



Effectiveness of Community-Based Periodic Closures for Octopus Fisheries in the Wakatobi Biosphere Reserve, Indonesia

Sariamin Sahari^{1*}, Basuki Rachmat², Khairuddin Isman¹, Sunarwan Asuhadi³,
Muhammad Musrianton¹, Arham Rumpa¹, Akhmatul Ferlin¹

¹ Study Program of Conservancy, Wakatobi Community Collage of Marine and Fisheries, Ministry of Maritime Affairs and Fisheries of the Republic of Indonesia, Jl. Soekarno Hatta Melaione Matahora Wakatobi Southeast Sulawesi, 95791, Indonesia

sariaminsahari.akkpwakatobi@gmail.com, khairuddin.isman@outlook.com, m.musrianton@kkip.go.id,
arhamrumpa@gmail.com, ferlinbatulo@gmail.com

² Fisheries Business Expert Polytechnic (AUP), Jl. AUP No. 1, Pasar Minggu, South Jakarta 12520, Indonesia

basukibye248@gmail.com

³ National Research and Innovation Agency (BRIN), Gedung B.J. Habibie Jl. M.H. Thamrin No.8 Central of Jakarta, 10340, Indonesia

sunarwan.asuhadi@gmail.com

*Correspondence: sariaminsahari.akkpwakatobi@gmail.com

Received: February 2nd, 2026; Revised: July 25th, 2026; Accepted: July 28th, 2026

ABSTRACT

Small-scale octopus' fisheries in tropical coastal waters are highly vulnerable to overexploitation due to open-access conditions and limited management capacity, leading to declining stock biomass and reduced catch productivity. Community-based fisheries management (CBFM) using time-area closures has emerged as a practical management tool to improve stock recovery and fisheries sustainability. This study evaluates the management effectiveness of a community-based open-close system (*parimpari*) for blue octopus (*Octopus cyanea*) fisheries in Kapota Wakatobi, Indonesia, using an adapted Management Effectiveness Tracking Tool (O-METT). Management effectiveness was evaluated using input, process, output, and outcome indicators through field surveys in five coastal villages, interviews with 70 stakeholders, including fishers, community leaders, and fisheries officers, the Government of Wakatobi, and the fisheries monitoring data collected between 2024 and 2025. Results indicate that the open-close system contributed to overall management effectiveness, which remained low at 28.9% (bronze level), constrained by limited human resources and financial capacity, and weak monitoring outputs. Despite high community participation and compliance, insufficient benefit-sharing mechanisms and weak fisheries data systems pose risks to long-term sustainability. The study highlights the need to strengthen fisheries management inputs, improve monitoring systems, and integrate scientific stock indicators to enhance the effectiveness of community-based octopus fisheries management.

Keywords: Community-based open-close system; octopus fisheries management; O-METT; small-scale tropical fisheries; Wakatobi Biosphere Reserve

INTRODUCTION

Traditional Ecological Knowledge (TEK) and Community-Based Fisheries Management (CBFM) play a crucial role in the

sustainability of small-scale fisheries (SSF) in tropical coastal ecosystems. Through the use of customary rules, local governance



institutions, and historical ecological observations, CBFM promotes high levels of compliance, minimizes conflicts over resource use, and protects critical habitats such as coral reefs and seagrass beds. Of the various CBFM strategies, periodic area and time closures often integrated into customary maritime tenure systems have emerged as an easily implementable management tool for marine invertebrates with rapidly growing populations but limited data, such as the blue octopus (*Octopus cyanea*). If socially accepted and legally supported, these temporary closures can effectively reduce fishing pressure, facilitate stock recovery, and enhance local biodiversity. Furthermore, TEK enhances adaptive resource management by enabling communities to adjust harvesting practices in response to seasonal variability, environmental change, and local ecological observations. Despite its importance, many contemporary co-management programs continue to overlook TEK in formal fisheries governance and conservation planning (Stori *et al.* 2019; de Sousa *et al.* 2022). Strengthening TEK through community-based conservation can help bridge traditional practices with formal management objectives and improve the long-term sustainability of co-management systems (Ariando *et al.* 2022).

In the Wakatobi Biosphere Reserve, Southeast Sulawesi, Indonesia a critical marine biodiversity hotspot within the Coral Triangle, coastal communities are overwhelmingly dependent on marine resources for their livelihoods. On Kapota Island, where over 90% of the population relies on small-scale fisheries, intertidal seagrass and reef habitats have historically suffered from open-access exploitation, habitat degradation, and destructive fishing practices. Consequently, local fishers experienced severe declines in octopus catch volumes and individual weights, directly jeopardizing coastal household incomes. To counter this degradation, the indigenous *Kadie Kapota* community revived *parimpari*, a customary open-close management system rooted in the historical governance of the Buton Sultanate. Under *parimpari*, specific intertidal octopus harvesting zones are temporarily closed and reopened based on decisions by the customary council (*Sara Kadie Kapota*). This customary practice gained formal legal backing through Wakatobi Regent Regulation No. 1 of 2024, establishing a collaborative management framework between indigenous authorities, the Wakatobi National Park, and local government agencies. Community based fisheries

management (CBFM), which enables coastal communities to actively participate in the management and preservation of marine resources, is one of the most promising strategies for attaining sustainable fisheries governance (Agardy *et al.* 2025; Dudayev *et al.* 2023; Roberts *et al.* 2018; Wiranti *et al.* 2025). Furthermore, community-based fisheries management significantly increases fish production, abundance, and biodiversity compared to existing management systems (Alekuzzaman 2022; Kim 2025). The role of community-based fisheries management is to reduce conflicts over resource use by leveraging the the customary marine governance that still respect one another and adhere to customary laws within their communities (Tetelepta *et al.* 2023; Handayani *et al.* 2025).

The coastal ecosystems of Wakatobi, particularly coral reefs and seagrass habitats, play an important role in supporting octopus fisheries and other small-scale marine resources (Wicaksono *et al.* 2023). However, increasing fishing pressure and limited management capacity threaten the sustainability of these ecosystems and associated fisheries resources. Wakatobi is located in the heart of the Coral Triangle. Ninety-seven percent of the total area, which is 1.39 million hectares, is seawater (Budiyanto *et al.* 2025). This region, designated as a National Marine Park, encompasses an expansive coral reef ecosystem that is critical for marine life and supports a significant portion of global coral and fish species (Card 2022; Budiyanto *et al.* 2025). The intertidal area consists of seagrass beds and coral reefs in the south of Kapota Island, which for years has been the site of bombing, poisoning, and other illegal fishing activities. This has caused a decline in the catch volume of local fishermen, especially octopus's fishermen. Several years ago, for every octopus caught, fishermen averaged 0.8 ounces to 1.5 kilograms, but since the area became open access, the volume of octopus caught has decreased in both quantity and weight. This has had an effect on the decline in fishermen's income.

The epistemology of maritime culture and genealogy of the coastal community of Kapota Island is unique because it has local wisdom that is still preserved and alive in the community, which is a valuable asset for the future. The local community has developed a very specific cultural system to adapt to the rhythm of the sea. Amidst the beauty of this ecosystem, Kapota Island emerges as a

unique cultural entity. The identity of the community is closely linked to the Kadie Kapota Customary Institution. The existence of customary law communities in the Kapota Wakatobi region is not new. It is a continuation of the political and social structures of the past that originated from the Buton Sultanate system (Pradana 2025). In Buton tradition, the Barata region was led by a Lakina, while the Kadie region was led by a Meantu'u. This hierarchy is still highly respected and obeyed by coastal communities to this day (Mustari *et al.* 2018; Turasih 2022). The indigenous inhabitants of Kadie Kapota on Kapota Island, Wakatobi Regency, Southeast Sulawesi, Indonesia, use *parimpari*, a type of local wisdom. *Parimpari* is a form of local wisdom rooted in indigenous communities for managing the open-and-close system for blue octopus (*Octopus cyanea*) fishing in the waters of Kapota, Wakatobi. A system known as *parimpari* involves temporarily closing and reopening a certain area for a predetermined amount of time. Sara Kadie Kapota makes a typical decision on the allocated area. The community is not allowed to exploit marine resources in the *parimpari* area during the specified time (Ananingsih *et al.* 2025).

