Management policy of small-scale tuna fisheries based on island cluster in Maluku

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Abstract. Tuna is one of essential economic fish commodities in Maluku which mostly caught by handline and trolling line small scale fishery with fishing vessel capacity under 5 GT. The fishing vessel numbers and fish production of this fishery are declining recently, and the catching was predominantly by small size. The highest yellowfin tuna production was found in Island Cluster 7 amounted to 9,107 tons or 31% of total yellowfin tuna production in Maluku by 2019. This study was aimed to analyze the condition of yellowfin tuna in Maluku and to propose a management policy for small-scale tuna fishery base on Island Cluster. Result shows that the production between 2013-2019 was stagnant with a declining tendency. The implementation of island cluster approach in small-scale tuna fishery management will increase the efficiency, productivity, and competitiveness on it, especially at the potential island clusters 7, 5, and 4. Of all island clusters found, island cluster 7 having the highest performance indicator for small-scale tuna fishery.

1. Introduction
Fisheries is a prime sector in Maluku since it contributes significantly towards the Maluku economy sector shown by Gross Domestic Regional Product (GRDP). Between 2015-2018 the average GRDP from the fishery sector was 12.72%, which decreased slightly to 12.53% in 2019 [1]. One of essential economic pelagic fish resources is tuna fisheries. The production of tuna in Maluku between 2010 and 2018 was fluctuating, with a yearly average increment of 45.46%, whereas the national production for the same year was 9.54% [2].

The small-scale fishery plays a significant role in tuna fishery in Indonesia, contributes 70% towards national production. However, this small-scale fishery management was not running appropriately. Based on Indonesian Community and Fisheries Report [3], in Maluku waters, especially in Banda Sea (FMA 714) and Ceram Sea (FMA 715), the fishermen's catching were dominated by juvenile yellowfin tuna in the last 3 years (2017-2019) with an average of 73.72%.

The condition of yellowfin tuna in Banda Sea and declared that natural mortality was 0.49 per year, fishing mortality was 0.98 per year, and exploitation status increase by 0.67 per year [4]. The study indicated that growth overfishing is taking place since the catch was not the size permitted. Overfishing happened since fishing mortality is higher than natural mortality and the utilization level is higher than optimum utilization of 0.5.

The small-scale tuna fishery belongs to a business that requires high investment and operational cost. The topmost variable cost is fuel (mainly gasoline) which in the last 5 years increase from an average of 40 L per day to 60 L per day, especially for the tuna fishermen from Ambon island. It is due to the increasing of travelling time from fishing base to the fishing ground, while the production decline of up to 50%. The present condition of small-scale tuna fishery has to be a concern by the local government to find out the solution because this fishery contributes significantly to the fishery sector.
and GDPR of the province. Other obstacles faced by this fishery is production quality and ecolabeling if it is targeted for export. To enter the international market, tuna product should obtain an ecolabel certificate from an ecolabel agency like the Marine Stewardship Council (MSC) or Fairtrade USA. This certificate explains that fishery management is undertaken in sustainable principles.

MDPI, as an independent foundation focuses on sustainable and responsible fisheries. It already supports small-scale fisheries in four districts in Maluku, Central Maluku, Buru, South Buru and Eastern Seram with 34 Fair-Trade Committee (FTC). Currently, only 16 FTC still active with 272 fishermen members, and produce a total premium fund of IDR 3.7 trillion [3].

Cluster island development plan has been organized in Spatial Zone Region Plan 2013 – 2033 of Maluku [5]. Accordingly, the Government of Maluku has established a fishery agency branch based on 12 cluster islands to manage the fish resources potency at each cluster island.

The management of small-scale tuna fishery up to the present time has not been organized based on the cluster island approach, particularly at island cluster that has potential tuna fishermen. Cluster island-based tuna fishery approach has the objective to create integrated spatial management incorporating all business sectors and tuna fishery stakeholders in Maluku.

Problem complexity and obstacle faced by small-scale tuna fishery in Maluku requires government role and policy to synergy small-scale tuna fishery management with multi-stakeholders integrated at all level of processes. This study aim to assess the condition of yellowfin tuna resources in Maluku and to formulate policies for small-scale tuna fisheries management based on island clusters.

2. Methodology

This study was conducted by using a qualitative approach. Data was collected by using observation and documents review, and analyzed by descriptive analysis. This study was limited to small-scale tuna fisheries, namely handline fishing fleets under 5 GT and focused on yellowfin, which is the most common type of tuna caught by small-scale handline tuna fishermen in Maluku.

3. Result and discussion

3.1. Yellowfin tuna potency and its exploitation level in Maluku

Tuna belongs to big pelagic fish with cosmopolitan characteristics, lives in a tropical and sub-tropical oceanic area with a distribution pattern related to oceanography regime. On a global scale, 65% of tuna stock is in sustainable abundance, 17.5% is in the over-exploitation level, and the other 17.5% at a moderate level. In terms of exploitation, 70% of tuna stock is under overfishing conditions, and the other 30% is in overfished status [6].

