

Lobster governance and sustainability in southern West Java, Indonesia

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Abstract. Lobster is a high-value fisheries commodity that requires effective management to ensure long-term sustainability and conservation. This study aims to identify priority policy options for sustainable lobster governance based on a multi-criteria decision analysis. An adaptive action research approach was applied in the southern coastal waters of West Java, Indonesia, specifically in Ujung Genteng, Sindang Barang, and Pameungpeuk villages. Data was collected through focus group discussions, structured interviews, and direct field surveys involving lobster fishers and stakeholders. The data analysis used multi-criteria analysis to examine sustainability management and governance. The dominant substrates for lobster seed/BBL (puerulus) are coral rubble and reef structures. The availability of lobster seeds/BBL was found to be increasing, while adult lobster prices remained relatively high, with individuals exceeding 5 cm in size valued at approximately IDR 15,000 per individual by fishermen. Strong market demand, including lobster seeds, continues to drive fishing pressure. In addition, lobster grow-out activities are constrained by high operational costs and long production cycles. Overall, the sustainability of lobster was classified as moderate, with a composite score of 56.82%. Strong policy influence combined with relatively low welfare outcomes indicates an imbalance among sustainability dimensions. To enhance both conservation outcomes and socio-economic benefits, improved data collection on stock conditions, environmental parameters, and fisher income and welfare are essential. Strengthening governance through integrated ecological, social, and economic considerations is critical for achieving sustainable lobster fisheries.

Keywords: Indian Ocean, multi criteria analysis, policy management.

Introduction. Lobster fisheries in the southern waters of Java (Pamengpeuk, Cianjur, Ujung Genteng), are predominantly based on capture fisheries. Fishing gears have evolved in both number and type for lobster seed and adults. Initially, the dominant fishing gear was used in this research area are pocong trap and lift net, gillnet (Setyanto & Halimah, 2019) and small monofilament gillnet (Boesono et al., 2011). However, during this study, lift nets (bagan angkat) have become more popular particularly to catch lobster larva. The intensiveness of fishing activity impacts stock sustainability and biodiversity. Research from Pratiwi (2018) found 3 species, and Setyanto et al. (2019) found five species.

Key components influencing sustainability of lobster fisheries are bio-ecological status, economic, social, policy, and marketing conditions (Milton et al., 2014). Bio-ecological status is crucial for lobster sustainability, particularly substrate conditions (Irianto et al., 2024), growth and reproduction capacity, and stock dynamics. Lobsters that grow well and are harvested after reaching gonadal maturity, under regulated fishing regimes, have higher sustainability. In addition, oceanographic conditions also influence to lobster distribution, growth, and stock dynamics (Wahyudin, 2018).

Intensive exploitation of both adult lobsters and lobster seeds is driven by high market demand and high prices (Wahyudin, 2018). Large-scale exploitation began following price increases at the fisherman level. Prior to price regulation, lobster seed prices ranged from IDR 20,000–40,000 per individual (Yonvitner et al., 2019). Following

price regulation at IDR 8,000 per individual and centralized trade through business service agencies, violations re-emerged.

High international prices subsequently stimulated illegal fishing and trade across all locations. Illegal fishing and trade practices persist due to limited community awareness. Fisherman involved in lobster seed collection often lack understanding of risks and quotas, as their primary concern is income generation (Setyanto et al., 2019). A new phenomenon observed is occupational shifting from agriculture to fisheries, where individuals previously engaged other activities moved into lobster fishing (Jones et al., 2019). Survey findings indicate that approximately 90 – 100 % of lobster seed collectors were new entrants to the activity. The proliferation of illegal activities is also exacerbated by weak law enforcement and inconsistent policies.

