

# Utilization of coastal & marine resources by the local community of Kei Kecil conservation area

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**Abstract.** Kei Kecil Island, a vital part of Indonesia's marine conservation areas, is rich in coastal and marine resources essential for local communities' economic sustainability. However, increased resource utilization due to population growth and expanding tourism and fisheries sectors poses challenges to environmental sustainability and the potential overexploitation of marine resources. This research analyzes the use of coastal and marine resources in Kei Kecil Island's conservation areas by coastal communities through a mixed-method approach, including field surveys, stakeholder interviews, and secondary data analysis. The study reveals that fishing and seaweed cultivation are the main sources of income, with significant variations in investment costs and business performance across different sub-districts. Higher investments generally lead to better financial performance, but challenges such as overfishing, destructive fishing practices, limited education, and governance issues threaten resource sustainability. The research suggests a multi-faceted approach involving collaborative management frameworks, investment in education and training, and strengthening regulatory frameworks to ensure the long-term health of the ecosystem and the welfare of local communities.

## 1 Introduction

Kei Kecil Island, a region with abundant coastal and marine resources, is an essential part of Indonesia's marine conservation areas[1]. Resources such as fisheries, coral reefs, and mangrove ecosystems offer substantial benefits, not only for the ecosystem but also for the economic sustainability of local communities. In recent decades, resource utilization has intensified owing to population growth and the expansion of the tourism and fisheries sectors. However, this increased activity brings serious challenges related to environmental sustainability and potential overexploitation of marine resources.

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The coastal conservation area of Kei Kecil Island and its surrounding waters have significant marine resource potential. However, if these resources are exploited unsustainably, it could jeopardize the health of the ecosystem and welfare of the local community. Effective management and sustainable practices [2] are crucial to ensure that both the marine environment and the livelihoods of people who depend on these resources can thrive together.

Economic pressure on communities in marine conservation areas can greatly affect the success of conservation [3]. When financial hardship is high, residents may turn to unsustainable resource use, such as overfishing or coral harvesting, to meet their immediate needs. This creates a conflict between livelihood demands and conservation goals, thereby reducing community support for protective measures. To address this, conservation efforts should integrate sustainable income options, such as sustainable fishing practices, to help communities gain economic stability while preserving marine resources. By aligning conservation goals with local economic interests, these programmes can foster both ecological preservation and community resilience.

This research aims to analyze the use of coastal and marine resources in small Kei Island conservation areas by coastal communities.

## 2 Research Method

The research method employed in this study on coastal and marine resource utilization on Kei Kecil Island combines both qualitative and quantitative approaches [4] to obtain a comprehensive understanding of the subject. The methodology included field surveys, stakeholder interviews, and secondary data analysis. Each of these components is designed to gather data on resource usage patterns, stakeholder perspectives, and the impact of these activities on both the environment and local community's well-being. The survey was carried out in August 2024 in four sub-districts that are included in the Kei Kecil conservation area: Kei Kecil sub-district, Manyeuw sub-district, Hoat Sorbay sub-district, Kei Kecil Barat sub-district, and Maluku Tenggara Regency, Maluku Province. Respondents were determined through purposive sampling, with 88 fishing households and 42 seaweed-cultivating households.

Field surveys were conducted to gather direct observations of the types of coastal and marine resources utilized and the scale of their usage by local communities. These surveys focused on areas with high levels of activity, including fishing, tourism, and marine aquaculture. Field data were recorded to assess the environmental conditions and potential impact of each type of activity on the local ecosystem.

In-depth interviews were conducted with a range of stakeholders, including local community members, fishermen, business owners, and representatives from local government agencies. These interviews provided insights into the motivations behind resource use, community dependency on coastal and marine resources, and challenges faced in managing these resources sustainably. Stakeholder perspectives on the importance of conservation efforts and their involvement in such initiatives are also captured.

To supplement the field observations and interview data, secondary data were obtained from local government reports, conservation agency publications, and relevant academic studies. These data helped contextualize findings within a broader scope, providing a historical background on resource utilization and existing conservation measures on Kei Kecil Island. Secondary data analysis also aided in identifying trends, comparing them with similar regions, and assessing the regulatory framework governing coastal and marine resource use.