The Kapota community is highly dependent on marine resources. The fisheries sector provides for most of their daily needs and identity. Data shows that around 94 percent of the Wakatobi population's livelihoods depend on marine resources. The majority of fishermen work on a small scale using traditional technology. However, in recent decades, pressure on marine resources has increased sharply. This is due to population growth, climate change, and unsustainable fishing practices in the past. This situation has created an urgent need for management that can balance economic exploitation and ecological protection. In this context, the *parimpari* practiced by Kapota fishermen emerges as a combination of traditional local wisdom and modern resource management needs (Humas KSDE 2023; Jaelani *et al.* 2024). *Parimpari*, aside from being local wisdom and a local conservation value of the Kapota community, is not only used in traditional fishing methods, but also as a tool for managing larger organizations. The customary maritime territory is managed by the Kadie Kapota Customary Law Community (MHA) (The Government of Wakatobi Regency 2024). Formal legislation reinforces the role of Kadie Kapota. In addition, Wakatobi Regent Regulation Number 1, 2024 years for mandates indigenous peoples to protect and manage coastal and marine resources in

accordance with local wisdom (The Government of Wakatobi Regency 2024). Following this recognition, Wakatobi National Park and the local government began working together to create a more inclusive and efficient management model. This became an important turning point in the history of marine conservation in Wakatobi and Indonesia. The Kapota Wakatobi local knowledge conservation technique known as "*parimpari*" alternately opens and closes octopus fishing grounds in order to preserve the population and boost fishermen's harvests. This "open-close" method allows marine species, such as octopuses, which are a valuable product in the area, to grow and recuperate. *Parimpari* is community-managed octopus conservation areas which has been producing a considerable amount of catch, but faces various challenges (Hesti 2025).

Despite the growing adoption of periodic closures and the formal legal recognition of customary management systems like *parimpari*, significant empirical knowledge gaps remain regarding their actual operational effectiveness. Existing studies on customary octopus fisheries often focus qualitatively on social legitimacy and cultural norms or narrowly evaluate short-term biological catch surges immediately following closure reopenings. However, there is a critical lack of comprehensive assessments evaluating whether formal legal recognition translates into operational capacity, sustainable financing, robust monitoring, and equitable socio-economic outcomes across multi-year cycles. Furthermore, standard evaluation tools such as the Management Effectiveness Tracking Tool (METT) widely used in protected areas and Indonesia's Conservation Area Management Effectiveness Evaluation (EVIKA) have rarely been integrated or tailored to systematically assess customary, invertebrate-focused temporary closure systems in small-scale tropical fisheries. The novelty of this study lies in evaluating the effectiveness of a customary community-based octopus fishery closure system using an adapted Management Effectiveness Tracking Tool (METT) framework integrating governance, ecological, institutional, and socio-economic indicators (Estradivari *et al.* 2022; Nugraha *et al.* 2024; Van 2025) or also known as Marine Tracking Tools / MPA Score Card (Farhum *et al.* 2021; Widodo *et al.* 2021) and then adapted with assessments from the Conservation Area Management Effectiveness Evaluation (EVIKA) tools (Farhum *et al.* 2021; Wulan *et al.* 2024).



To bridge this gap, this study introduces an adapted Octopus Management Effectiveness Tracking Tool (O-METT), combining international METT indicators with national EVIKA frameworks to evaluate the multidimensional effectiveness of the *parimpari* system in Kapota, Wakatobi. Specifically, this research evaluates four core governance dimensions Inputs, Processes, Outputs, and Outcomes across five coastal villages following three years of implementation (2023–present). By systematically assessing institutional readiness, enforcement capacity, ecological responses, and benefit-sharing mechanisms, this study aims to: (1) evaluate the overall management effectiveness of the community-based *parimpari* open–close system; (2) identify key operational bottlenecks constraining long-term sustainability; and (3) provide evidence-based recommendations to harmonize customary governance with formal marine spatial management in tropical biosphere reserves.

METHODS

Size Structure

The research was conducted from January 2024 to June 2025. It was carried out at the “*parimpari* Octopus Site,” a protected conservation area managed by the Kapota

Indigenous community, also known as the Octopus Conservation Area in Wakatobi Regency. Geographically, the area is located at polygon coordinates 5°20'2.72"S–5°20'12.04"S–5°21'14.24"S–5°21'21.67"S and 123°27'48.76"E–123°27'23.37"E–123°28'26.81"E–123°28'9.84"E. It spans five villages: Kabita Village, Kabita Togo Village, Kapota Village, North Kapota Village, and Kollo Tourism Village (Figure 1). The “*parimpari*” conservation area is now part of the marine conservation area in the southern part of Kapota Island.

The area totally covered by the Kapota indigenous community's octopus “*parimpari*” opening-and-closing system, which involves several fishing groups, is 910 hectares, almost all of which is benthic or intertidal. The areas affected by *parimpari* are in the coastal region of Kapota Island, including Kolofofa (800×700 meters, 560 hectares) and Oa-wolio (700×500 meters, 350 hectares) (Primus 2023). Table 1 indicates an area of approximately 241 hectares; this is the size of the marine area covered by the octopus *parimpari* program agreement between the fishermen's group and, YPL, Komanangi, Blue Ventura Program. The aim is to align capital and human resource capacity, facilitate monitoring, and assess the potential for optimizing community-based management over the program's five-year duration.

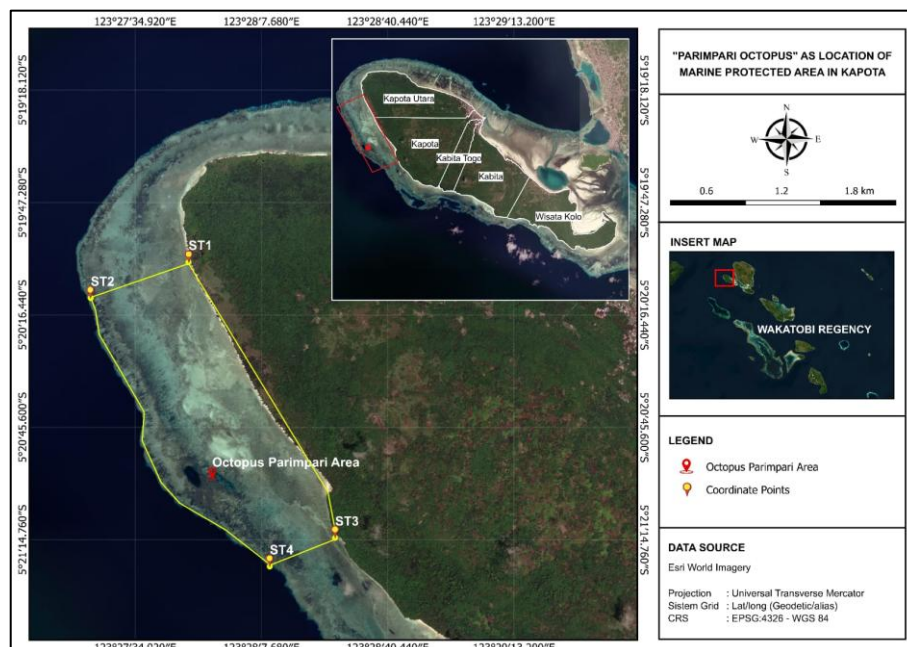


Figure 1 Spatial boundaries and location map of the community-based “Parimpari Octopus” conservation area (910 ha) covering five coastal villages (Kabita, Kabita Togo, Kapota, North Kapota, and Wisata Kollo) on Kapota Island, Wakatobi Regency, Southeast Sulawesi, Indonesia. Inset maps illustrate the relative geographic position of Kapota Island within the Wakatobi Archipelago

Table 1 Geographical, institutional, and socio-economic baseline profile of the Kadie Kapota customary territory and the parimpari octopus fisheries management area in South Wangi-Wangi, Wakatobi Regency, Indonesia.

