutions (LPMUKP), banks, and other capital institutions can play a role in providing capital assistance for fishers and business actors.
3. Provision of a fish processing unit (UPI) to handle and post-harvest shrimp processing to maintain shrimp quality. Currently, several UPI units are not operational. So it takes the role of the private sector and the government, in this case, the Director-General of PDSKP, to revitalize UPI
4. The development of post-harvest technology aims to maintain the quality of shrimp caught by small-scale fishermen. Shrimp handling facilities on small-scale vessels are inadequate, so shrimp handling technology is needed. Post-harvest researchers, fish processing academics, and the private sector can play a role in acquiring technology for handling shrimp caught by small-scale fishermen.
5. Workforce training to acquire fishing skills, especially in shrimp fishing. This training aims to improve fishermen's skills in operating large-scale fishing gear. It is known that so far, the operators of trawling vessels are foreign crew members or better known as foreign crew. The government can cooperate with overseas training institutions that have expertise in operating trawlers.

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