The world tuna production in 2018 was 5,171,182 ton consist of 3,042,606 t of skipjack (59%), followed by yellowfin tuna with a yield of 1,496,586 t (30%), big-eye tuna with the production of 402,641 t (8%), and albacores of 229,349 t (5%). Approximately 61% of tuna stock is in sustainable abundance, 17% is in overexploitation, and 22% is a moderate level. In the sense of exploitation, 78% of tuna is not in overfishing, while 22% is in an overfishing situation [6].

The tuna potency in Indonesia, especially in Maluku waters, is in Fishing Management Area (FMA) 714 of the Banda Sea and FMA 715 of Seram Sea, with yellowfin tuna being the dominant one. This area also is a part of the center and western Pacific Ocean area and can be a core source in assessing tuna potency in Maluku waters. The highest tuna production in 2018 was found in the western and central Pacific Ocean with a yield of 2,773,631 t (54%) [7].

The potency of yellowfin tuna in the form of maximum sustainable yield (MSY) has not been able to assess. Based on the decree of The Ministry of Marine and Fisheries Affairs of the Republic of Indonesia No. 107/2015, concerning the management plan of tuna and skipjack tuna, the total production in 2012 was 120,524 t with the average production between 2005 and 2018 was 46,126 t. In this case, the level of yellowfin tuna utilization has not been able to assess. The estimation of yellowfin tuna production in 2018 at the Pacific Ocean (FMA 713, 714, and 715) was 167,363 t [2].
Figure 1. Estimation of tuna catches in FMA 713, 714, and 715 in Indoensia waters between 2005-2018 [8]

Figure 1 showed that the production of yellowfin tuna in FMA 713, 714, and 715 between 2005-2018 reached the highest production in 2013 with a total yield of 122,191 t. The production then decreased up to 2017 with the production of 105,605 t or decreased by about 15.7%. In 2018, the production increased again to 167,363 t. Based on fishing gear, the small handline contributes the highest production amounted to 64,788 t (30.06%), followed by purse seine (18.45%), pole and line (10.3%), and long-line (7.9%) [8]. The yellowfin tuna production in Maluku between the year of 2013-2019 tends to stagnant with a steady decrease. The production in 2013 was 22,084 t, down to 17,087 t in 2019 as showed in figure 2.

Figure 2. Production and production value of yellowfin tuna Maluku Province between 2013-2019 [9]
The yellowfin tuna production of FMA 714, 715, and 718 landed in Nusantara Fishing Port of Ambon between 2010-2019 (figure 3) shows the highest production in November, December, and May. This is aligned with the result [10] shows that the yellowfin tuna peak fishing season took place in November and December. Maluku yellowfin tuna production in 2017 was 66.06 t with the production value of IDR 1.8 billion. In the same year, yellowfin tuna production from Papua was only 5.17 t with the production value of IDR 2.2 billion, higher than Maluku. [11]. This indicates that apart from the production number, the quality of production should be in prime quality as well.

![Figure 3](image_url)

**Figure 3.** The average production number and production value of yellowfin tuna between January to December of the year 2010-2019 [12]

The yellowfin tuna production from Maluku not only came from small-scale fishery under 5 GT, but also from other fishing gear above 5 GT like purse seine (34.24%), troll and line (31%), longline (13.98%), and others gear (16.64%) (PPN Ambon, 2020). This data shows that purse seine is still in a high proportion. Some studies revealed that purses seine is non-selective fishing gear, and many have resulted in over-exploitation towards fish resources [13, 14]. This is a challenge in the tuna fishery management since the purse seine is arguing as less sustainable fishing gear, and to sustainable management principles towards purse seine.

Base on figure 4, the highest yellowfin tuna production between January to December for small-scale fishery from island cluster 7 landed in the village of Tial, Asilulu, and Laha occur in September, November, and April. This trending has also aligned with big-scale fisheries for the last 10 years.
3.2. Tuna fisheries management approach-based island cluster in Maluku

The development of Maluku based on islands in intended to accelerate regional development, to optimize the use of natural resources based on sustainable principles, human resources building capacity empowerment, and bring the service close to community. This will increase quality public service and community welfare in the 12 island cluster [5].

Observation done at the center of small-scale handline tuna fishery of island cluster 7 shows that there is a decrease in fishermen number as well as fishing vessel of less than 5 GT since 2012. Based on interviewed with the tuna supplier of island cluster 7 revealed that the decrease reaches 50% per day started from 2012. This in turn affect the small-scale tuna fishermen. Some factors believed causes this decline in tuna production as follows:

1) Decreased income of tuna fishermen;
2) Fishermen's catch has decreased both in number and size of fish (growth overfishing
3) High operating cost;
4) The fishing grounds are getting further away
5) Low supporting technologies in fishing;
6) There is still a lack of fishermen who apply fair trade principles
7) Lack of fish aggregating devices (FAD)
8) Large-scale tuna fishing fleets operating in small-scale fishing grounds.