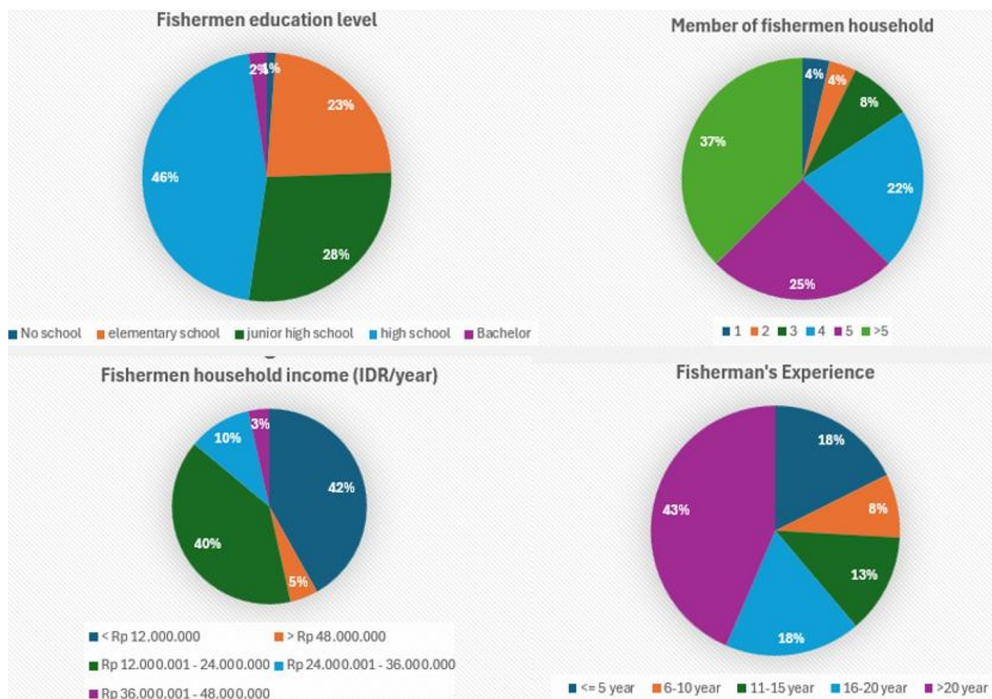
Data analysis was conducted using descriptive and financial methods. Descriptive analysis provides an overview of the characteristics and trends within the data, helping

identify patterns, challenges, and opportunities in the community's seaweed cultivation and fishing activities. Financial analysis evaluates the economic viability of seaweed cultivation and fishing businesses by assessing profitability, income distribution, costs, and potential returns. This combined approach offers insights into both the social and economic aspects of the community's activities, informing strategies for sustainable income improvement and resource management.

### 3 Result and Discussion

#### 3.1 Sociodemographic Kei Islands Conservation Area

The Kei Islands Conservation Area, located in Indonesia's Maluku region, is characterized by a rich socio-demographic landscape that is deeply influenced by its coastal environment and traditional maritime culture. The communities are predominantly rural, with livelihoods closely tied to natural resources, particularly fisheries, marine aquaculture, small-scale agriculture, and tourism. As the mainstay of local income, fishing has been practiced for generations, with knowledge and skills passed down through families, forming the cultural backbone of the community. This reliance on traditional practices highlights the close relationship between people and their surrounding environment, where resources such as coral reefs, mangroves, and open waters provide both sustenance and economic security.