Over the past five years, lobster management policies have undergone frequent changes with various modifications. At least five policy revisions have occurred, yet lobster governance has not significantly improved fisherman livelihoods (Wahyudin et al., 2017). Programs such as lobster villages, size regulations, and aquaculture zoning have not been effectively implemented. Export policies for lobster seeds and adults are widely perceived as unprofitable and even detrimental to Indonesia. Setyanto et al. (2023) explain that policy instability disrupts business systems, marketing chains, enterprise development, and causes widespread economic losses. These challenges are further compounded by limited involvement of local governments and constrained fisheries surveillance capacity.

Sustainable lobster management depends on addressing these issues. Sustainability research can be conducted using both quantitative and qualitative approaches. While biological and ecological analyses are essential, social and policy dimensions must also be considered (Hilyana et al., 2021). Sustainability is not solely determined by stock and environmental conditions (Amin et al., 2022), but also by human interactions within the lobster value chain (Fadjar et al., 2023). Therefore, a multi-criteria approach is necessary to comprehensively assess sustainability, which constitutes the primary objective of this study.

Material and Method

Research location. The research was conducted in the Indian Ocean waters along the southern coast of Java, specifically in southern West Java from September 2022 until May 2023. The selected fishing locations were Pameungpeuk village (Garut Regency), Sindang Barang village (Cianjur Regency), and Ujung Genteng village (Sukabumi Regency) as sampling sites (Figure 1). These areas represent major fishing grounds for lobsters and lobster seeds (BBL) in southern part of West Java.



Figure 1. Research locations on the south coast of West Java (map generated using Google Maps).

Data collection. Data were collected each month from lobster fishers and relevant stakeholders using a combination of focus group discussions (FGDs), structured interviews, and direct field observations. A total of 34 respondents participated in the study, consisting of 5 respondents from Pameungpeuk, 4 from Cianjur, and 25 from Ujung Genteng.

The dataset comprised both qualitative and quantitative information covering five sustainability dimensions: bio-ecological, economic, social, policy, and marketing aspects. In total, 30 indicators were assessed, including 8 bio-ecological parameters, 5 economic parameters, 6 social parameters, 6 policy parameters, and 6 marketing parameters. Indicator definitions, measurement units, data collection procedures, and scoring criteria were standardized to ensure comparability across study sites.

Data analysis. Each indicator was evaluated using a four-point Likert scale (1–4), reflecting performance levels from poor to good (Table 1). Indicator scores were subsequently transformed into a standardized 0–100 scale following the method proposed by Brown and Corbera (2003). This transformation allowed for consistent comparison among indicators with different units and value ranges. For the indicators where higher values represented better performance, a direct normalization formula was applied. Conversely, for indicators where lower values indicated better conditions, an inverse transformation was used. The standardized scores for each indicator were then aggregated within each sustainability dimension.

Table 1

Parameter measure in each variable, collecting procedure and data clasification for scoring

No	Indicator in each criterion	Unit	Data collection procedure	Class score of criteria
A			Bio-ecology	
1	Substrate	%	Recorded from survey	1 = mud; 2 = mud mix sand; 3 = sand; 4 = rubble
2	Composition of mature catch	%	Recorded from survey	1 => 50 %; 2 = 20 - 50 %; 3 = 10 - 20 %; 4 = < 10 %
3	Month of BBL Season	Number	Recorded from survey	1 = found > 7 th month; 2 = 3 - 5 month; 3 = 1 - 3 month; 4 = each month
4	Number of BBL catch in each fishing process	Ind	Recorded from survey	1 => 200 ind / catch; 2 = 100 - 200 ind / catch; 3 = 100 - 50 ind / catch; 4 =< 50 ind / catch
5	Water transparency	m	Direct measurement	1 = 0 - 2 m; 2 = 2 - 5 m; 3 = 5 - 10m; 4 => 10 m
6	Frequency of fishing in a week	Day	Recorded from survey	1 => 4 d/w; 2 = 3 - 4 d/w; 3 = 2 - 3 d/w; 4 = 1 - 2 d/w
B			Economy	
1	Price of lobster	IDR	Recorded from survey	1 =< 20.000; 2 = 20.000 - 30.000; 3 = 30.000 - 50.000; 4 = 50.000 - 75.000
2	Market distribution level	Level	Recorded from survey	1 = 2 level (local and non-local); 2 = 1 level; 3 = (temporary local and direct); 4 = direct
3	Total lobster catch/year	Ind	Recorded from survey	1 => 3000/year; 2 = 1500 - 3000 ind/y; 3 = 1000 - 1500 ind/y; 4 =< 1000 ind/y;
4	Operational cost	IDR	Recorded from survey	1=> 5 jt/ops; 2 = 3 - 5 jt/ops; 3 = 1 - 3 jt/ops; 4 =< 1 jt/ops
5	Income per trip	IDR	Recorded from survey	1 =< 100.000; 2 = 200000 - 500000; 3 = 50000 - 1.000.000; 4 = > 100000
C			Social	

