Improving the sustainability status of small-scale tuna fisheries in Central Halmahera Regency, North Maluku Province, Indonesia

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Abstract. The issue of sustainable use of tuna has been studied to meet information needs in establishing strategic policies for small-scale fisheries management in Central Halmahera Regency. The aim of study that applies the Rapfish method produced the actual status of sustainability of tuna fisheries and its improvements. The tuna fishing system, using trolling and hand fishing gear, was relatively identically coordinated and relatively sustainable components. Sustainability status improvement was designed gradually from 3%, 5%, and 10% to identify sensitive sustainability attributes. The analysis results showed that of the five components of fisheries system sustainability, the regional government policy dimension played a dominant role in improving sustainability status. For this reason, a descriptive model of sustainable co-management of tuna fisheries is proposed to implement strategies for improving sustainability attributes in small fishing cooperatives.
Key Words: co-management, improvement strategies, tuna fish, welfare.

Introduction. Tuna and its fisheries are an integral part of coastal communities that have contributed to livelihoods, economic growth and social welfare in Central Halmahera Regency. Even though this is very important and valuable, the challenges of development progress and the resulting social changes require small-scale tuna fisheries to be able to adapt to be sustainable.

In the western and central sea areas of the Pacific Ocean in Fisheries Management Area of the Republic of Indonesia (WPP-NRI 715), tuna is harvested by local fishers using trolling lines and hand lines with boats measuring no more than 5 GT. From 2020 to 2021 records, the average tuna production volume was around 6,865.66 tons year^{-1}. Tuna has contributed 30.50% of capture fisheries production in Central Halmahera Regency, North Maluku Province. The location quotient (LQ) value for tuna commodities is greater than one, so that it actually becomes the leading commodity in Central Halmahera Regency (DKP Halteng 2022).

The demand for tuna in Central Halmahera Regency is increasing, but its contribution has not provided economic benefits for local fishers groups and economy. In other words, the fish demand is increasing, but fishers have not yet benefited from production increase. This is because the marketing distribution of tuna harvest by local fisher is limited to local markets with relatively low prices and limited demand. Along with the nickel mining industry development in this area since 2018, the tuna demand for nickel mining workers consumptions has created a new larger market opportunity. The mining company employees are more than 60,000 who potentially need tuna as a source of protein (BPS 2023). On this basis, it is necessary to develop a sustainable tuna resource management strategy.

Sustainable tuna fisheries are determined by the interaction of fisheries system components which, according to Charles (2023), consist of ecology, biophysics, economics, social, culture, law, and management. The interaction strenght of the components of this system when it coexists with the rapid development of the mining industry has been studied with a diagnosis of fishery sustainability. One good diagnostic instruments is the Rapfish method (Rapid Appraisal for Fisheries) introduced by Pitcher (1999).

The Rapfish method evaluates a fishery sustainability based on a number of attributes grouped into ecological, economic, social, technological, and ethical or institutional categories using multivariate statistical ordination (MDS) techniques to map the degree of sustainability from bad to good (Pitcher 1999; Kavanagh & Pitcher 2004). This analysis technique for poor data fisheries has flexibility in evaluating fisheries health so it is widely used and developed to date, such as reports on tuna fishery in Bulukumba Regency (Ratu et al 2019), South Halmahera Regency (Abdullah & Taeran 2021), Sikka Regency (Parera et al 2021), Southeast Java waters (Harahab et al 2021), and Central Maluku Regency (Tetelepta et al 2023).

So far, there is no information available about the sustainability status of tuna fisheries in Central Halmahera Regency that can describe the resilience of this fisheries system. For this reason, a series of research activities were carried out to meet these information needs by applying the Rapfish method. This study aimed to produce recommendations for improving tuna fisheries management based on the actual sustainability status of tuna fisheries. At the end, the study results could provide good considerations in planning and establishing sustainable management policies for tuna fisheries in Central Halmahera Regency.

Material and Method. Primary and secondary data were collected through a survey conducted during May-August 2023 in Central Halmahera Regency. Primary data was collected from local fishers who live in coastal sub-districts, especially from fishers in the Weda and Patani fish landing centers (Figure 1). Respondent sampling was carried out purposively. A total of 40 respondents consisting of 20 fishers with trolling line gear and 20 fishers with handline fishing gear were selected representing a population of small-scale tuna fishers totaling 311 fishers. The sample consisted of small-scale tuna fishers with a fishing vessel capacity of no more than 5 GT.