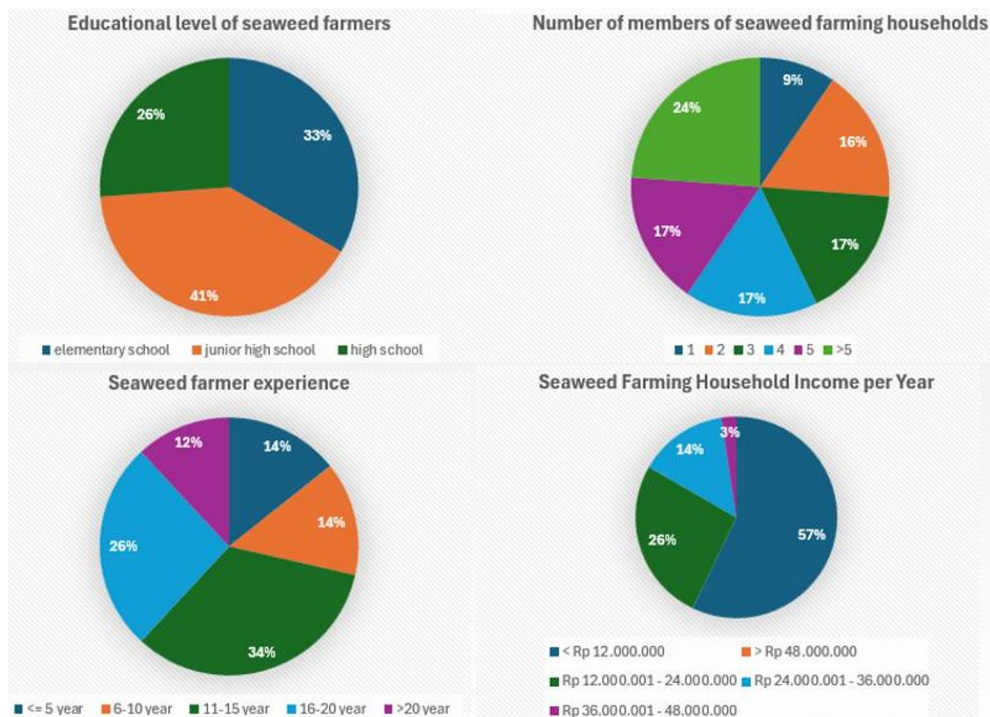


**Fig. 1.** Fishermen household sociodemographic aspect.

**Figure 1** provides an overview of the sociodemographic aspects of fishermen households. Most fishermen in this area have a secondary education (junior and senior high school), with only a few reaching higher education. This suggests that although formal education is accessible to most, there are challenges in advancing to higher levels. Higher education is expected to provide additional skills for managing marine resources and exploring other job opportunities in related sectors. Fishermen's households are generally large, with most having

more than five members, indicating possible economic challenges, particularly in terms of welfare. Larger households tend to have more dependents, which can affect their ability to improve welfare. However, more household members can benefit if they contribute to productive work. Overall, the welfare of fishing households may rely on effective resource management and economic distribution within large households. Fishing experience is strongly correlated with productivity and income. Fishermen with more than 15 years of experience tend to have higher productivity and income because of their knowledge of fishing strategies, resource management, and market networks. By contrast, those with less than five years of experience may face productivity and income challenges. Thus, the longer the fishing experience, the greater the likelihood of increasing catch and income. Household income data show that most fishermen have relatively low incomes, indicating income inequality. Most fall into the low-income category, with only a few reaching higher income levels, likely because of limited access to resources or broader markets.

In addition to fishing, most of the communities in the conservation area of Kei Kecil Island engage in seaweed cultivation to meet their daily needs. Seaweed cultivation has been developing in this area for more than 20 years. The growth of seaweed has fluctuated, mainly due to variations in productivity and the dynamics of seaweed selling prices. The following image shows the characteristics of the seaweed cultivator respondents in the conservation area of Kei Kecil Island:



**Fig. 2.** Seaweed farmer household's sociodemographic aspect.

**Figure 2** illustrates various sociodemographic aspects of seaweed farming households. Seaweed cultivators and fishermen have similar educational profiles, with most having only basic or secondary education. Lower education, especially among seaweed cultivators and fishermen, can hinder the adoption of new technologies and effective business management. However, seaweed cultivators with secondary education have the potential to improve productivity and business management, especially through training and access to information resources. Most seaweed cultivator households are smaller than fishermen's households.

While smaller households have lighter expenses, they may face productivity challenges due to limited labor. Conversely, fishermen with larger households face higher economic burdens but can also benefit from additional labor for economic activities. Seaweed cultivators generally have significant experience, with most having 11 to 20 years of experience in the field. Experienced cultivators tend to have better skills and knowledge, which leads to higher productivity and income. Those with less than ten years of experience are still in the learning phase, which may limit their yield. Cultivators with over 20 years of experience need to adapt to technological and market changes to maintain a stable income. Training programs for new cultivators are essential for boosting skills and productivity. Most seaweed cultivator households earn less than IDR 12,000,000 per year, limiting their ability to meet their basic needs. Only a few earn above IDR 24,000,000. These low-income groups force many to allocate most earnings to basic needs, hindering investment or business development. Increasing income through training, market access, and cultivation technology is essential to improve welfare.

