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Analysis of Factors Influencing the Sustainability of Parang Fish in North Rupert Subdistrict, Bengkalis Regency

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ABSTRACT: Parang fish (*Chirocentrus dorab*) fishing is one of the key capture fisheries activities for the community in North Rupert Subdistrict, Bengkalis Regency. The utilization of parang fish must be conducted sustainably to ensure that fish stocks are preserved and that fishing activities continue to benefit fishers. This study aims to (1) analyze the sustainability status of the parang fishery based on ecological, economic, and social dimensions; (2) analyze the key variables/attributes in the sustainable management of the parang fishery; and (3) develop management policies that determine the sustainability of the parang fishery in North Rupert Subdistrict, Bengkalis Regency. The results indicate that the sustainability status of the parang fishery is categorized as moderately sustainable, with index values of 55.17% for the ecological dimension, 51.06% for the economic dimension, and 51.72% for the social dimension. The determinants of sustainability comprise bycatch, fishing-ground range, market access, fishers' income relative to the regional minimum wage (UMR), social conflicts among fishers, and formal education level. Policy recommendations include reducing bycatch through more selective fishing gear, regulating fishing areas, improving market access and fishers' income, developing alternative livelihoods outside fishing, strengthening communication and cooperation among fishers, and improving education, extension services, and fishing skills.

I. INTRODUCTION

Fisheries and marine resources are natural resources with significant economic potential for communities, particularly by providing food and employment and supporting the economies of coastal communities (Sari et al., 2023). Fisheries resources need to be utilized sustainably so that fishing activities can continue in the long term without reducing the availability of the fish resources being exploited (Hehanussa, 2023).

The sustainability of capture fisheries is associated with ecological, economic, and social conditions because these three aspects are interconnected in maintaining fish resources and fishers' livelihoods (Fahrudin et al., 2019). North Rupert Subdistrict is a coastal area in Bengkalis Regency where most residents work as fishers and fisheries activities are dominated by capture fisheries (Afsari, 2012).

North Rupert Subdistrict is one of the coastal areas of Bengkalis Regency whose communities depend heavily on capture fisheries. Parang fish (*Chirocentrus dorab*) is one of the main fishery commodities in the waters of North Rupert Subdistrict, with production of approximately 280 tons per year. Parang fish are generally caught using gillnets with mesh sizes of 3.3–3.5 inches and motorized boats of 2–6 GT; parang fish account for approximately 75% of total catches (UPT Pulau Rupert Fish Landing Base, 2024).

Continued utilization of parang fish needs to be balanced with appropriate management so that it does not place excessive pressure on the resource or undermine the continuity of fishers' businesses. Therefore, it is necessary to assess the

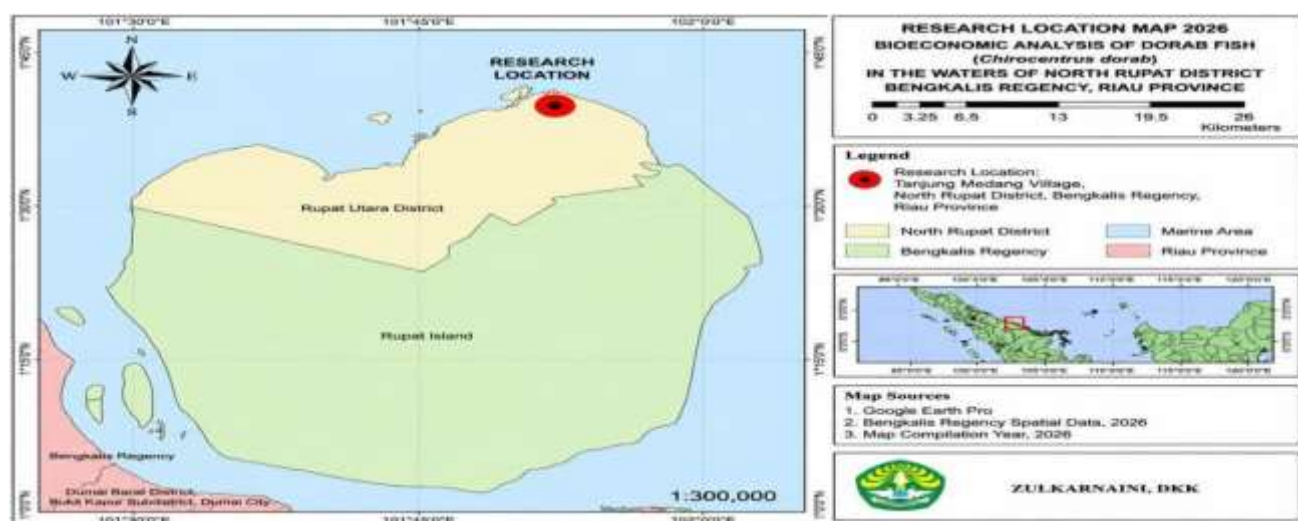
sustainability of the parang fishery from ecological, economic, and social perspectives and identify the factors or attributes that most influence changes in its sustainability index. This study aims to (1) analyze the sustainability status of the parang fishery (*Chirocentrus dorab*) based on ecological, economic, and social dimensions; (2) analyze leverage variables/attributes for sustainable management of the parang fishery; and (3) develop management policy directions that determine the sustainability of the parang fishery in North Rupat Subdistrict, Bengkalis Regency.