Parameters	Description of Territory and Culture
Administrative Location	South Wangi-Wangi Subdistrict, Wakatobi Regency, Southeast Sulawesi.
Institutional Basis	Sara Kadie Kapota (<i>Customary Institution</i>) is led by Meantu'u.
Total Area of Wakatobi Marine National Park	1.32 - 1.39 million hectares (approximately 97% of which is ocean).
Area's of Parimpari (Komanangi, YPL and Blue Ventura Program)	241 hectares. This is the size of the marine area covered by the octopus parimpari program agreement between the fishermen's group and, YPL, Komanangi, Blue Ventura Program. The aim is to align capital and human resource capacity, facilitate monitoring, and assess the potential for optimizing community-based management over the program's five-year duration.
Economic Dependency	> 90% of the population works as fishermen or marine farmers.
Leading Commodities	Octopus (<i>Octopus cyanea</i>) and Reef Fish.
Legal Status of Customary Law	Recognized through Wakatobi Regent Rule of the Regent of Wakatobi Number 1 of 2024 (The Government of Wakatobi Regency 2024)

(Sources : Research data 2025)

Data Collection

This study employed a mixed-method descriptive approach integrating qualitative stakeholder analysis and quantitative management effectiveness assessment. The collected data were used to identify management stakeholders and evaluate the effectiveness of the Parimpari octopus conservation system within the Wakatobi Biosphere Reserve). Primary data were collected using two approaches. First, field visits and direct observations were conducted during the three-month closure period of the "parimpari" area and continued through the reopening of the fishing season. Second, meetings and semi-structured interviews were conducted with octopus fishers in the five coastal villages on Kapota Island. Respondents were selected through purposive sampling to ensure the participation of stakeholders directly involved in the implementation and management of the "parimpari" system.

The selection of respondents was intended to capture diverse perspectives related to the implementation of the "parimpari" system. Respondents were chosen using purposive sampling based on the following criteria: having a permanent residence in the study village (for at least 1–2 years); being of working age (≥ 17 years or married), so as to be considered capable of providing valid information regarding the management of the parimpari floodgate system; having knowledge of or direct

involvement with the research subject; being willing to serve as a respondent and provide information voluntarily; and representing a variety of social backgrounds (gender, occupation, and educational level) to ensure data diversity. A total of 70 respondents participated in the study, consisting of local fishers, village leaders, beach guards, representatives of the Wakatobi National Park Authority, and staff from the Wangi-Wangi Fishermen Community NGO (Komanangi), which actively supports the development of local fisheries management practices.

In addition, secondary data were obtained from historical fisheries records, preliminary ecological assessments, and previous monitoring reports related to octopus catch trends, habitat degradation, and destructive fishing practices prior to implementation of the Parimpari open–close system.

Figur 2 present the distribution of respondents by gender across five villages on kapota Island: Kabita, Kabita Togo, Kapota, North Kapota, and Wisata Kollo. Villages with higher respondent numbers, particularly North Kapota, were prioritized due to their relatively high levels of octopus fishing activity and involvement in parimpari management practices. The gender distribution reflected existing community roles in fisheries management and resource monitoring. Male respondents were predominantly involved in fisheries surveillance and enforcement activities during closure periods, while female



respondents were included to incorporate gender perspectives related to fisheries utilization and community participation. A total of 70 respondents participated in the study ($n = 70$), consisting of 46 men and 24 women, with a mean age of 55.02 ± 6.56 years. Educational backgrounds included primary education (<9 years; $n = 50$), secondary/vocational education (9–12 years; $n = 15$), and university-level education ($n = 5$).

Data Analysis

The study applied an adapted Octopus Management Effectiveness Tracking Tool (O-METT) framework to evaluate management effectiveness through input, process, output, and outcome indicators. Qualitative and quantitative data were analyzed descriptively to assess management performance and stakeholder participation in the parimpari system. The qualitative data analysis followed several stages, including data collection, reduction, classification, interpretation, and validation to ensure the consistency and reliability of the findings. This approach was used to examine the role of traditional ecological knowledge in community-based fisheries management and marine resource conservation. Then, to begin the O-METT assessment, first select the questions that are considered most appropriate for each indicator (questions in the assessment form) based on the actual conditions experienced in the conservation area concerned. Next, points are automatically obtained by selecting the appropriate statement for each indicator.

This O-METT included the Management Effectiveness Monitoring Tool (METT) (Gopalakrishnan *et al.* 2024; Stolton *et al.* 2020), and then adapted the indicators available in EVIKA (Kep Dirjen PRL 28 2020). Finally, an analysis of information on the current condition of the protected area in the Kapota octopus parimpari was conducted. Over 2500 protected areas spanning more than 4.2-million-square-kilometers in at least 127 countries have employed METT, one of the most popular instruments for Protected Area Management Effectiveness (PAME) (Hockings *et al.* 2018).

METT is divided into two primary parts an assessment form and two datasheets with important details about the protected area. Key details regarding the areas, such as their name, categories, establishment date, size and location, and management goals, are provided in the first datasheet. A comprehensive list of risks that protected places are currently encountering or may face in the future is documented in the second datasheet. The employees of protected locations should complete this datasheet, identify the dangers, and then rate how they affect the protected areas. Each of the 42 questions on the assessment form (which includes modifications to METT and EVIKA, referred to in the study as O-METT or Octopus-METT) has four possible answers, with scores ranging from 0 (poor) to 3 (outstanding).

During the O-METT assessment form assessment, each indicator receives a certain number of points; 20 main indicators receive 0 to 4 points, and each additional indicator receives +1 point, with a total of 42 key questions representing input, process, output, and outcome criteria. Table 2 presents a summary of the explanations regarding the indicator levels on the O-METT assessment form. The highest score for all 42 main questions and 21 supplementary questions, as well as the highest score or weight for each indicator item, is 10–30 points.

The points or weighting values for each assessment of each question under each criterion are summarized and entered into Table 2 to determine the final evaluation score, after which the conservation status of the parimpari area is determined. With this approach, researchers can become a bridge between local knowledge and the world of modern science without losing the essence of unique and valuable culture. The determination of the status score is based on the scores obtained, as shown in Table 3. Bronze is Minimally Effective, Silver is Optimally Managed, and Gold is Sustainably Managed / Highly Effective.

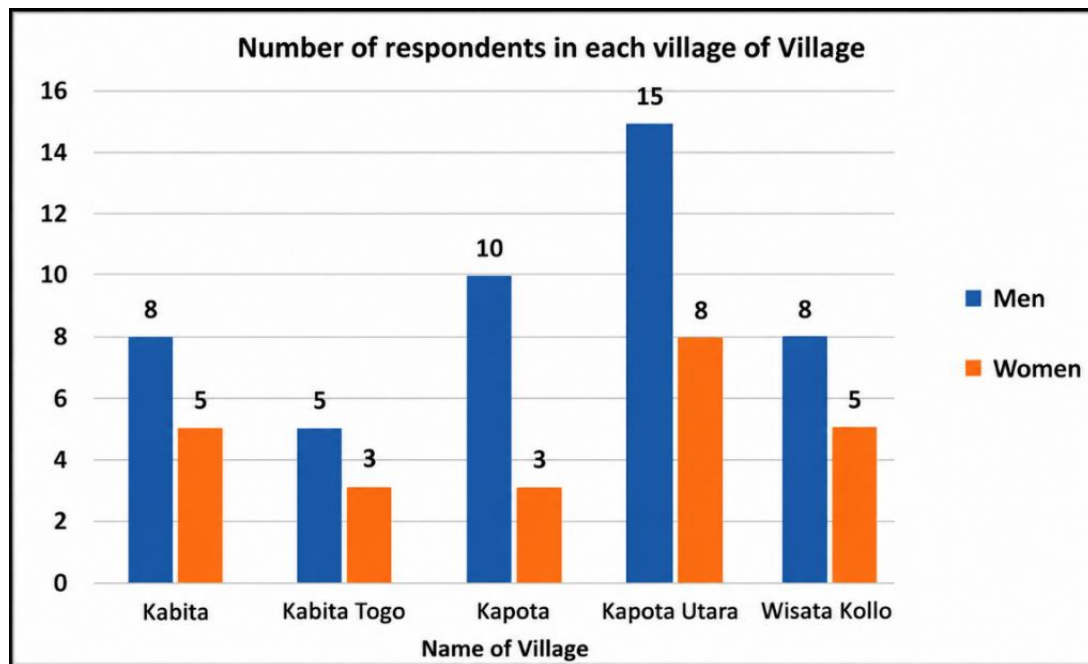


Figure 2 Gender Distribution of study respondents (n = 70) across five coastal villages on Kapota Island, Wakatobi Regency, representing key stakeholders (local fishers, community leaders, village officials, beach guards, and NGO staff) involved in evaluating the parimpari octopus fisheries management system (Sources: Research data 2025)

Table 2 Calculation Template and weighting scheme for evaluating the management effectiveness of the *parimpari* octopus marine protected area using the adapted Octopus Management Effectiveness Tracking Tool (O-METT) framework across four assessment criteria (Inputs, Processes, Outputs, and Outcomes).