Primary data was then converted to a Likert scale scores to determine whether fisheries sustainability was good or bad. The score of fishers's responses to each attribute of fisheries sustainability is determined by the mode, as a statistical measure of data centrality. Next, data processing for each sustainability dimension was carried out using Rapfish, which is an add-in to Microsoft Excel. This data processing and analysis was carried out both to evaluate the current sustainability status of tuna fisheries, and to design improvements to sustainability status. The concept of improvement through fisheries sustainability attributes was designed at 3%, 5% and 10% of the fisheries sustainability status. Meanwhile, examples of secondary data sources are literature studies from journals, scientific works, previous research, and books.

The output of the Rapfish analysis was interpreted following method developed by Kavanagh & Pitcher (2004) with five Rapfish ordination category intervals, namely 80-100 (good, very sustainable), 60-79 (enough, quite sustainable), 40-59 (medium, fairly sustainable), 20-39 (bad, less sustainable), and 0-19 (worse, not sustainable). The reliability and validity test of the MDS Rapfish results was based on the coefficient of determination $R^2 \geq 0.8$ (Chicco et al 2021). Meanwhile, the suitability of Kruskal stress as a measure of measurement accuracy in multivariate analysis techniques was classified as feasible in the score range of 0.0-19.9 (Johnson & Wichern 2007). For fisheries sustainability development plans, five dimensions of sustainability were used as criteria for comparison by applying an analytical hierarchy process (Saaty 1987).

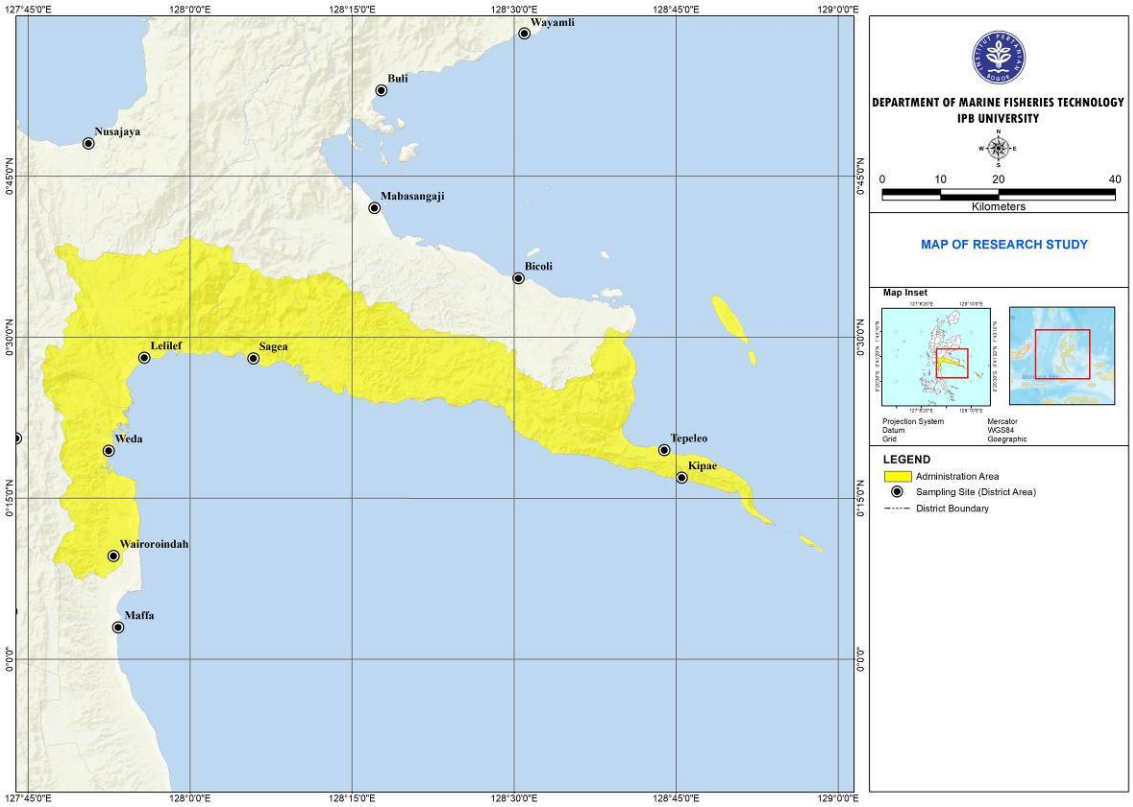


Figure 1. The location of Central Halmahera Regency, North Maluku Province, Indonesia.