II. RESEARCH METHODS

A. Time and Location of the Study

The study was conducted in July 2026 in North Rupat Subdistrict, Bengkalis Regency, Riau Province. The work included measurements, primary-data collection, and the collection of secondary data. The research location is shown in Figure 1.

Figure 1. Research location.



B. Types and Sources of Data

The data collected comprised primary and secondary data. Primary data were obtained directly in the field through interviews with parang fishers using questionnaires concerning ecological, economic, and social conditions. Secondary data were obtained from reading materials and documents related to the parang fishery. The types and sources of data are detailed in Table 1.

Aspect	Variable	Type of Data	Data Source
Sustainability level/status of parang fish	Sustainability dimensions and attributes	Primary and secondary data	Analysis results; secondary data
Leverage variables/attributes in management	Leverage attributes from each dimension	Primary data	Questionnaires (stakeholders)
Policy-development directions	Objectives, criteria, alternatives	Primary data	Interviews

Table 1. Types and sources of study data.

Source: Research design, 2026.

C. Data Collection Methods

Data were collected using a survey and a literature review. The survey was used to collect primary data through interviews and visual observation of the parang fishery in North Rupat Subdistrict. The literature review was used to collect secondary data from documents and reading materials related to the parang fishery in North Rupat Subdistrict, Bengkalis Regency. The data collection methods are detailed in Table 2.

Objective	Variable	Type of Data	Data Collection Method
Assessment of parang-fish sustainability	Sustainability dimensions and attributes	Primary and secondary data	Survey (measurement and observation); literature review
Assessment of key variables/attributes for parang-fish sustainability	Leverage attributes from each dimension	Primary data	Survey (interviews)
Policy-development directions	Objectives, criteria, alternatives	Primary data	Survey (interviews)

Table 2. Data collection methods.

Source: Research design, 2026.

D. Data Analysis Methods

The data-analysis methods were selected according to the research objectives. They included multidimensional scaling (MDS) using Rapfish software, leverage analysis, Pareto analysis, and Monte Carlo analysis. The methods are summarized in Table 3.

1. Sustainability Analysis / Multidimensional Scaling (MDS)

The sustainability analysis was intended to provide an overview of the sustainability status of the parang fishery in North Rupert Subdistrict. The analysis used a multidimensional scaling (MDS) approach with Rapfish software. Rapfish stands for Rapid Appraisal for Fisheries. This approach is based primarily on the principles of Multi-Criteria Analysis (MCA), using an algorithm known as the MDS algorithm (Fauzi and Anna, 2002).

Each dimension was scored on a scale from 0 (worst) to 100 (best). An index value above 50 indicates that the assessed dimension is sustainable; conversely, a value below 50 indicates that the dimension is not yet sustainable or is unsustainable (Pitcher and Preikshot, 2001). The sustainability-index categories are presented in Table 4.