Criteria	Score Obtained (Ni)	Maximum Score (Nmax)	Criterion Value (Nk) (%)	Weight (Bk)	Weighted Score (%)	Criteria	Score Obtained (Nak)
Input		1075		0.25			
Process		430		0.35			
Output		650		0.25			
Outcomes		625		0.15			

Description: the indicator score (Ni) is the sum of the scores for each indicator; the criterion value (Nk) is $Ni / Nmax \times 100\%$, the criterion weight (Bk) is the weight assigned to each criterion; and the final criterion score (Nak) is $Nk \times Bk$

Table 3 Final Evaluation score thresholds, performance tiers (Bronze, Silver, Gold), and operational status definitions for assessing marine protected area management effectiveness based on adapted O-METT and Indonesian EVIKA guidelines.

Final Score	Color	Status	Description
< 50%	Bronze	Minimally Effective	The zone design and planning have been completed, and management activities have been initiated, but further efforts are needed to achieve management objectives.
>50% - 85%	Silver	Optimally Managed	Management functions are operating adaptively, and several management objectives have been achieved.
>85%	Gold	Sustainably Managed / Highly Effective	Management benefits are experienced by the community, with conservation values protected and sustained.



RESULTS

The Effectiveness of Parimpari in Conservation Area Management

The METT assessment indicated that the overall management effectiveness score of the parimpari system was 28.9%, categorized as the bronze level. Input indicators received the lowest scores, particularly in financial capacity, human resources, and monitoring systems. In contrast, community participation and

compliance with seasonal closures showed relatively higher performance (Table 4).

Input Indicators

The Input dimension obtained a score of 16.8%, representing the lowest score among all O-METT components (Figure 3). Low scores were primarily associated with limitations in financial resources, staffing capacity, technical support, and monitoring infrastructure. These findings indicate that the foundational resources required to support effective management remain insufficient.

Table 4 Final Evaluation score thresholds, performance tiers (Bronze, Silver, Gold), and operational status definitions for assessing marine protected area management effectiveness based on adapted O-METT and Indonesian EVIKA guidelines.

Terms and Conditions	Key Performance Indicators	Ni	Nmax	Nk
Inputs	Legal status of the area	37,5	75	50
	Zoning plan	40	40	100
	Management plan	20	40	50
	Human Resources	33	750	4
	Budget	40	80	50
	Facilities and Infrastructure	10	90	11
	Numbers	181	1075	16,8
Process	Standard Operating Procedure for Area Management	10	40	25
	Surveillance/Monitoring	35	135	26
	Outreach	10	45	22
	Partnerships	20	60	33
	Area Resource Monitoring	45	45	100
	Facility Management	30	30	100
	Permits	30	30	100
	Community Capacity Building	30	45	67
	Numbers	150	430	34,9
Outputs	Controlled Utilization	40	200	20
	Degree of Threat	45	45	100
	User Compliance Level	45	45	100
	Public Awareness	15	165	9
	Community Empowerment	30	60	50
	Data Collection and Publication	20	135	15
	Numbers	195	650	30,0
Outcome	Conservation Target Conditions (Octopus)	60	90	67
	Core Zone Conditions	62,5	150	42
	Socioeconomic Change Conditions	43,75	325	13
	Community Participation / Other Stakeholders	40	60	67
	Numbers	206	625	33,0

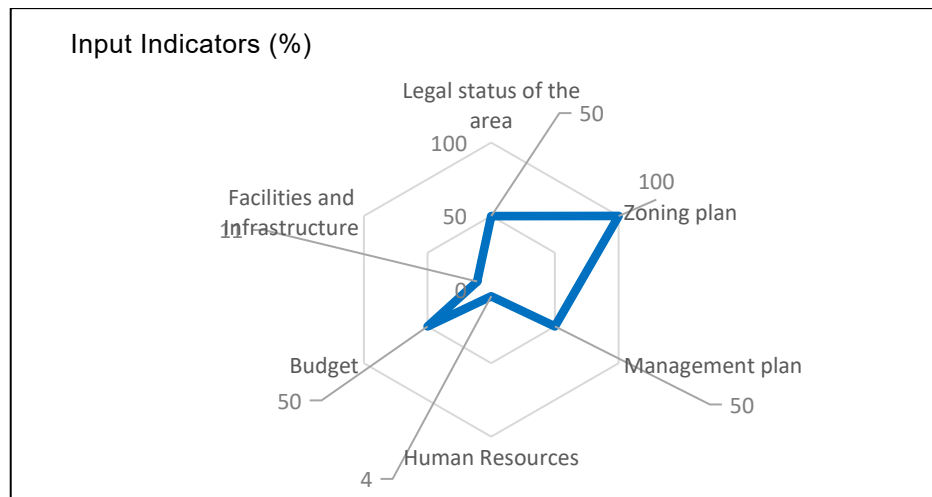


Figure 3 Management effectiveness evaluation scores for the Input dimension indicators under the adapted O-METT framework for the Kapota *parimpari* octopus conservation area, Wakatobi Regency (Indonesia). The chart illustrates critical resource constraints, particularly in operational funding, human resource capacity, and surveillance infrastructure.

Process Indicators

The process indicator radar diagram as shown in Figure 4 indicates the extent to which operational activities for managing the Kapota *parimpari* Marine Conservation Area have been implemented. Process indicators measure the implementation of plans, which should be supported by the availability of inputs (human resources, budget, infrastructure). The licensing aspect has reached a value of 100%, which means that all relevant permits for area management activities (e.g., operational permits, research permits, or regulated limited use permits) have been obtained or issued. This confirms the operational legality of the area. The same value was also obtained from the sub-

indicator, namely the optimal management of facilities and infrastructure (100%), meaning that in terms of fishermen, the supporting infrastructure they have is quite good. although interviews and observations revealed that there is still a lack of facilities such as standardized patrol boats, equipment for taking action in the event of disturbances within the area, and communication devices. In general, fishermen are unable to adapt to communication devices such as Android mobile phones for reporting violations and sending evidence to the marine surveillance unit. in this case, officers from the Wakatobi Marine National Park Office or Marine Surveillance Post officers based on Wangi-Wangi Island.

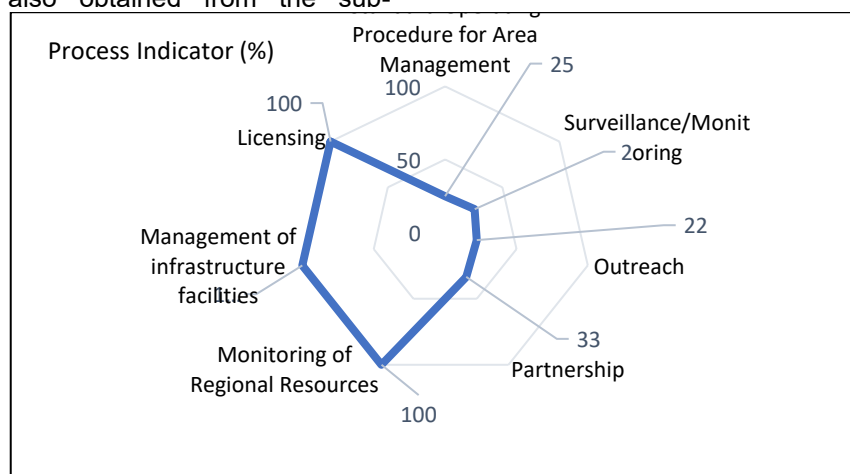


Figure 4 Management effectiveness evaluation scores for the Process dimension indicators using the adapted O-METT framework across five coastal villages on Kapota Island, Wakatobi Regency (Indonesia). The results highlight a pronounced gap between formal administrative authorization (100% score in legal backing) and the field implementation of participatory surveillance, routine monitoring, and community outreach.



The surveillance/monitoring sub-indicator shows that the implementation of patrols, surveillance, and law enforcement efforts in the octopus conservation zone is almost non-existent. This condition is directly caused by a lack of human resources (4%) and infrastructure (11%) from the initial input/planning stage. This includes the partnership sub-indicator, which has only reached a value of 33%, indicating that although there are parties involved in the collaboration, formal partnerships or operational collaboration with external parties (NGOs, universities, the private sector, or other government agencies) are still limited and have not been utilized to their full potential.