### 3.2 Most utilizing marine and fisheries resources in Kei Islands Conservation Area

Marine and fisheries resources are the cornerstone of economic activity and sustenance in the Kei Islands Conservation Area, with these resources deeply embedded in the daily lives, traditions, and economic structures of local communities. The islands boast a highly diverse marine ecosystem home to a multitude of fish species, vibrant coral reefs, and expansive mangrove forests, each playing a critical role in supporting various livelihoods. Artisanal and small-scale fishing, which draws on generation-old techniques and knowledge, is the most widespread activity and a primary source of food security and household income for many of the population.

**Table 1.** Fishing business investment costs.

<b>Fishing gears</b>	<b>Investment value (IDR)</b>
<b>Hoat Sorbay Sub district</b>	
traps	6,660,000
gillnet	25,296,000
handline	42,623,571
mini pурсeseine	96,882,857
mini longline	38,543,333
<b>Kei Kecil Sub district</b>	
gillnet	53,750,625
spearguns	33,400,000
handline	10,725,833
<b>Kei Kecil Barat Sub district</b>	
gillnet	22,720,714
handline	43,060,000
mini longline	18,425,000
<b>Manyeuw Sub district</b>	
liftnet	211,148,000
gillnet	23,756,818
handline	38,833,333

**Table 1** presents the investment costs of various fishing gears across different sub-districts. The investment values in fishing gear across different sub-districts on Kei Island

vary significantly, reflecting the diversity in fishing methods and financial resources available. The largest investment cost component in a fishing business is the fishing fleet, its machines, and fishing gear. In Manyeuw Sub-district, liftnet shows the highest investment at IDR 211 million, suggesting that it is a costly, possibly large-scale operation. Mini purseseines in Hoat Sorbay (IDR 96.9 million) and gillnets in Kei Kecil (IDR 53.8 million) also have high investment values, indicating substantial capital input in these areas. In contrast, lower investments, such as handlines in Kei Kecil (IDR 10.7 million) and traps in Hoat Sorbay (IDR 6.7 million), are more accessible, likely used by smaller-scale or traditional fishers. This distribution highlights the varying levels of fishing gear investment across regions with potential differences in fishing capacity and productivity. The following table shows the business operational costs and business performance of each fishing gear for each fishing effort.

**Table 2.** Fishing business performance per fishing trip (by vessel).

Fishing gears	Total cost (IDR/trip)	Catch/trip (Kgs)	Total revenue (IDR/trip)	Profit (IDR/trip)
<b>Hoat Sorbay Sub district</b>				
traps	134,861	6	700,000	565,139
gillnet	227,107	55	461,083	233,977
handline	314,109	17	730,714	416,605
mini purseseine	529,008	276	1,615,000	1,085,992
mini longline	338,833	25	1,276,667	937,833
<b>Kei Kecil Sub district</b>				
gillnet	336,690	27	527,250	190,560
spearguns	393,000	26	550,000	157,000
handline	177,152	9	606,667	429,514
<b>Kei Kecil Barat Sub district</b>				
gillnet	129,238	13	303,571	174,334
handline	399,309	35	635,000	235,691
mini longline	229,355	10	400,000	170,645
<b>Manyeuw Sub district</b>				
liftnet	406,639	74	813,125	406,486
gillnet	258,318	19	490,909	232,591
handline	327,444	18	813,889	486,445

**Table 2** presents the fishing business performance across different sub-districts, highlighting total costs, catch per trip, revenue, and profit per trip for various fishing gears. Mini purseseine and mini longline operations in Hoat Sorbay generated the highest profits per trip (IDR 1,085,992 and IDR 937,833, respectively), which is attributed to their high catch volumes (276 and 25 kg). Conversely, gillnets and spearguns in Kei Kecil yield lower profits (IDR 190,560 and IDR 157,000, respectively), partly because of higher costs relative to their catch size. Smaller-scale options, such as traps in Hoat Sorbay and handlines across several regions, provide moderate profits, showing that traditional, lower-cost methods still bring reasonable returns. Overall, higher-cost gear often results in higher profits, but the balance between cost, catch size, and revenue varies significantly by method and region. In the next discussion, we examine the business costs and performance of the fishing business during a year of activity.