Objective	Variable	Analysis Method	Analysis Output
Assessment of fisheries sustainability/status	Sustainability dimensions and attributes	MDS analysis (Rapfish)	Sustainability status; sensitive variables; dimensional trade-offs
Assessment of key variables/attributes for fisheries sustainability	Leverage attributes from each dimension	Leverage analysis	Leverage/sensitive variables; influential variables
Policy-development directions	Objectives, criteria, actors	Pareto analysis	Policy alternatives

Table 3. Data analysis methods.

Source: Research design, 2026.

Index Value	Sustainability Category
0–25	Poor; unsustainable
26–50	Low; less sustainable
51–75	Moderate; moderately sustainable
76–100	Good; highly sustainable

Table 4. Sustainability-index categories.

Source: Pitcher and Preikshot, 2001.

2. Leverage Analysis and Leverage Attributes

Leverage analysis is a method used to identify the attributes most sensitive to changes in the sustainability index. It aims to determine which attributes have the greatest influence on the sustainability of the parang fishery across the ecological, economic, and social dimensions.

3. Pareto and Monte Carlo Analyses

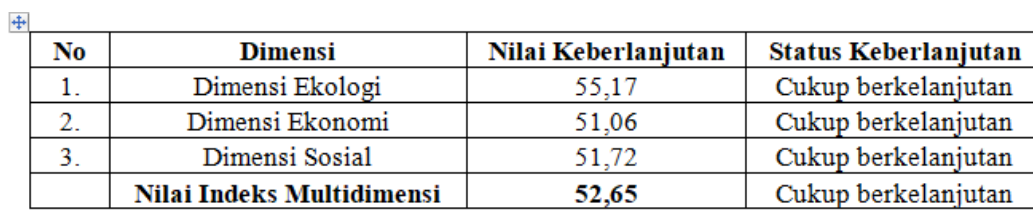
Pareto analysis was then used to determine leverage attributes according to their level of sensitivity, while Monte Carlo analysis was used to assess uncertainty in the sustainability-analysis results. These analyses identify sensitive attributes or determining factors that should be considered when developing policies to improve the sustainability of the parang fishery.

III. RESULTS AND DISCUSSION

A. Sustainability Status of the Parang Fishery

The sustainability of the parang fishery in North Rupert Subdistrict was assessed across three dimensions: ecological, economic, and social. Each dimension was evaluated using attributes that serve as indicators of the sustainability of the parang fishery. The Rapfish analysis produced an overall sustainability index of 52.65%, indicating that the parang fishery is moderately sustainable. The graphical results are presented in Figure 3.

Figure 3. Sustainability status of the parang fishery.



No	Dimensi	Nilai Keberlanjutan	Status Keberlanjutan
1.	Dimensi Ekologi	55,17	Cukup berkelanjutan
2.	Dimensi Ekonomi	51,06	Cukup berkelanjutan
3.	Dimensi Sosial	51,72	Cukup berkelanjutan
	Nilai Indeks Multidimensi	52,65	Cukup berkelanjutan

The Rapfish analysis yielded a sustainability-status value of 52.65%, classified as moderately sustainable. This indicates that the parang fishery in North Rupert Subdistrict can still be conducted sustainably, although several attributes require attention. This result is supported by the Monte Carlo analysis, which produced a sustainability value of 52.40%, a difference of 0.25 percentage points. The small difference indicates that the influence of errors in scoring and the analytical process was relatively low.

Monte Carlo analysis was used to examine uncertainty in the sustainability-analysis results. A Monte Carlo value that is not substantially different from the Rapfish index indicates that the results are relatively stable. Differences may be influenced by the scores assigned to each attribute, differences in respondent assessments, or the data-processing procedure. The sustainability results for each dimension are presented in greater detail in Table 6.