Output Indicators

The Output dimension achieved a score of 30.0% (Figure 5), indicating that management activities have generated measurable outputs but remain below the level required for effective management performance. The results demonstrate that while key management actions have been implemented, several expected outputs, particularly those related to monitoring systems, information dissemination, and institutional support, have not yet been fully realized. This finding highlights the need to improve the translation of management processes into consistent and measurable management outcomes.

The majority of sub-output indicators show very low values, confirming that functional incapacity at the process stage (lack of patrols, outreach, and SOPs) has resulted in inadequate outputs, with only the output sub-indicators of threat level and compliance reaching 100%. This is consistent with the statements from KOMANANGI respondents and the head of the parimpari Fishermen's Group, who is also the monitoring coordinator, that the number of threats and violations has decreased by more than 50% compared to the baseline (initial) conditions. However, some respondents stated that recently, threats have arisen after it became known that octopus catches had increased following the opening and closing system, with outside fishermen coming to fish at night and on Fridays, when the Parimpari guards are still in their villages/homes, but the frequency of this is now very low. As is known, the distance between the "Parimpari" location and the settlement is approximately 6.795 km by sea because it is located west of the settlement (there is no 24-hour surveillance), while by land it is 4.07 km.

Outcome Indicator

The outcome indicator radar diagram shown in Figure 6 displays four main outcome indicators for assessing the effectiveness of the Kapota parimpari conservation management, where higher scores indicate better outcome performance. Two sub-indicators show relatively high and identical scores, namely Conservation Target Conditions and Community Participation, both reaching 67% (Figure 6). This indicates that the high scores on these two pillars imply a positive correlation between inclusive governance and the achievement of ecological goals at the broad ecosystem level. The community participation sub-indicator (67%) reflects the success of this area in building social legitimacy and bottom-up support, or fully involving direct fishermen and gaining the approval of the Kadie Kapota Customary Institution.

The sub-indicator of socioeconomic conditions scored 13% as very ineffective/very low. This very low score is a critical signal and the greatest potential threat to the long-term sustainability of the parimpari marine protected area. Although community participation is high (67%), the direct socioeconomic benefits felt by the community are minimal. This condition reflects a failure to achieve conservation equity. Conservation has succeeded in protecting resources (Target Conditions, with a value of 67%), but the opportunity cost of conservation is borne entirely by the local community without adequate benefit sharing. The socioeconomic change conditions sub-indicator received the lowest score (13%), indicating that the ecological benefits generated by the parimpari system have not yet translated into significant socioeconomic improvements for local communities. This low score is primarily due to the absence of a formal benefit-sharing mechanism, limited alternative livelihood opportunities during closure periods, and the lack of measurable increases in household income from octopus fisheries.

Final Score

The overall O-METT score for the parimpari (Figure 7) management system was 28.9%, which falls within the bronze. This result indicates that the management system is functioning but remains in its early stages of effectiveness and requires substantial improvement to achieve higher levels of management performance. Among the four assessment components, the Input dimension recorded the lowest score (16.8%), reflecting

limitations in financial resources, staffing capacity, technical support, and monitoring systems. In contrast, Process (34.9%), Output (30.0%), and Outcome (33.0%) indicators

achieved relatively higher scores, suggesting that community participation, implementation of management activities, and short-term management outcomes.

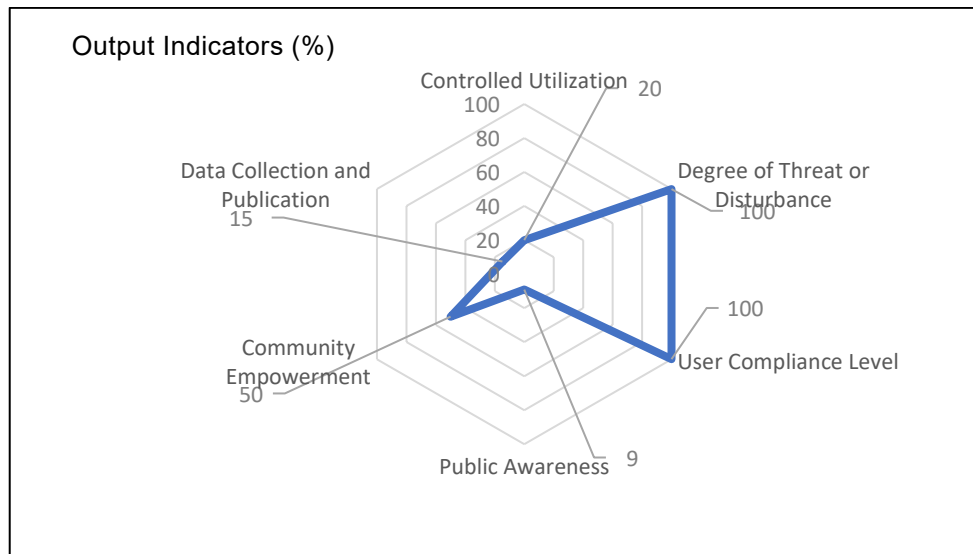


Figure 5 Management effectiveness evaluation scores for the Output dimension indicators assessed under the adapted O-METT framework for the *parimpari* octopus management area, Wakatobi Regency (Indonesia). The score breakdown demonstrates strong achievement in physical boundary demarcation and community compliance with customary closure rules, contrasted with low outputs in standardized catch reporting and formal enforcement records.

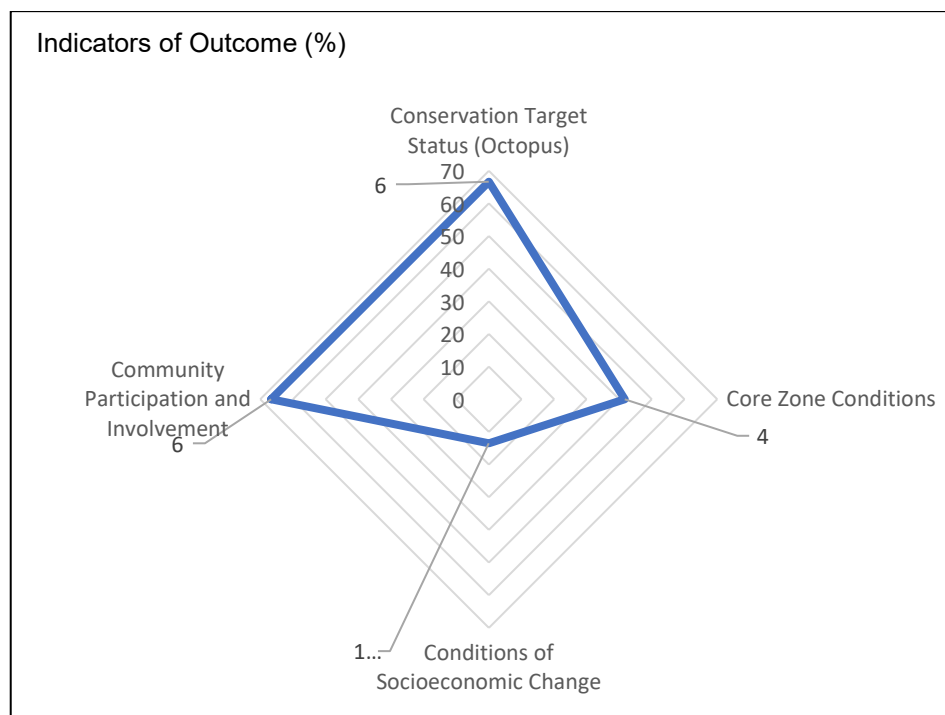


Figure 6 Management effectiveness evaluation scores for the Outcome dimension indicators under the adapted O-METT framework for the Kapota *parimpari* octopus, Wakatobi Regency (Indonesia). The evaluation reflects positive biological responses in octopus stock recovery and catches rates (CPUE) during open seasons alongside ongoing challenges in equitable socio-economic benefit distribution among coastal households.