1	Percentage of lobster fisherman compared to total fisherman	%	Survey and questioner	1 => 80 %; 2 = 60-80 %; 3 = 20 – 50 %; 4 =< 20 %
2	Percentage of lobster aquaculture	%	Survey and questioner	1 =< 10 %; 2 = 20 – 50 %; 3 = 60 – 80 %; 4 => 80 %
3	Education level of lobster fisherman	Freq	Survey and questioner	1 = no school; 2 = elementary school; 3 = junior high school; 4 = senior high school
4	Conflict	Freq	Survey and questioner	1 = most conflict; 2 = have on each semester; 3 = rare (once a year) ; 4 = never have conflict
5	Stakeholder participation on monitoring and surveillance	Freq	Survey and questioner	1 = monitoring only from security; 2 = security and DKP; 3 = security, DKP and community. ; 4 = security, DKP, community and trader
6	Fisherman contribution conservation	Number	Survey and questioner	1 = no conservation action; 2= passive contribution on conservation; 3 = active with regulation; 4 = active on conservation
D	Policy			
1	Availability policy	Freq	Survey and questioner	1 = not available policy; 2 = policy only at national level; 3 = policy available from national to provincial; 4 = policy complete and operationally
2	Policy Implementation	Freq	Survey and questioner	1 = not implemented yet; 2 = sometime implemented; 3 = regularly implemented; 4 = implemented well and consistently
3	Implementation of ministry regulation KP No 16/2022 (Ministry of Marine Affairs and Fisheries, 2022)	Status	Survey and questioner	1 = not implemented yet; 2 = sometime implemented; 3 = regularly implemented; 4 = implemented well and consistently
4	Local government on monitoring and implementation policy	Status	Survey and questioner	1 = no support for implementation; 2= limited support; 3 = mandatory support; 4 = active and participative support
5	Permit of lobster investment	Status	Survey and questioner	1 = no permit whatsoever; 2 = permit but with different fishing gear; 3 = permit and fishing gear relay; 4 = permit, fishing gear relay and regular report
6	Permit access	Status	Survey and questioner	1 = no access to permit; 2 = limited access; 3 = easy to access but nothing explained; 4 = permit with explanation and operationality
E	Marketing			
1	BBL market	-	Survey and questioner	1 = local fisherman; 2 = middleman; 3 = middleman; 4 = export
2	Lobster market	-	Survey and questioner	1 = local fisherman; 2 = middleman; 3 = middleman; 4 = export
3	Distribution system	No stage	Survey and questioner	1 = catch; 2 = catch - middleman; 3 = catch – middleman - distributor; 4 = catch – middleman – distributor - exporter
4	Number of BBL exported	Ind	Survey and questioner	4 = 100.000 ind/year; 3 = 100.000 - 300.000 ind/year; 2 = 300.000 - 500.000 ind/year; 1 = > 500.000 ind/year
5	BBL prices (IDR/Ind)	IDR	Survey and questioner	4 = < 10.000; 3 = 10.000 - 15.000; 2 = 15.000 - 20.000; 1 = > 20.000

6	Consumer preference	-	Survey and questioner	1 = stone lobster (<i>Panulirus penicillatus</i>); 2 = sand lobster (<i>Panulirus homarus</i>); 3 = pearl lobster (<i>Panulirus ornatus</i>); 4 = batik lobster (<i>Panulirus longipes</i>)
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Note: DKP - Dinas Kelautan dan Perikanan (Marine and Fisheries Office).