**Table 3.** Fishing business performance in a year.

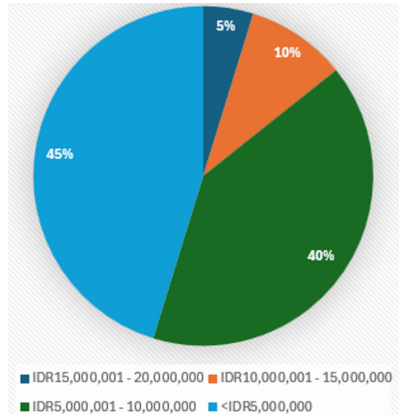
Fishing gears	Effort (Trip/year)	Total cost (IDR/year)	Total revenue (IDR/year)	Profit (IDR/year)	R/C ratio
<b>Hoat Sorbay Sub district</b>					
traps	288	38,840,000	201,600,000	162,760,000	5.19
gillnet	140	36,665,200	72,043,833	35,378,633	2.78
handline	187	66,217,143	155,658,571	89,441,429	2.58
mini purseseine	152	80,490,000	240,228,571	159,738,571	3.20
mini longline	160	54,213,333	204,266,667	150,053,333	3.86
<b>Kei Kecil Sub district</b>					
gillnet	152	50,775,500	80,217,000	29,441,500	1.58
spearguns	108	42,444,000	59,400,000	16,956,000	1.40
handline	173	27,558,500	93,326,667	65,768,167	3.89
<b>Kei Kecil Barat Sub district</b>					
gillnet	140	19,238,571	44,612,857	25,374,286	3.16
handline	94	34,749,000	55,265,000	20,516,000	2.30
mini longline	128	32,646,667	56,750,000	24,103,333	2.19
<b>Manyeuw Sub district</b>					
liftnet	141	54,445,000	121,382,500	66,937,500	2.08
gillnet	156	43,281,273	78,080,909	34,799,636	2.28
handline	121	45,237,111	118,702,222	73,465,111	2.92

**Table 3** presents the annual fishing business performance across different sub-districts, highlighting the effort (trips per year), total cost, total revenue, profit, and the Revenue-Cost (R/C) ratio, which indicates the profitability of different fishing gears. The Hoat Sorbay Sub-district shows high profitability, especially with traps (R/C ratio 5.19) and mini purseseines (R/C ratio 3.20), indicating significant returns on investment. The Kei Kecil Sub-district has lower R/C ratios, with spearguns generating the lowest (1.40), suggesting limited profitability. The Kei Kecil Barat Sub-district has moderate R/C ratios, with gillnets performing relatively well (3.16). The Manyeuw Sub-district displays an average performance, with handlines yielding the highest profit and R/C ratio (2.92). Overall, traps in Hoat Sorbay and handlines in Kei Kecil offer the highest returns relative to costs, whereas spearguns in Kei Kecil yield the lowest profitability.

The performance of fishing operations in the Kei region is influenced by factors such as wave conditions and availability of resources or assets within coastal communities. In June, July, and August, the primary fishing grounds across the waters of the Kei Islands show strong potential[5]. Rainfall and wind speed [6]can limit fishing activities, thereby reducing both the frequency and safety of trips. Additionally, access to fishing assets such as boats, nets, and equipment varies among households, impacting their ability to fish effectively and consistently. Communities with better resources can operate more resiliently, whereas those with limited assets may struggle to sustain fishing efforts and income during challenging conditions. Consequently, these environmental and resource-related factors play crucial roles in determining the productivity and economic stability of local fishing efforts.

In addition to fishing, seaweed farming has become an important source of livelihood for coastal communities in the Kei Kecil Island conservation area. This activity has grown rapidly due to the environmental conditions that support seaweed cultivation, such as clean, nutrient-rich waters. Seaweed farming provides economic benefits to the community, helping

increase income and diversify livelihoods beyond fishing. In this area, seaweed farming is also considered environmentally friendly, as it does not harm the ecosystem and supports marine conservation efforts, contributing to the balance of the coastal ecosystem.



**Fig. 3.** Distribution of seaweed cultivators based on the size of business investment.

**Figure 3** illustrates the distribution of seaweed cultivators according to their business investment size. The data show that most seaweed cultivation businesses on Kei Island operate with lower investments, with 45% of farmers investing under IDR 5 million and 40% investing between IDR 5-10 million. Only a small proportion of farmers (15% in total) invest in IDR 10 million. This suggests that seaweed cultivation on Kei Island is largely a low-capital venture, likely because of limited access to financial resources. However, as previous analyses show, higher investments tend to yield better returns and greater efficiency, indicating that there may be potential for growth if farmers gain access to more capital. Supporting these farmers with resources or financial assistance could help them scale up and increase their profitability.