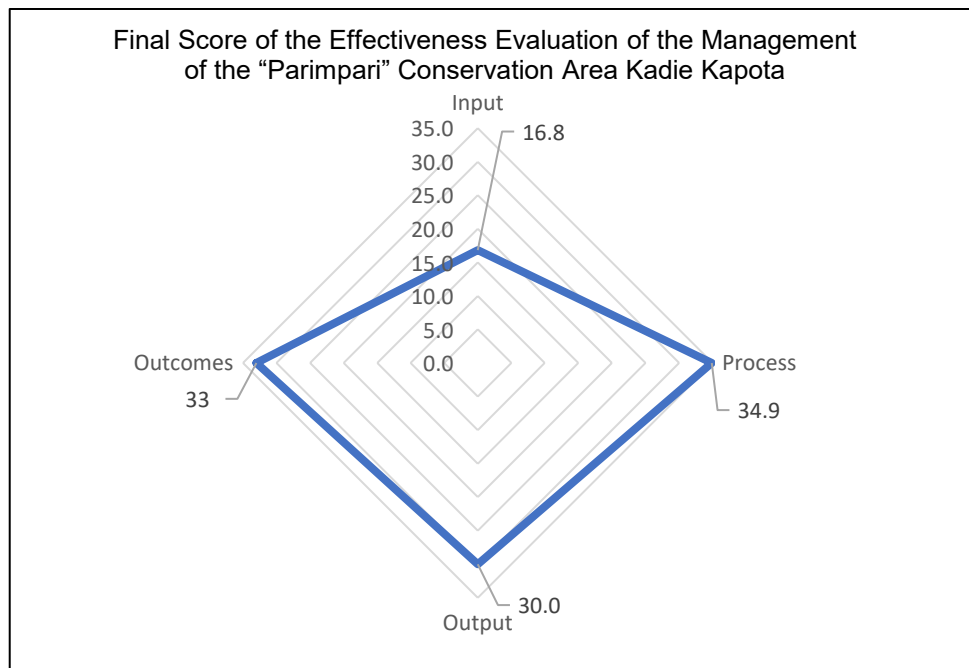


Figure 7 Composite O-METT radar profile showing the aggregate management effectiveness index of the community-based *parimpari* octopus management system in Wakatobi Regency (Indonesia). By integrating the dimension scores evaluated, the synthesis demonstrates how high community acceptance and positive ecological outcomes are constrained by low financial and infrastructure inputs, maintaining the overall system within a *Bronze* performance threshold.

DISCUSSION

The findings demonstrate that the *parimpari* tradition represents not only a local fisheries management practice but also a form of traditional ecological knowledge that strengthens community identity and adaptive marine resource governance. Integrating local knowledge into contemporary conservation strategies may help bridge the gap between traditional practices and modern scientific approaches to sustainable fisheries management. In the traditional sense of the METT is often criticized for its greater focus on measuring management steps (Input, Process, Output) rather than measuring ecological outcomes (Outcome) in detail (Jack-Kadioglu *et al.* 2020; Nugraha *et al.* 2024). Although METT composite scores may not always correlate strongly with ecological outcomes, certain individual indicators, such as research and cooperation activities, have been shown to have a direct impact on effectiveness. Therefore, the adaptation of O-METT must fundamentally address these limitations. O-METT must explicitly incorporate strict quantitative ecological and fisheries metrics, such as those derived from fisheries stock assessments, into the

Outcome element to validate conservation success.

Although the seasonal opening-closing system based on *parimpari* has been running for five cycles since 2023, the main diagnosis of this study shows that the input strategy is the most vulnerable variable and requires urgent policy intervention in the form of program sustainability, such as participation in monitoring, provision of infrastructure assistance, public campaigns, and budget allocation. By looking at the results of the input indicators, particularly the sub-indicator of public awareness, in the future, there must be educational efforts not only in fishing communities but also among the younger generation, in order to provide an understanding that the environment has an impact on octopus abundance through *parimpari* management. Without adequate scientific data on these factors, conservation efforts may not receive public support (Pagong and Nisperos 2024), resulting in ineffective efforts to protect the habitat and life cycle of octopus species (Dominguez-Lopez *et al.* 2021; Dridi *et al.* 2023).

There is severe gap between formal planning (legal prerequisites) and operational

implementation capacity, a condition that fundamentally threatens the sustainability of octopus stocks, which have a fast-turnover life cycle and are highly sensitive to exploitation. Partnerships are very beneficial if there is a division of roles, resources, and responsibilities to cover the human resource and budget/financial deficits experienced by the region, for the sake of the sustainability of marine protected area management (Bohorquez *et al.* 2022; Di Franco *et al.* 2016; Di Franco *et al.* 2020; Maynard *et al.* 2020). In the literature on Marine Protected Area (MPA) Management Effectiveness (ME), participation is a key predictor of sustainability (Aziz 2025; Mast *et al.* 2025). In the same context, emphasizing the need for co-management and local ownership rights results in higher compliance rates compared to top-down (government-only) approaches, which in turn reduces monitoring and law enforcement costs (Voorberg and Van der Veer 2020; Masud *et al.* 2022).

Therefore, the O-METT results indicate the need for a radical transformation from a static conservation model to time-based adaptive fisheries management, namely the implementation of an open-close system for octopus fishing (Di Franco *et al.* 2020; Ghoddous *et al.* 2022; McCabe *et al.* 2024) and science in the form of CPUE, bioecology, and socioeconomic calculations (Time-based and Science-based Adaptive Fisheries Management), which focuses on three main policy pillars: strengthening critical inputs, optimizing dynamic processes, and establishing quantitative outcome accountability (Aeberhard *et al.* 2018; Beckensteiner *et al.* 2023). The implementation of this policy must be carried out immediately by policy makers at the regional level (Wakatobi Regency, Southeast Sulawesi Province) to the central level (Ministry of Marine Affairs and Fisheries) to ensure that Kapota not only has recognized conservation documents (the parimpari Zoning Plan is valued at 100%), but also truly effective management in the field. The greatest risk in octopus' conservation is that without adequate scientific data and public awareness, efforts to protect specific habitats (such as octopus spawning grounds) and species life cycles will be directionless and lack social support, ultimately resulting in poor outcomes (long-term impacts) (Santamaría *et al.* 2023). In addition, the long-term impact of a study on the existence of community-based marine protected areas emphasizes that if socio-economic benefits (Keith *et al.* 2020), increased income from fishing, tourism, or

alternative livelihoods) are not realized, while the current high level of compliance (outcome value of 67% participation) will be eroded by dissatisfaction, which will ultimately lead to erosion of community support and an increase in illegal fishing in the future (Robertson *et al.* 2020; Ballad *et al.* 2022).

CONCLUSION

The implementation of a periodic open-and-close system based on the local wisdom of "parimpari" demonstrates the great potential of traditional governance in fostering social compliance and community participation in the conservation of small-scale octopus fisheries. However, the long-term sustainability of this governance model is vulnerable to disruption if ecological success and high levels of local participation are not balanced by strengthening basic capacity such as funding, human resources, monitoring.

SUGGESTION

Regular monitoring of CPUE, octopus' size and weight distribution, and habitat condition should be institutionalized as part of adaptive management cycles. Improving socio-economic benefit-sharing mechanisms is necessary to sustain long-term compliance. While ecological outcomes have shown positive trends, limited direct economic benefits for fishers pose a risk to the durability of the open-close system. Fisheries management policies should therefore incorporate incentives such as preferential access during opening periods, value-chain improvements, or market-based mechanisms to ensure that conservation gains translate into tangible livelihood benefits.

ACKNOWLEDGMENTS

We would like to thank the Coastal Conservation Foundation (YPL), the Indonesian Marine Conservation (YKL) and the Wangi-Wangi Fishermen's Community (KOMANANGI), and The Kadie Kapota Indigenous Community and the local octopus fisherman for their invaluable knowledge and participation. Special thanks are extended to the Wakatobi National Park Authority (Area Management Section 1, the Wakatobi College of Marine Affairs and Fisheries (MMAF), and the local government agencies for facilitating the fieldwork and data collection.