Overall sustainability was assessed using the technique for order of preference by similarity to ideal solution (TOPSIS) (Lai et al 1994). This multi-criteria decision-making method evaluates each alternative by comparing its distance from an ideal best solution (maximum values) and an ideal worst solution (minimum values).

The TOPSIS procedure involved the following steps: (1) normalization of indicator scores, (2) weighting of indicators, (3) identification of ideal best and worst solutions, (4) calculation of Euclidean distances to both ideal solutions, and (5) computation of preference scores.

Sustainability levels were classified into four categories: very sustainable (≥ 0.75), sustainable ($0.50 - 0.74$), moderately sustainable ($0.25 - 0.49$), and unsustainable (< 0.25) (Lai et al 1994).

Results. Research conducted in Pameungpeuk, Sindang Barang, and Ujung Genteng villages along the southern coast of West Java revealed limited spatial variation among study sites. Assessment of five variables comprising 29 parameters showed broadly comparable patterns across locations, with differences remaining relatively small. All measured values were subsequently transformed into standardized scores (indicated in parentheses) to facilitate comparison, as summarized in Table 2.

Table 2

Results of parameter analysis on each dimension

No	Parameters	Value and score of each parameter in each survey location			
		Pameungpeuk	Sindang Barang	Ujung Genteng	South coast
A		Bio-ecology			
1	Substrate	Dominant rubble (3.8)	Rubble (4)	Rubble (4)	Dominant rubble (3.9)
2	Mature composition	20 – 30 % (2.8)	0 – 10 % (3.75)	0 – 10 % (3.68)	0 – 10 % (3.4)
3	Months of BBL season	1 - 2 months (3.2)	Every month (4)	Every month (4)	1 - 2 months (3.7)
4	Number of BBL catches in each fishing process	< 50 ind/catch (4)	50 - 100 ind/catch (3.75)	100 - 200 ind/catch (2.8)	3.5
5	Transparency	> 10 m depth (4)	> 10 m depth (4)	> 10 m depth (4)	> 10 m depth (4)
6	Fishing frequency during a week	> 4 days/week (1)	> 4 days/week (1)	> 3 - 4 days/week (1.64)	1.2
B		Income and welfare			
1	Lobster price IDR	20.000 - 30.000 (2.4)	20.000 - 30.000 (2)	30.000 - 50.000 (3)	20.000 - 30.000 (2.5)
2	Lobster marketing	Direct selling to middleman (4)	Direct selling to middleman (4)	Direct selling to middleman (4)	Direct selling to middleman (4)
3	Annual lobster catches	1000 - 3000 ind/year (2.4)	Less than 1000 ind/year (4)	Less than 1000 ind/year (4)	1000-1500 ind/year (3.4)
4	Operation cost/cycle	< 1 jt/trip (1)	< 1 jt/trip (1)	< 1 jt/trip (1)	< 1 jt/trip (1)
5	Income business	500 rb - 1 jt/trip	> 1 jt/trip (4)	500 rb - 1 jt/trip	500 rb - 1 jt/trip