To overcome this problem, a holistic and integrative approach in fishery management need to be implemented. Fishery business management is conducted with the choice of alternative management where highly depend on the specification, situation and condition of fishery being manage, as well as the objective of the management [15]. For this reason, one of approach proposed is the gradual fishery management, which incorporate the fishermen to be able to suit their fishery activity with new fishery activities. The government can evaluate the negative impact of fishery management implemented. Fishery management in Indonesia up to the present time is still implemented in a partial way, not integrated properly and tend to be conducted for the wellbeing of community, not the fishermen [16].

The development plan approach based on the island cluster in Maluku has been assigned in Maluku Province Directive No. 16/2013 concerning Maluku Regional Spatial Planning (Bappeda Maluku, 2013). In that directive, Maluku Province is divided into 12 island clusters based on each environmental, physical, socio-economy characteristics (Figure 5).
Apart from the island cluster development base, the development in Maluku also uses the ‘sea-land approach.’ The sea is considered as a medium that connects the islands. Marine water in Maluku is predominantly by three marine regions vis. Banda Sea, Seram Sea, and the Arafura Sea. The area also consists of various channels, bays all have their characteristics. The Maluku Province development, therefore, should need a specific plan to optimize the development to provide better social-economy welfare to the community. Sustainable principles should become a basis in the development plan and its implementation. The island cluster, therefore, becomes a basis in the management plan development [5].

The development of the island cluster concept is based on the consideration that firstly, the sea is a transportation media that connect islands in Maluku; secondly, seas as a potential area to cultivate as a productive region, thirdly, Maluku islands is a one economy unison with other areas outside Maluku, and fourthly, the development of Maluku region is not only originated from Maluku administrative but also expected to be influenced by development centers outside Maluku. The island cluster approaches adopting the multigate system that connected Maluku development centers with other development centers outside Maluku.

Based on the condition, characteristics, and development approaches mention earlier, the fisheries development approach in Maluku is also based on island cluster. Align with government regulation No. 23/2014 concerning Regional Governance, the provincial authority on fisheries management covers: 1) spatial marine area is up to 12 miles, excluding oil and natural gas; 2). Issuance permit authority up to 12 miles exclude oil and natural gas; 3). Coastal and small island community empowerment.

The development of small-scale tuna fisheries as a prime commodity of Maluku Province needs to be developed mainly at the center of the small-scale tuna fishery. The management of tuna fishery, therefore, should be differentiated from other captured based fishery. The tuna fishery needs supporting production factors like fishing fleet and fishing gears that require a high operational cost.

In the context of fisheries management including small-scale tuna fishery, some aspects that should be taken into account are the fishery ecosystem, the socio-cultural of the fishermen, technological choice available, tuna stock potency, and fishery logistic and transportation. All these factors can increase input production efficiency to produce optimal output.
The island cluster approaches will increase business efficiency if all the production inputs available uniformly at each potential small-scale tuna fishery in the island cluster. Some of the potential small-scale tuna fisheries are island cluster 7 (Ambon and Lease islands), island cluster 5 (South Seram), and island cluster 6 (Banda Islands) as showed in figure 6.

![Figure 6. Yellowfin tuna production based on Maluku island cluster.](image)

The yellowfin tuna production based on island cluster between the year of 2017-2019 shows the highest tuna fish production lies at island cluster 7, island cluster 5, and island cluster 6. Based on a one-year observation (2019) displays that there is variability in production, fishing ground, and fishing season at each island cluster. The village of Tial and Laha fishing ground is located in the Banda Sea (FMA 714), while the Asilulu Village fishing ground is located in the Seram Sea (FMA 715).

The fishery production analysis based on the island cluster shows that the tuna fishery center is not distributed uniformly at all island cluster. This is mainly due to the development of island clusters with high tuna production (Table 1). This table shows that island cluster 7 contributes significantly to the production (31%) followed by island cluster 5 (23%), and island cluster 6 (11%).

| Dimensions | Indicator                  | IC 1       | IC 2       | IC 3       | IC 4       | IC 5       | IC 6       | IC 7       | IC 8       | IC 9       | IC 10      | IC 11\& IC 12 |
|------------|----------------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|----------------|
| Ecology    | Production (ton)           | 1,207.42   | 449.11     | 29.70      | 6,671.77   | 5,891.64   | 3,250.69   | 8,165.19   | 285.24     | -          | 203.52     | 70.94         |
| Economii   | Price (IDR/Kg)             | 60,000     | 65,000     | 58,000     | 47,500     | 79,000     | 42,000     | 82,000     | 25,000     | 0          | 25,000     | 25,000        |
| Social     | Fair trade (social fund)   | 2,806.00   | 0          | 0          | 0          | 916        | 0          | 0          | 0          | 0          | 0          | 0              |
| Fisheries  | Fish Management Unit       | 100        | 0          | 0          | 150        | 0          | 0          | 5,426      | 1,450      | 4,040      | 0          | 0              |