Results and Discussion. The results of the sustainability analysis of tuna fisheries showed relatively similar results for tuna harvesting using troll line and hand line. Rapfish's ordination of these fisheries sustainability dimensions is presented in Figure 2 and Figure 3. Tuna harvesting carried out by small fishers in Central Halmahera Regency at WPP-NRI 715 was classified as a 'quite sustainable' fisheries system for ecological, social, and technological components. Meanwhile, the economic components and regional government policies are still classified as 'moderately sustainable' (Figures 2 and 3). Evaluation of tuna stocks shows that harvest mortality was generally estimated to be at moderate sustainable levels (Hare et al 2021).

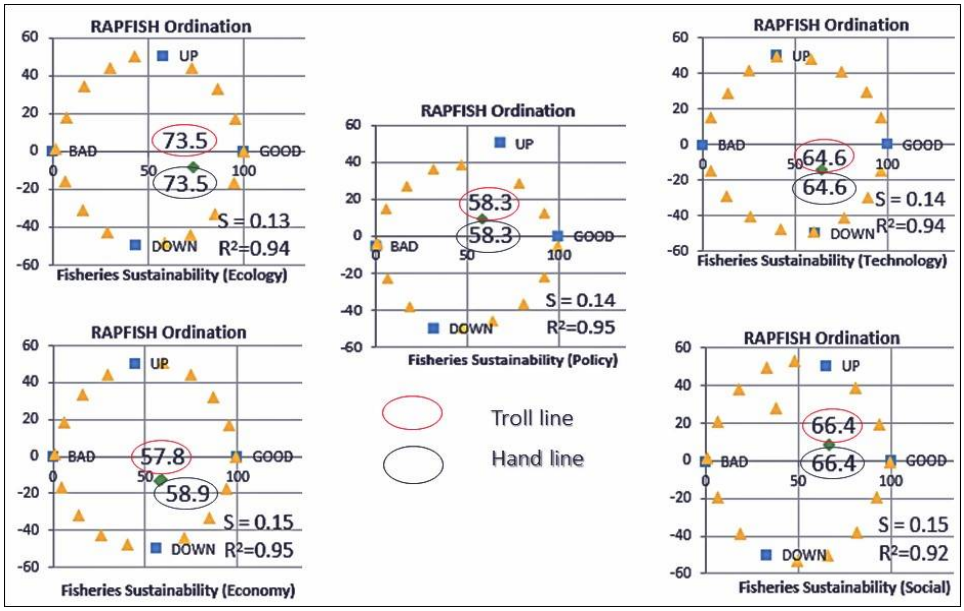
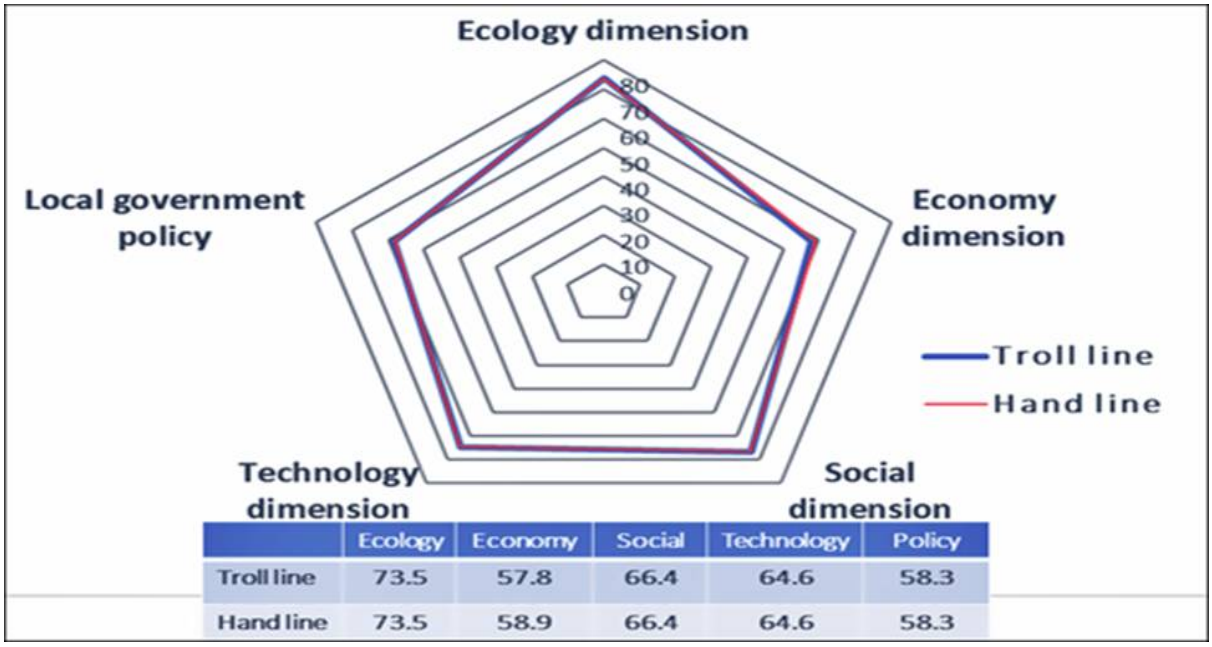