		(3.2)		(3.8)	(3.7)
C			Social		
1	Proportion of fishermen	More than 80% (1)	More than 80% (1)	More than 80% (1)	More than 80% (1)
2	Proportion of aquaculture	Less than < 10% (1)	Less than < 10% (1)	Less than < 10% (1)	Less than < 10% (1)
3	Fishermen education level	Elementary to junior school (2.6)	Junior school (3)	Elementary to junior school (2.7)	Elementary to junior school (2.7)
4	Conflict	Rare (3.2)	Rare (3)	Rare (3.3)	Rare (3.1)
5	Stakeholder participation on monitoring	Security (1)	Security and DKP (2)	Security and DKP (2)	Security and DKP (1.9)
6	Fishermen engagement on conservation	High participation (3.4)	Low participation (1.75)	Low participation (1)	Medium participation (2.05)
D			Policy		
1	Policy availability	Policy available and adequate (4)	Policy available and adequate (4)	Policy available and adequate (4)	Policy available and adequate (4)
2	Current policy status	Implemented irregularly (2)	Implemented irregularly (2)	Implemented irregularly (2)	Implemented irregularly (2)
3	Implementation of ministry regulation KP No 16/2022 (Ministry of Marine Affairs and Fisheries, 2022)	Fully implemented(4)	Fully implemented(4)	Fully implemented(4)	Fully implemented(4)
4	Regent participation on monitoring	Active (4)	Active (4)	Active (4)	Active (4)
5	Ownership of lobster fishing permit	No permit (1)	No permit (1)	No permit (1)	No permit (1)
6	Permit obtaining process	Permit with explanation and operationality (4)	Permit with explanation and operationality (4)	Permit with explanation and operationality (4)	Permit with explanation and operationality (4)
E			Marketing		
1	BBL market	Large collector (3)	Large collector (3)	Large and small collector (2.32)	Large and small collector (2.32)
2	Lobster market	Large collector and exporter (2.6)	Large collector and exporter (3.5)	Large collector and exporter (3.5)	Large collector and exporter (3.5)
3	Marketing chain	Single collector chain (1)	Double collector chain (1)	Double collector chain (1)	Double collector chain (1)
4	Volume BBL export	> 500.000 ind/year (1)	> 500.000 ind/year (1)	> 500.000 ind/year (1)	> 500.000 ind/year (1)
5	Lobster seed price IDR/ind	Export market price > 20.000/export (1)	Export market price > 20.000/export (1)	Export market price > 20.000/export (1)	Export market price > 20.000/export (1)
6	Consumer target and preference	Pearl lobster (3)	Pearl lobster (3)	Pearl lobster (3)	Pearl lobster (3)

Note: DKP - Dinas Kelautan dan Perikanan (Marine and Fisheries Office).

Bio-ecological and economic dimensions. The bio-ecological assessment shows that lobster management performance is generally high across the study areas, with average scores ranging from 71.1 to 82.5 (Figure 2A). The highest bio-ecological score was recorded for the southern coastal area (82.5), followed by Sindang Barang (80.6) and Ujung Genteng (78.4), while Pameungpeuk showed a comparatively lower score (71.1). Simbolon et al (2024) state bio-ecological parameters are one of the important indicators for determining the status of lobster utilization and protection.