REFERENCES

- Aeberhard WH, Flemming JM, Nielsen A. 2018. Review of State-Space Models for Fisheries Science. *Annual Review of Statistics and Its Application*. 5: 215–235. <https://doi.org/10.1146/annurev-statistics-031017-100427>
- Agardy T, Himes-Cornell A, Bowser L, Hoelting K. 2025. *Documenting Biodiversity Outcomes in Marine Fisheries Management – A Supplemental Guide to the FAO Handbook on Identifying, Evaluating, and Reporting Fisheries other Effective Area-Based Conservation Measures*. FAO Fisheries and Aquaculture Technical Paper No. 709: 1-122. Rome: FAO. <https://doi.org/10.4060/cd6085en>
- Alekuzzaman M. 2022. Community Based Fisheries Management in Bangladesh. *International Journal of Advanced Research Higher Studies*. 1(1): 15–26. <https://doi.org/10.70818/ijarhs.v01i01.2022.0220702>
- Ananingsih SW, Adhim N, Muhyidin. 2025. Parimpari on Kapota Island, Wakatobi (A Study from Environmental, Social, and Cultural Aspects). *IOP Conference Series: Earth and Environmental Science*. 1537: 1–11. <https://doi.org/10.1088/1755-1315/1537/1/012030>
- Ariando W, Arunotai N. 2022. The Bajau as a Left-Behind Group in the Context of Coastal and Marine Co-Management System in Indonesia. *Journal of Marine and Island Cultures* 1(11): 260-278. <https://doi.org/10.21463/jmic.2022.11.1.18>
- Aziz B. 2025. *Pengelolaan Perikanan Berbasis Komunitas dan Partisipasi Masyarakat*. Yogyakarta: Gita Lentera.
- Ballad EL, Morooka Y, Shinbo T. 2022. Ensuring Sustainability of Community Participation in Locally-Managed Marine Protected Area in North-Western Cagayan, Philippines. *Maritime Technology and Research*. 4(4): 1–12. <https://doi.org/10.33175/mtr.2022.258234>
- Beckensteiner J, Boschetti F, Thébaud O. 2023. Adaptive Fisheries Responses May Lead to Climate Maladaptation in the Absence of Access Regulations. *NPJ Ocean Sustainability*. 2(3): 1–5. <https://doi.org/10.1038/s44183-023-00010-0>
- Bohorquez JJ, Dvarskas A, Jacquet J, Sumaila UR, Nye J, Pikitch EK. 2022. A New Tool to Evaluate, Improve, and Sustain Marine Protected Area Financing Built on a Comprehensive Review of Finance Sources and Instruments. *Frontiers in Marine Science*. 8: 742846. <https://doi.org/10.3389/fmars.2021.742846>
- Budiyanto, Riani I, Rosmawati. 2025. Impact of Managing Wakatobi National Park as a Marine Conservation Area. *AACL Bioflux*. 18(2): 1046–1055. <https://bioflux.com.ro/docs/2025.1046-1055.pdf>
- Card DC. 2022. Wakatobi Archipelago Coral Reefs. *EBSCO Knowledge Advantage*. pp. 1–2. <https://www.ebsco.com/research-starters/science/wakatobi-archipelago-coral-reefs> (Accessed: February 13, 2026).
- de Sousa WL, Zacardi DM, Vieira TA. 2022. Traditional Ecological Knowledge of Fishermen: People Contributing towards Environmental Preservation. *Sustainability*. 14(9): 4899. <https://doi.org/10.3390/su14094899>
- Di Franco A, Thiriet P, Di Carlo G, Dimitriadis C, Francour P, Gutiérrez NL, Jeudy de Grissac A, Koutsoubas D, Milazzo M, Otero MdM, Piante C, Plass-Johnson J, Susana Sainz-Trapaga S, Santarossa L, Tudela S, Guidetti P. 2016. Five Key Attributes Can Increase Marine Protected Areas Performance for Small-Scale Fisheries Management. *Scientific Reports*. 6: 1–9. <https://doi.org/10.1038/srep38135>
- Di Franco A, Hogg KE, Calò A, Bennett NJ, Sévin-Allouet MA, Alaminos OE, Lang M, Koutsoubas D, Prvan M, Santarossa L, Niccolini F, Milazzo M, Guidetti P. 2020. Improving Marine Protected Area Governance Through Collaboration and Co-Production. *Journal of Environmental Management*. 269: 1–13. <https://doi.org/10.1016/j.jenvman.2020.110757>

- Dominguez-Lopez M, Follana-Berná G, Arechavala-Lopez P. 2021. Behaviour and Body Patterns of Octopus Vulgaris Facing a Baited Trap: First-Capture Assessment. *Scientia Marina*. 85(1): 29–38. <https://doi.org/10.3989/scimar.05065.003>
- Dridi A, Baali A, Achi AE, Belghyti D. 2023. A Preliminary Analysis of the Relationship Between the Common Octopus (*Octopus vulgaris*) Juveniles Abundance and Environmental Parameters off the Moroccan Coast. *Egyptian Journal of Aquatic Biology & Fisheries*. 27(3): 863–879. <https://doi.org/10.21608/ejabf.2023.306125>
- Dudayev R, Hakim LL, Rufiati I. 2023. Participatory Fisheries Governance in Indonesia: Are Octopus Fisheries Leading the Way? *Marine Policy*. 147: 1–8. <https://doi.org/10.1016/j.marpol.2022.105338>
- Estradivari, Agung MF, Adhuri DS, Ferse SCA, Sualia I, Andradi-Brown DA, Campbell SJ, Iqbal M, Jonas HD, Lazuardi ME, Nanlohy H, Pakiding F, Pusparini NKS, Ramadhana HC, Ruchimat T, Santiadji IWV, Timisela NR, Veverka L, Ahmadia GN. 2022. Marine Conservation Beyond MPAs: Towards the Recognition of Other Effective Area-Based Conservation Measures (OECMs) in Indonesia. *Marine Policy*. 137: 1–12. <https://doi.org/10.1016/j.marpol.2021.104939>
- Farhum MF, Jompa J, Restu M. 2021. Management Effectiveness of the Bunaken National Park, Indonesia. *AACL Bioflux*. 14(2): 1089–1097. <https://bioflux.com.ro/docs/2021.1089-1097.pdf>
- Ghoddous A, Loos J, Kuemmerle T. 2022. An Outcome-Oriented, Social-Ecological Framework for Assessing Protected Area Effectiveness. *BioScience*. 72(2): 201–212. <https://doi.org/10.1093/biosci/biab114>
- Gopalakrishnan L, Abidin SZ, Cheng M, Arsir A, Salman bin Saaban. 2024. Developing Strategies to Improve Mett Scores and Overall Management Effectiveness in Selected Malaysian Protected Areas. *Parks*. 30(2): 34–46. <https://doi.org/10.2305/MVFT5945>
- Handayani S, Ibrahim MA. 2025. Collaborative Governance in Locally-Based Fisheries Management: A Literature Review. *KnE Social Sciences*. 10(18): 1252–1269. <https://doi.org/10.18502/kss.v10i18.19553>
- Hesti WO. 2025. *Mengenai Parimpari: Pembesaran Gurita Nelayan di Wangi-Wangi Wakatobi*. Telisik Indonesia. [internet]. Available at: <https://telisik.id/news/mengenai-parimpari-pembesaran-gurita-nelayan-di-wangi-wangi-wakatobi>
- Hockings M, Stolton S, Dudley N, Deguignet M. 2018. Protected Area Management Effectiveness (PAME). *Report on a Training Course for Protected Area Staff in Myanmar December 2018*. https://iucn.org/sites/default/files/content/documents/2019/myanmar_mett_course_report_dec_2018_final.pdf
- Humas KSDE. 2023. Parimpari, Kearifan Lokal Masyarakat Sekitar TN Wakatobi. <https://ksdae.kehutanan.go.id/publikasi/berita/parimpari-kearifan-lokal-masyarakat-sekitar-tn-wakatobi-eDka6N8h/>
- Jack-Kadioglu T, Estradivari, Lazuardi ME, Rukma A. 2020. *Management of Marine Protected Areas in Indonesia: Status and Challenges 2020*. Jakarta. Available at: <https://doi.org/10.6084/m9.figshare.13341476>
- Jaelani LORD, Jania, Ridwan. 2024. Pengaruh Kearifan Lokal Parimpari dalam Menjaga Kelestarian Spesies Gurita (*Octopus Spp.*) di Pulau Kapota Wakatobi. *Jurnal Pendidikan Tambusai*. 8(1): 2146–2151. <https://doi.org/https://doi.org/10.31004/jptam.v8i1.12717>
- Keith DM, Sameoto JA, Keyser FM, Ward-Paige CA. 2020. Evaluating Socio-Economic and Conservation Impacts of Management: A Case Study of Timearea Closures on Georges Bank. *PLoS ONE*. 15(10): 1–25. <https://doi.org/10.1371/journal.pone.0240322>
- Kep Dirjen PRL. 2020. Keputusan Direktur Jenderal Pengelolaan Ruang Laut Nomor 28/KEP-/DJPRL/2020 tentang