**Table 4.** Seaweed Cultivation Business Performance in a Year.

No.	Investment value (IDR)	Variable cost (IDR per year)	Fixed cost (IDR/year)	Total cost (IDR/year)	Total revenue (IDR/year)	Profit (IDR/year)	R/C ratio
1	15,000,001 - 20,000,000	7,760,000	2,630,000	10,390,000	28,466,667	18,076,667	2.73
2	10,000,001 - 15,000,000	8,300,000	3,450,000	11,750,000	34,666,667	22,916,667	2.87
3	5,000,001 - 10,000,000	5,688,529	2,752,941	8,441,471	19,520,588	11,079,118	2.20
4	<5,000,000	3,610,526	1,792,105	5,402,632	14,238,596	8,835,965	2.65

**Table 4** presents the annual business performance of seaweed cultivation based on different levels of investment. Analysis of seaweed cultivation businesses by investment level reveals that higher investments generally lead to better financial performance. Businesses with investments in the IDR 10-15 million range achieve the highest revenue (IDR 34.7 million), profit (IDR 22.9 million), and cost efficiency (R/C ratio of 2.87), making this the most profitable and efficient bracket. Even at lower investment levels, all groups showed profitability with R/C ratios above 2.0, indicating that seaweed cultivation is financially viable across different scales. For the best returns, farmers may consider investing at least IDR 10 million, whereas those with limited capital can still achieve decent profits with smaller investments.

Seaweed cultivation is attractive to coastal communities because of its low capital and operational costs, simple cultivation techniques, relatively low labor requirements, and short production cycles, which provide a steady income [7], [8], [9]. However, currently, the price of seaweed is relatively low, and it cannot grow optimally. This prevents seaweed farmers from optimizing their cultivation areas. Seaweed price levels are determined by aggregation centers and main transportation hubs in remote areas. [10]

### **3.3 Opportunity and challenge of marine and fisheries utilizing**

The utilization of marine and fishery resources in the Kei Islands Conservation Area embodies a complex blend of opportunities and challenges that impact both the local economy and the environment. The region's rich marine biodiversity, including various fish species, coral reefs, and mangrove ecosystems, provides a wealth of economic opportunities for the local community. Fishing and seaweed farming are critical sources of income, providing stability for households and supporting food security across the islands.

However, such opportunities pose substantial challenges. Overfishing, driven by both local demand and commercial interests, strains fish populations and threatens the long-term sustainability of fishing [11], [12]. Additionally, unsustainable fishing practices, such as the use of destructive methods like blast fishing and cyanide fishing, [13] cause significant harm to coral reefs and other vital habitats. Although illegal, these destructive methods can be difficult to eradicate because of insufficient enforcement and economic pressure on fishers to maximize short-term catches.

Another critical challenge is limited access to education and alternative employment opportunities, which leaves many residents reliant on extractive activities. For many locals, fishing has been the primary livelihood for generations, and transitioning to other forms of income, such as ecotourism or sustainable aquaculture, requires new skills, knowledge, and often upfront investment. Furthermore, governance issues such as limited funding for conservation programs, insufficient monitoring capabilities, and a lack of integrated resource management policies hamper efforts to implement sustainable practices.

To fully realize the opportunities and address the challenges of marine and fishery resource utilization in the Kei Islands, a multi-faceted approach is necessary. This involves building collaborative management frameworks that actively engage local communities, government agencies, and NGOs to create shared responsibility for resource sustainability. Investing in environmental education, vocational training, and capacity-building programs will empower residents to adopt sustainable practices and to explore alternative livelihoods. Strengthening regulatory frameworks with stricter enforcement and transparent management is also essential to curb illegal and destructive fishing practices. With a holistic strategy, the Kei Islands can harness the economic potential of their marine resources while preserving the ecological integrity of the conservation area, ensuring a sustainable future for both the community and environment.

## **4 Conclusion**

The Kei Kecil Island conservation area has significant coastal and marine resources and is an important marine conservation area. Fishing and seaweed cultivation play an important role as sources of livelihood for coastal communities in the Kei Island conservation area. This effort provides sufficient results to meet the needs of coastal communities.

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