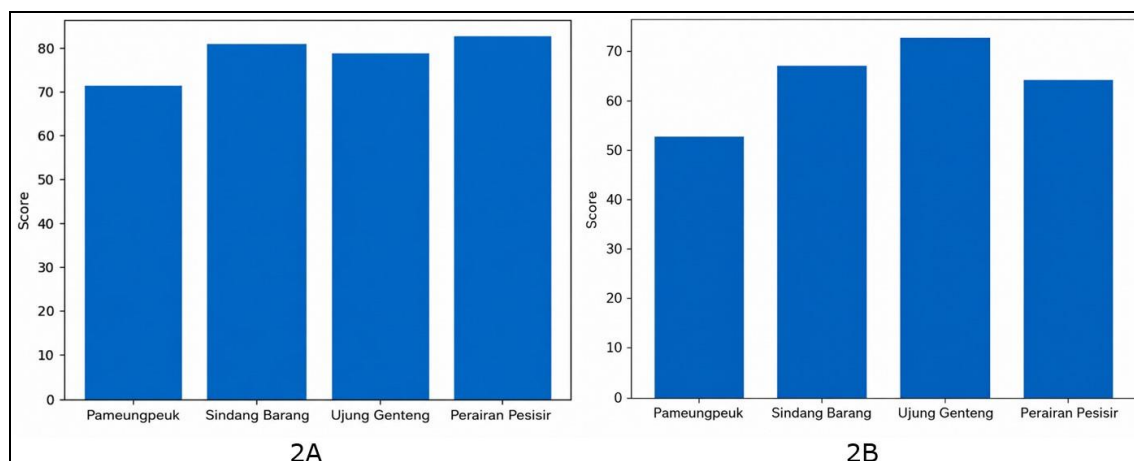


Figure 2. Bio-ecology dimension (1A) and economic dimension (1B) in each location.

High scores for substrate suitability and lobster grow-out habitat (score = 100 in all areas) indicate suitable environments and substrate conditions supporting lobster survival and recruitment (Setyanto et al 2025). The frequent presence of puerulus and juvenile lobsters (BBL), particularly in Sindang Barang and Ujung Genteng, suggests that these areas function as effective nursery grounds. However, fishing frequency remains low in Pameungpeuk and Sindang Barang, indicating limited fishing effort or operational constraints. It means the lobster population is potentially overexploited (Zairion et al 2017) and stock is decreasing.

The economic dimension exhibits moderate to high performance, with average values ranging from 53.3 to 72.0 (Figure 2B). Ujung Genteng achieved the highest score (72.0), followed by Cianjur (66.7). All study areas recorded maximum scores for lobster market access, reflecting strong demand and established trading networks. Despite relatively high-income levels from lobster fishing, the absence of grow-out operational costs across all areas indicates that lobster-related economic activities are still predominantly capture-based rather than cultivation-based. This reliance on capture fisheries may increase pressure on natural stocks and reduce long-term economic sustainability.

Social dimension. The social dimension shows the lowest overall performance, with average scores ranging from 28 to 34 (Figure 3). None of the study areas reported the presence of specialized lobster fishers or lobster aquaculture practitioners, indicating weak social organization and limited professional specialization.

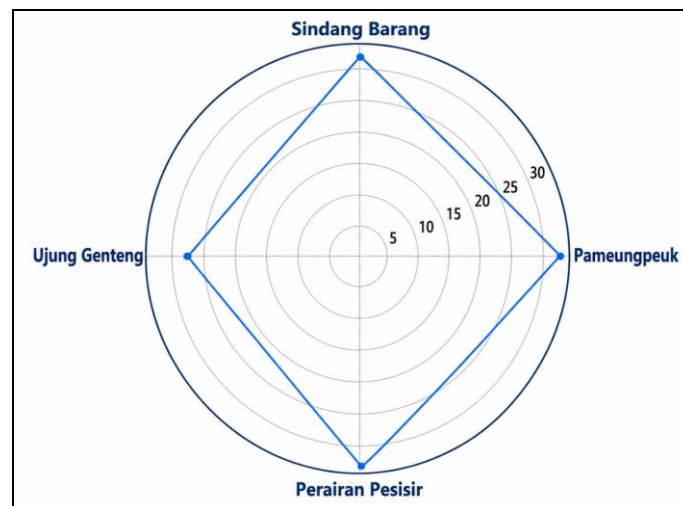


Figure 3. Socio community dimension of lobster management.

Although educational levels among fishing communities are moderate, this has not translated into strong stakeholder engagement or collective action for resource conservation. The low participation of fishers in sustainability initiatives, particularly in Ujung Genteng, suggests a critical gap between awareness and practice.