Figure 2. Actual status of sustainability of troll and hand line fisheries in harvesting tuna.



	Ecology	Economy	Social	Technology	Policy
Troll line	73.5	57.8	66.4	64.6	58.3
Hand line	73.5	58.9	66.4	64.6	58.3

Figure 3. Diagram of actual status according to dimensions of sustainability of tuna fisheries.

The ordination of the ecological component for hand lines and trolling lines was 73.5, the social component for hand lines and troll lines was 66.4, the economic components for hand lines and troll lines were 58.9 and 57.8, respectively, and the technological component for hand lines and troll lines of 64.6 (Figure 2). Compared with similar fisheries case studies, the ordination value of the results of this research was higher than the results of research in other locations (Ratu et al 2019; Abdullah & Taeran 2021; Harahab et al 2021; Tetelepta et al 2023). Meanwhile, for local government policy, fishers in Central Halmahera Regency were perceived to be in a lower position (58.3) (Figure 2) compared to tuna fisheries in South Halmahera Regency (Abdullah & Taeran 2021).

In addition to the health of tuna fisheries systems that differ according to location, differences in ordination values can also occur due to differences in method modification and interpretation of attributes, as well as the type of harvesting equipment and habitat of the fish being harvested. Based on the attributes of fisheries sustainability, at least in this research, the value of ordination explains the components of the fisheries system that have direct influences on harvesting and post-harvest activities along with interactions between the components of management activities and governance of the fisheries system (Pitcher 1999; Cochrane & Garcia 2009; Charles 2023).

The analysis results regarding improvements of sustainability status of tuna fisheries (Figure 4) explained that an increase of 3% (Rapfish ordination 66) could bring about changes in ordination values of all components making up the tuna fisheries system being studied, as was the case with increases of 5% (ordination 68) and 10% (ordination 71).

This conceptual design could then identify sustainability attributes that were both sensitive for determining the ordination of components and improvable. In addition, according to Saaty (1987), AHP (analytical hierarchy process) can be used to assess the components of local government policy that are dominant in determining improvements of tuna fisheries sustainability status (Figure 5). Thus, a descriptive model of co-management of sustainable tuna fishery is proposed to be initiated by the Regency Government in form of small fishers cooperatives (Figure 6).