In the context of the regional aspect, the tuna fishery management policy is in line with sustainable spatial characteristics [17] based on three domains vis. ecological system, socio-economy, and institutional. This should be in consideration in the management policy of small-scale tuna fishery based on the island cluster.

Based on fisheries management dimension analysis shows that the island cluster 7 has the highest indicator performance, but no fair-trade indicator is found. In 2014, the villages of Asilulu and Tulehu once applied the fair-trade principle in the tuna fishery. Other information can be seen in Table 1. The existence of Fair Trade is to support fishers associations and build their capacity to enhance their income and livelihood security. Funds have been applied at a community level toward a variety of...
social activities, such as: savings accounts for children’s education, school supplies, illness and bereavement funds, donations to local community centres and mosques [18].

3.3. Management policy in small-scale tuna fishery in Maluku

The FAO recommends a small-scale fishery management principle which stated that the state acknowledges the significant contribution from the artisanal fishery, small-scale fishery, the income, and food security. The country should also protect the right of fishermen, and the labor associated with fishery, especially those involve in subsistence fishery, artisanal, and small-scale [19].

Concerning small-scale fisheries management, the global scale, the developed country Common Fishery Policy (CFP) of the European Union, especially article 17, cannot increase the access to the small-scale fishery. This is contrary to the SDGs point 14.b objectives declare “offering the access to market and marine resources to small fisheries”. The recommendation, therefore, the change in the present institutional management fishery policy [20].

The tuna fishery management policy in Indonesia is built upon the directive of The Ministry of Marine and Fisheries Affair of Republic Indonesia No. 107/KEPMEN KP/2015 concerning the Fishery Management Plan (FMP) of tuna, skipjack tuna, and mackerel tuna. This directive is currently under review for new skipjack tuna and mackerel tuna FMP that focuses on fish resources and ecosystem, institutional, and market requirements. The management will be based on FMA. The area management for tuna and skipjack has been divided into Regional Fishery Management Organization (RFMO), whereas FMA 714 and 715 include in that region. Even though FMA 718 not included in RFMO for tuna and skipjack, the highest yellowfin tuna production in 2019 come from this area with the yield of 360.6 t (58.2%), followed by FMA 714.

The management policy for small-scale yellowfin tuna fishery in Maluku that based on the island cluster approach and the implementation is integrated with FMA 714 and 715. The FMA function is a tuna fishing ground, while the island cluster function as a fishery center (landing site). The management policy of small-scale tuna fishery based on the island cluster can solve the actual problem of small-scale tuna fishery in Maluku. The policy for this management is summarised in Table 2.

| Dimension       | Policy                                                                                      | Island Cluster (IC)          |
|-----------------|--------------------------------------------------------------------------------------------|------------------------------|
| Ecology         | 1. Optimizing the production and productivity of small-scale tuna fishery.                  | IC 1, IC 2, IC 3, IC 8, IC 10, IC 11 & IC 12 |
| Social and Economy | 1. Fair-trade USA system replication as a part of MDPI program in Maluku at each island cluster. | IC 2, IC 3, IC 4, IC 6, IC 7, IC 8, IC 10, IC 11 & IC 12 |
|                 | 2. Improve the price (market) system by managing market chain from the fishermen up to the Fish Processing Unit. | IC 1, IC 2, IC 3, IC 4, IC 5, IC 6, IC 8, IC 10, IC 11 & IC 12 |
|                 | 3. Preparing fish landing site infrastructure at each island cluster.                       | All islands cluster          |
| Governance      | 1. Revitalizing small-scale tuna fishery data system and management as a based for producing better management plan. | All islands cluster          |
|                 | 2. Implementing tuna size allowable catch by managing type of fishing gear used for sustainable small-scale tuna fishery. | All islands cluster          |
4. Conclusion
The study shows that the highest yellowfin tuna in Maluku was in 2013 then stagnant with decline tendency up to 2019. The highest tuna production was noted at the month of November and December. The implementation of island cluster fishery management for small-scale tuna will create efficiency, productivity, and competitiveness in the fishery especially at island cluster 7 Ambon Lease island, island cluster 5 South Seram, island cluster 4 East Seram, and island cluster 6 Banda Island. Island Cluster 7 is an island group that has a better coverage indicator for small-scale tuna fisheries compared to other island clusters in Maluku.

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