Policy and marketing dimension. The policy dimension demonstrates consistent and relatively strong performance across all areas, with an average score of 72 (Figure 4A). Policy availability, implementation by fishers, and local government participation in monitoring and enforcement received uniformly high scores. Al Farizi and Pramesti (2022) found on the southern coast of East Java, Ministerial Regulation No. 17 (Ministry of Marine Affairs and Fisheries, 2024) has also been gradually implemented. Nevertheless, the absence of formal business permits for lobster enterprises in all study areas highlights a structural gap between policy frameworks and administrative implementation. This disconnection may limit legal certainty and access to institutional support for fishers.

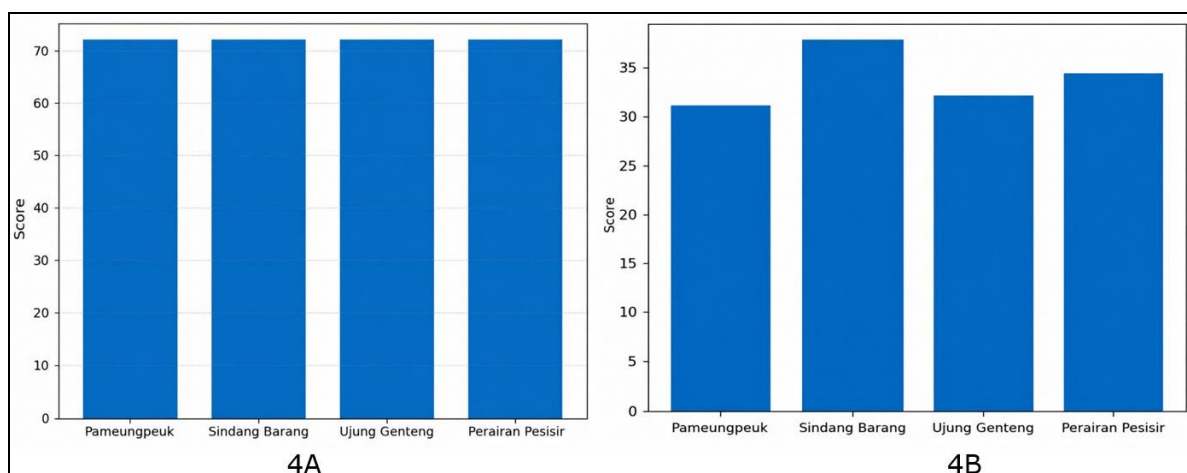


Figure 4. Policy dimension and marketing dimension of lobster management.

The marketing dimension records relatively low scores, ranging from 31 to 38 (Figure 4B). While domestic markets for adult lobsters and consumer preferences are well established, marketing chains remain short and poorly integrated. No export activities for lobster seeds or juveniles were reported in any study area. These results indicate that lobster marketing systems are largely local and lack downstream value addition, which constrains income diversification and economic resilience.

Discussion. The results demonstrate a structural imbalance in lobster management across the study areas, where strong bio-ecological conditions and supportive policy frameworks are not matched by equivalent social and marketing performance (Figure 5). This imbalance suggests that sustainability challenges are not primarily ecological, but rather institutional and socio-economic in nature. One of the main issues that influence sustainability is in balance with the raw data and information for other parameters (Wardiatno et al., 2020).