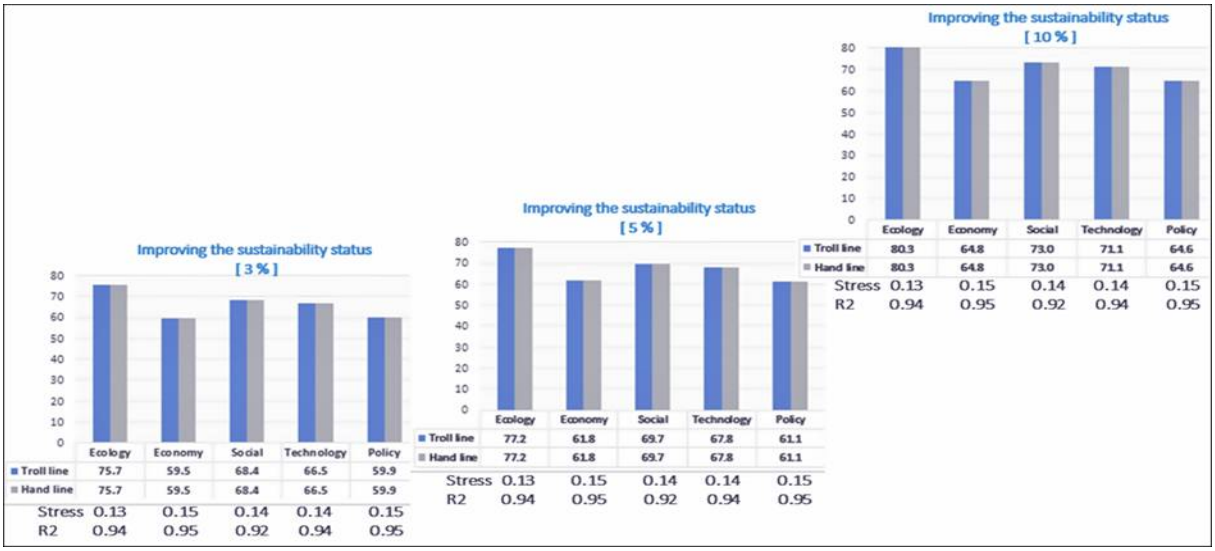


Figure 4. Improvements of tuna fisheries sustainability status.

Since early 2000s, co-management has been identified as promising innovative approach in fisheries management because it implies the importance of power-sharing arrangements between the government and fishing communities in the fisheries management system (Nielsen & Degnbol 2002). To date, the development and implementation of co-management is still a challenge faced in realizing sustainable fisheries management (SEAFDEC 2022). According to Cohen et al (2021), the impacts and outcomes associated with fisheries co-management are generally positive across a range of social, ecological, and governance dimensions. However, fisheries systems continue to experience a range of pressures from factors that are beyond the reach or effective influence of co-management systems. It is further explained: (1) without effective law enforcement, joint management may fail to provide planned results and benefits; (2) There may be a tendency for managers to focus only on compliance and law enforcement, thereby sacrificing attention to other root issues related to resource status, fisheries performance, or social welfare; (3) a focus on excluding outsiders may bring local benefits, but does not address local landscape or national level issues regarding resource conditions, livelihoods, and food security; (4) a government that overly enforces law enforcement can damage the collaborative nature of co-management and fishers's welfare.

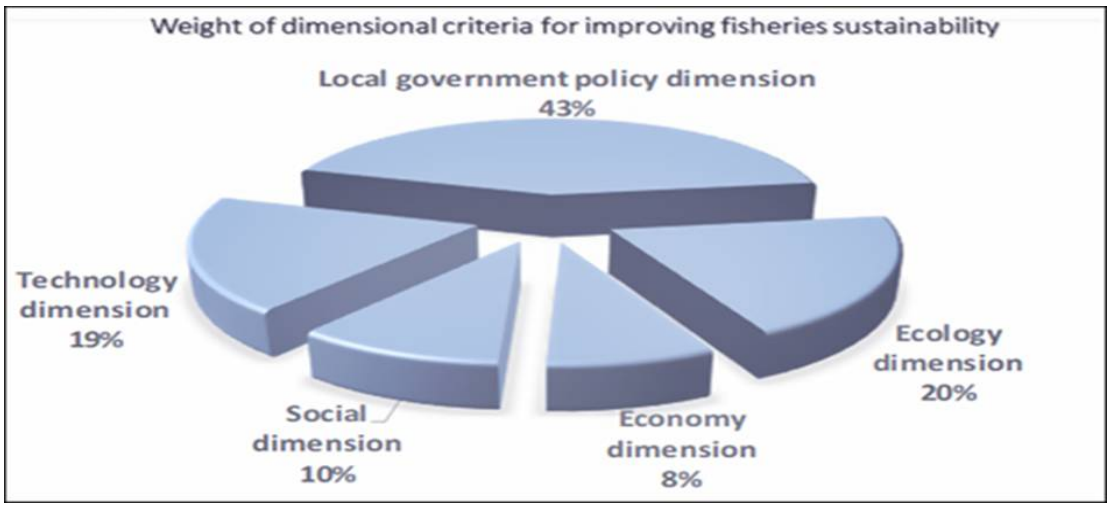


Figure 5. Proportion of components regading improvement of tuna fisehery sustainability status.