- Pedoman Teknis Penilaian Evaluasi Efektivitas Pengelolaan Kawasan Konservasi (Evika). Available at: <https://surajis.wordpress.com/wp-content/uploads/2021/12/2020-kepdirljen-prl-28-pedoman-teknis-evaluasi-efektivitas-pengelolaan-kk.pdf>
- Kim S. 2025. Linking Community Characteristics to Performance in Fisheries Co-Management and Community-Based Management: Evidence from South Korea. *Society & Natural Resources an International Journal*. 38(10): 1081–1102. <https://doi.org/10.1080/08941920.2025.2500412>
- Mast A, Gill D, Ahmadia GN, Darling ES, Andradi-Brown DA, Geldman J, Epstein G, MacNeil MA. 2025. Shared Governance Increases Marine Protected Area Effectiveness. *PLoS ONE*. 20(1): 1–21. <https://doi.org/10.1371/journal.pone.0315896>
- Masud MM, Shahabudin SM, Baskaran A, Akhtar R. 2022. Co-Management Approach to Sustainable Management of Marine Protected Areas: The Case of Malaysia. *Marine Policy*. 138: 105010. <https://doi.org/https://doi.org/10.1016/j.marpol.2022.105010>
- Maynard L, Jacobson SK, Kamanga J. 2020. Stakeholder Collaboration: Evaluating Community-Based Conservancies in Kenya. *Oryx Fauna & Flora International*. 54(5): 723–730. <https://doi.org/10.1017/S0030605318000789>
- McCabe MK, Mudge L, Randrianjafimanana T, Rasolofoarivony N, Vessaz F, Rakotonirainy R, Said FA, Rakotoarisoa F, Ratoniherson T, Box S, Cox C. 2024. Impacts of Locally Managed Periodic Octopus Fishery Closures in Comoros and Madagascar: Short-Term Benefits Amidst Long-Term Decline. *Frontiers in Marine Science*. 11: 1–17. <https://doi.org/10.3389/fmars.2024.1358111>
- Mustari T, Manaf S, Munafi AOL. 2018. Pola Pemanfaatan Sumberdaya Laut Berbasis Kearifan Lokal pada Masyarakat Wabula, di Kabupaten Buton. 2(1): 53-62. <https://doi.org/10.21107/sml.v2i1.5521>
- Nugraha RT, Komara WY, Krisna PAN, Puspita OR, Muslich M, Marthy W. 2024. Evaluating the Effectiveness of Protected Area Management in Indonesia. *Oryx*. 58(4): 474–484. <https://doi.org/10.1017/S003060532300145X>
- Pag-ong AIG, Nisperos DMP. 2024. Reassessment of Masinloc and Oyon Bay Protected Landscape and Seascape Management Effectiveness. *Philippine Journal of Science*. 153(6B): 2321–2327. <https://doi.org/10.56899/153.6B.08>
- Pradana AP. 2025. *Community and Wakatobi National Park Collaborate to Protect Conservation Areas Through Local Wisdom*. Yayasan Konservasi Alam Nusantara. pp. 1–3. <https://www.ykan.or.id/en/publications/articles/press-release/protect-conservation-areas-trough-local-wisdom/> (Accessed: February 13, 2026).
- Primus J. 2023. *Parimpari, Stories of Local Wisdom for a Sustainable Sea*. Kompas.Com, 22 May, pp. 1–2. Available at: https://www.kompas.com/stori/read/2023/05/22/200000879/parimpari-cerita-kearifan-lokal-demi-laut-lestari?lgn_method=google&google_bt n=onetap&lgn_method=google&google_btn=onetap (Accessed: February 13, 2026).
- Roberts KE, Valkan RS, Cook CN. 2018. Measuring Progress in Marine Protection: A New Set of Metrics to Evaluate the Strength of Marine Protected Area Networks. *Biological Conservation*. 219: 20–27. <https://doi.org/10.1016/j.biocon.2018.01.004>
- Robertson T, Greenhalgh S, Korovulavula I, Tikoibua T, Radikedike P, Stahlmann-Brown P. 2020. Locally Managed Marine Areas: Implications for Socio-Economic Impacts in Kadavu, Fiji. *Marine Policy*. 117: 1–11. <https://doi.org/10.1016/j.marpol.2020.103950>
- Santamaría, A. Euán Ávila, J.I. Munguia-Rosas, M.A. Saldívar-Lucio, R. Fraga, J. 2023. Environmental Variability and Governance: The Fishery of Octopus Maya in Yucatan, Mexico. *Frontiers in Marine Science*. 10: 1–10.

- <https://doi.org/10.3389/fmars.2023.1018728>
- Stolton S, Hockings M, Dudley N. 2020. A Guide to the Online Excel Version of the Management Effectiveness Tracking Tool (METT) for Protected and Conserved Areas. *IUCN, WWF, BIOPAMA*. 1–27. <https://rris.biopama.org/sites/default/files/2020-12/METT-4%20guide.pdf> (Accessed: March 18, 2026).
- Stori FT, Peres CM, Turra A, Pressey RL. 2019. Traditional Ecological Knowledge Supports Ecosystem-Based Management in Disturbed Coastal Marine Social-Ecological Systems. *Frontiers in Marine Science*. 6: 1–22. <https://doi.org/10.3389/fmars.2019.00571>
- Tetelepta JMS, Abrahamsz J, Mamesah JAB, Pattikawa JA, Wawo M, Al Hamid F. 2023. The Local Wisdom Knowledge Applied in the Management of Coastal Resources at Ilii Village, Western Seram District, Indonesia. *IOP Conference Series: Earth and Environmental Science*. 1207: 1–10. <https://doi.org/10.1088/1755-1315/1207/1/012023>
- The Government of Wakatobi Regency. 2024. *Rules of the Regent of Wakatobi Number 1 of 2024 concerning the Protection and Management of Coastal and Marine Resources Based on the Customary Law of Kadie Kapota, Wangi-Wangi Selatan District, Wakatobi Regency, The Government of Wakatobi Regency*. Indonesia: <https://peraturan.bpk.go.id/Details/303437/perbup-kab-wakatobi-no-1-tahun-2024> (Accessed: March 7, 2026).
- Turasih T. 2022. Social Construction of Local Wisdom of Kaombo Laut in Binongko Island Communities, Wakatobi Islands. *Syekh Nurjati: Jurnal Studi Sosial Keagamaan*. 02(02): 120-140. <https://doi.org/10.24235/sejati.v2i2.30>
- Van LN. 2025. *Management Effectiveness Evaluation of Protected Areas in Central Vietnam using the Fourth Version of the Management Effectiveness Tracking Tool*. Discover Forests. pp. 1–21. <https://link.springer.com/article/10.1007/s44415-025-00023-2>
- Voorberg W, Van der Veer R. 2020. Co-management as a Successful Strategy for Marine Conservation. *Journal of Marine Science and Engineering*. 8(8): 1–12. <https://doi.org/10.3390/JMSE8070491>
- Wicaksono VA, Nasution AM, Putriraya AR, Digdo A. 2023. Understanding the Socio-Ecological System of Small-Scale Octopus Fisheries in North Minahasa to Achieve Sustainable Certification. *IOP Conference Series: Earth and Environmental Science*. 1220: 1–9. <https://doi.org/10.1088/1755-1315/1220/1/012033>
- Widodo HHW, Zainuri M, Saputra SW, Anggoro S, Widodo HHW. 2021. Management Effectiveness: Nusa Penida MPA in Authority Transition. *AACL Bioflux*. 14(6): 3583–3595. <https://bioflux.com.ro/docs/2021.3583-3595.pdf>
- Wiranti, Maskun, Ilmar A, Naswar Idris I, Gontha E. 2025. Strengthening Community-Based Fisheries Governance in Indonesia's Coastal Areas. *BIO Web of Conferences*. 185: 1–14. <https://doi.org/10.1051/bioconf/202518506001>
- Wulan FN, Mangkurat RSB, Suhendar M, Yanuar Y, Manafi MR. 2024. Harmonisasi EVIKA dan METT terhadap IUCN Green List Menuju Efektivitas Pengelolaan Kawasan Konservasi Laut Berstandar Internasional. *Science Technology and Management Journal*. 2(4): 80-83. <https://doi.org/10.53416/stmj.v4i2.235>