Dimension	Sustainability Value (%)	Stress Value	Coefficient of Determination (R^2)
Ecological	55.17	15.50	93.81
Economic	51.06	15.41	93.84
Social	51.72	15.37	93.75

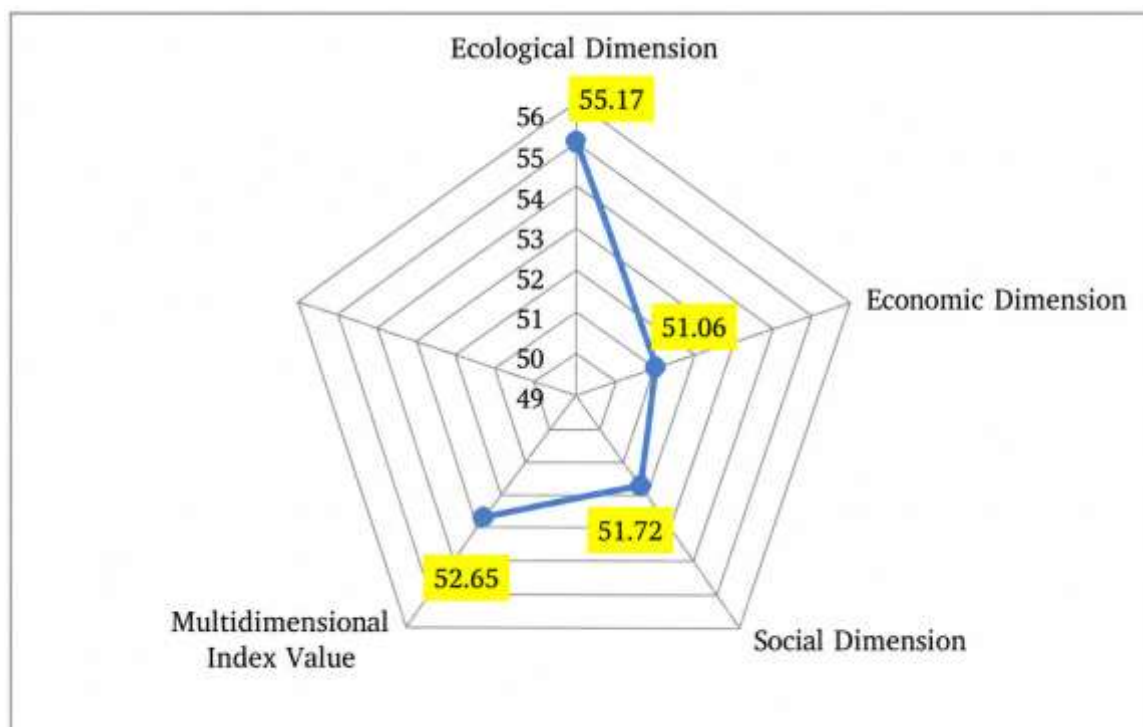
Table 6. Sustainability values, stress values, and coefficients of determination (R^2).

Source: Rapfish analysis, 2026.

The sustainability values for all three dimensions fall within the moderately sustainable category, namely the range above 50% to 75%. The ecological dimension has a sustainability value of 55.17%, the economic dimension 51.06%, and the social dimension 51.72%. These values indicate that all three dimensions are moderately sustainable, although several attributes still need attention to maintain and improve the sustainability of the parang fishery. Trade-offs among the dimensions can be illustrated in a kite diagram, as shown in Figure 4. The influence of each sustainability dimension is also reflected in the

leverage-attribute analysis (Figure 4), where the root mean square (RMS) value indicates the contribution of an attribute to the sensitivity of the sustainability status (Kavanagh and Pitcher, 2004).

Figure 4. Kite diagram of parang-fishery sustainability.



B. Leverage Attributes in Parang-Fishery Sustainability

The Rapfish analysis identified six main leverage attributes, or attributes with the greatest influence on the sustainability of the parang fishery in North Rupert Subdistrict. These comprised two ecological attributes, two economic attributes, and two social attributes. The details are presented in Table 7.

Leverage Attribute	Sustainability Dimension	RMS Value
Bycatch	Ecological	6.51
Fishing-ground range	Ecological	2.87
Market access	Economic	6.54
Fishers' income relative to the regional minimum wage (UMR)	Economic	5.25
Social conflicts among fishers	Social	6.95
Formal education level	Social	6.70

Table 7. RMS values of leverage attributes.

Source: Rapfish analysis, 2026.