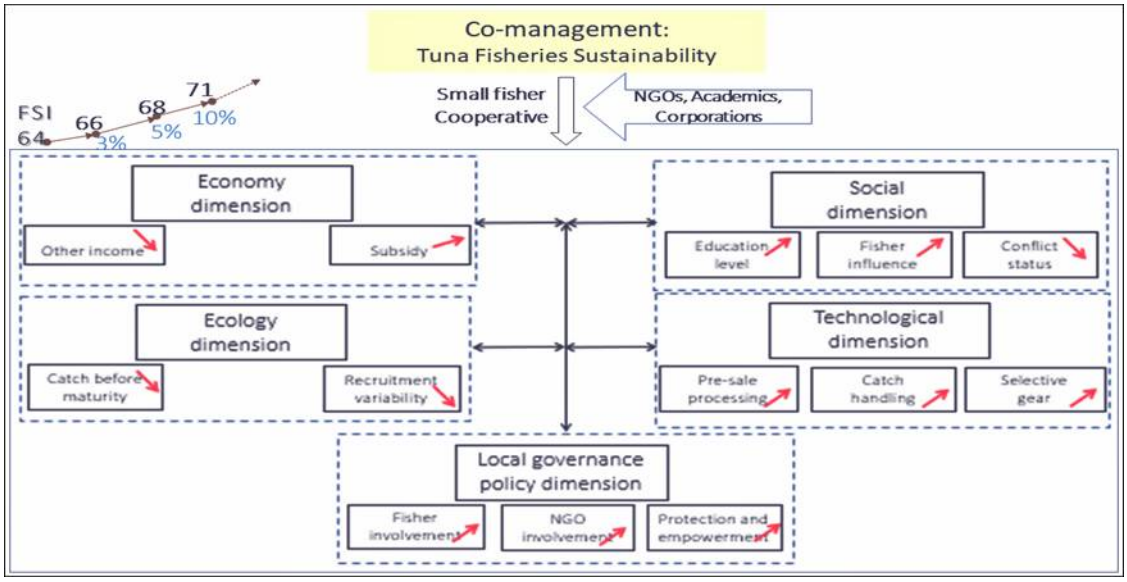


Figure 6. Co-management diagram model for small-scale sustainable tuna fisheries in Central Halmahera Regency of North Maluku Province.

The idea of a small fishers cooperative referred to in this research is a forum for co-management of the tuna fisheries system where local government and fishing communities work together as equal partners for the sustainable development of small-scale tuna fisheries in Central Halmahera Regency. Co-management is basically a collaborative and participatory process whose concept is often also referred to as adaptive management, ecosystem management, and community-based management. A study of 130 co-managed fisheries in various countries (Gutierrez et al 2011) indicated strong leadership as the most important attribute contributing to successful co-management. Strong local leaders with a clear vision for mutual progress and benefit, able to sacrifice personal and group interests, will encourage strong social cohesion between fishing communities and other parties, thereby strengthening success in co-management.

The small fishers cooperative is also conceptualized as a business space related to tuna harvesting and increasing the capacity of fishers and their families where government policies are implemented in accordance with the small fishers protection and empowerment program (as described in Indonesian Law Number 7 of 2016). According to Gansefort (2023), coastal fisheries in Japan are often idealized as one of the last bastions of collective management in industrialized countries, where local cooperatives collectively control territorial rights to harvest fish. It is therefore recognized as a leading institution in shared resource governance and is frequently presented as a role model for co-management in a number of international literatures (Delaney & Yagi 2017). It was also informed that this cooperative platform is characterized by local and inclusive agreements, combined with government supervision, scientific evaluation and consultation. Officially and legally, state (government) regulations are above regulations and agreements at the cooperative level, but in practice, without cooperative support, top-down regulations will be difficult to enforce.

As a collaborative and participatory process, successful co-management by a fishers cooperative takes a long time and challenging, but is worth doing. According to Jentoft & Chuenpagdee (2019), interactive governance recommends that problems related to small-scale fisheries governance must be identified properly, both on the government side and on the fishers side, as well as understanding the interactions that occur between the two. Problems like this cannot be defined unilaterally and handled by higher authorities, but require a collective and interactive approach to identify these problems. The government has an important role and power, but interactive governance or co-management also involves other actors. A co-management system absolutely requires building partnerships with civil society organizations, academics and small-scale

fisheries stakeholders, in a way that helps level the playing field and broaden the knowledge base in decision making.

Conclusions. The sustainability status of tuna fisheries is in the 'fairly good' category and is expected improvable through strengthening the attributes of each component of the regency sustainable fisheries system. Fisheries, especially tuna fisheries in the study location, are expected to support the downstream action policy for the nickel mining industry in Indonesia's Weda Bay Industrial Park. The resilience of the tuna fisheries system can be maintained and developed through the interaction of all components where local government policy becomes the dominant component. The implications of the study results recommend establishment of co-management between the government and fishers and other parties in a small fishers cooperative in Central Halmahera Regency.

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Conflicts of interest. The authors declare that there is no conflict of interest.

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