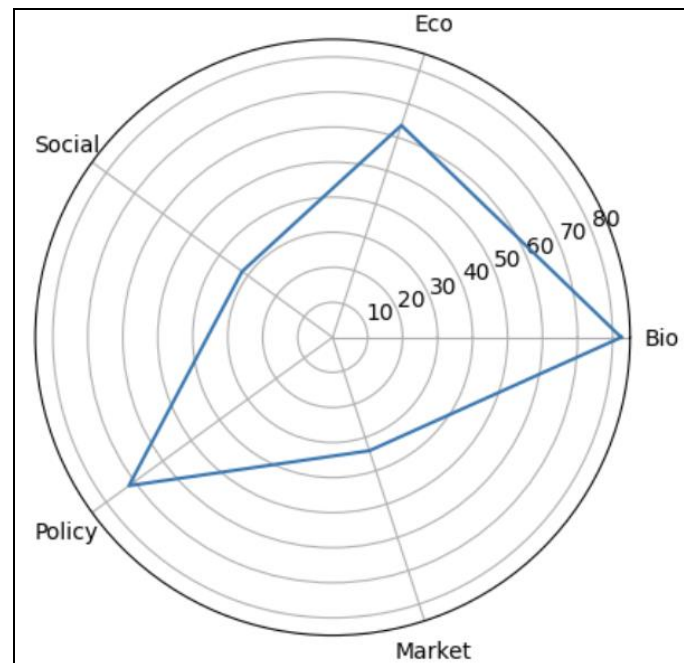


Figure 5. Multi-criteria analysis of five dimensions for lobster management.

High bio-ecological scores indicate that environmental carrying capacity remains adequate; however, continued reliance on capture fisheries without parallel development of grow-out or aquaculture systems, could threaten long-term stock sustainability (Arizona, 2025). Similar patterns have been reported in small-scale lobster fisheries in other tropical regions, where weak social institutions undermine effective resource governance. Hilyana et al. (2021) state that *Panulirus* sp. farming is relevant to the aquaculture sector in East Lombok

The consistently low social dimension underscores the need for strengthening fisher organizations, cooperative-based management, and stakeholder collaboration. Social capital plays a critical role in translating policy instruments into effective on-the-ground practices, particularly in community-based fisheries management. From an economic and marketing perspective, the limited development of marketing chains and absence of export-oriented value addition suggest unrealized economic potential. Integrating lobster fisheries into broader value chains through certification, processing, and regulated export mechanisms could enhance both economic returns and compliance with sustainability objectives. The lobster economic drivers, particularly the price of lobster, have increased since the aquaculture sector started improving its practices such as in Pangandaran (Rahayu et al., 2024).

Overall, the findings emphasize that future lobster management strategies should prioritize social institutional strengthening, business formalization, and market integration, while maintaining the existing ecological and policy strengths. An operational strategy that will influence stock sustainability is zonation scenario for closing-open system (Zamroni et al., 2021). An integrated, multi-dimensional approach is therefore essential for achieving sustainable lobster fisheries in the southern coastal waters of West Java.

Conclusions. This study provides a multidimensional assessment of lobster management performance in the southern coastal waters of West Java by integrating bio-ecological, economic, social, policy, and marketing dimensions. The results reveal a clear asymmetry among dimensions, where strong bio-ecological conditions and supportive policy frameworks are not matched by comparable social and market performance.

High bio-ecological scores across all study areas indicate that environmental suitability and recruitment potential remain relatively intact, suggesting that ecological degradation is not the primary constraint to sustainability. Similarly, the uniform performance of the policy dimension reflects the availability of regulatory instruments and government involvement in monitoring and enforcement. However, the absence of formalized business licensing highlights a critical gap between policy design and practical implementation.

In contrast, the consistently low performance of the social dimension underscores weak institutional capacity, limited fisher organization, and insufficient stakeholder engagement. These social deficits constrain the effective translation of ecological potential and policy instruments into sustainable management practices. Furthermore, the underdeveloped marketing dimension, characterized by short value chains and the absence of export activities, limits economic diversification and reduces incentives for compliance with sustainability measures.

Overall, the findings suggest that future lobster management strategies should move beyond an ecologically focused and regulation-driven approach towards an integrated governance framework that prioritizes social institutional strengthening, business formalization, and value chain development. Strengthening fisher organizations, enabling legally recognized lobster enterprises, and integrating fisheries into higher-value and certified markets are essential steps to enhance both sustainability and socio-economic resilience. This study highlights the importance of addressing institutional and market constraints as central components of sustainable small-scale fisheries governance.

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Conflict of Interest. The authors declare that there is no conflict of interest.

Data Availability. The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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