C. Pareto and Monte Carlo Analyses

Pareto analysis was used to determine leverage attributes according to their sensitivity, while Monte Carlo analysis assessed uncertainty in the sustainability-analysis results. These analyses identify sensitive attributes or determining factors that should inform policy development for the sustainability of the parang fishery.

The sensitive attributes identified were bycatch, fishing-ground range, market access, fishers' income relative to the regional minimum wage (UMR), social conflicts among fishers, and formal education level.

Bycatch needs attention in parang-fishery management because incidental catches of other fish can increase pressure on fish resources. Appropriate policies include promoting more selective fishing gear, monitoring the types and quantities of bycatch, and educating fishers to release non-target organisms that are still alive.

The fishing-ground-range attribute concerns the size or extent of the fishing areas used by fishers. Future management could include regulating and mapping fishing grounds so that fishing activities are not concentrated in particular areas. Establishing fishing zones may also help reduce pressure on fish resources and maintain sustainable use in the long term (Mahmud, 2021).

Market access needs attention because fishers' ability to sell their catches affects the sustainability of the economic benefits they receive. Possible measures include expanding market access, strengthening links between fishers and buyers or marketing institutions, and encouraging fishers to market their catches through fisher groups so that they have stronger bargaining positions. Market access is one of the attributes with a substantial influence on changes in the sustainability index for the economic dimension (study source).

The attribute of fishers' income relative to the regional minimum wage (UMR) highlights the importance of income in supporting the sustainability of fishing activities. Future policies could focus on increasing the economic value of catches, developing supplementary livelihoods outside fishing, and improving fishers' skills so that their income is more stable and better able to meet living needs. This is important because fisheries sustainability depends not only on resource conditions but also on the ability of fishing activities to provide economic benefits to fishers.

Social conflicts among fishers require attention because conflicts can disrupt social relationships and the smooth operation of fishing activities. Measures could include strengthening communication and cooperation among fishers, establishing shared agreements on the use of fishing grounds, and increasing the role of fisher groups as forums for resolving problems. Active fisher participation in management is expected to improve relationships and support sustainable fishing.

Formal education level is related to fishers' ability to receive information, understand regulations, and apply knowledge that supports sustainable fishing. Possible measures include increasing access to education, extension activities, and training, particularly on environmentally responsible fishing, catch handling, occupational safety, and sustainable resource use. Improving education and knowledge is important because educational attainment can influence thinking, attitudes, and behavior in fisheries activities (Wahyudin et al., 2019).

Based on these sensitive attributes, policy directions for the sustainability of the parang fishery should be integrated and consider ecological, economic, and social aspects. Bycatch control and fishing-ground regulation should protect resources, while improvements in market access and fishers' income should strengthen the economic dimension. Meanwhile, stronger cooperation among fishers and improved education and knowledge should support better social conditions. Thus, the sensitive attributes identified through Pareto analysis can provide a basis for setting management priorities for the parang fishery in North Rupert Subdistrict.

IV. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

The sustainability status of the parang fishery in North Rupert Subdistrict, Bengkalis Regency, is currently classified as moderately sustainable, with values of 55.17% for the ecological dimension, 51.06% for the economic dimension, and 51.72% for the social dimension.

The determining attributes for the sustainability of the parang fishery are bycatch, fishing-ground range, market access, fishers' income relative to the regional minimum wage (UMR), social conflicts among fishers, and formal education level.

Policy directions for improving the sustainability of the parang fishery in North Rupert Subdistrict include reducing bycatch through the use of more selective fishing gear; regulating and mapping fishing grounds; improving market access and fishers' income; developing alternative livelihoods outside fishing; strengthening communication and cooperation among fishers to reduce social conflict; and improving education, extension services, and fishers' skills.

B. Recommendations

All three dimensions need to be considered in the sustainable management of the parang fishery in North Rupert Subdistrict, where the current sustainability status is categorized as moderately sustainable. To maintain and improve sustainability in the future, attention should be given to all three dimensions and to the determining attributes of the parang fishery in North Rupert Subdistrict, Bengkalis Regency. These efforts are expected to conserve parang fish resources, improve fishers' welfare, and support fisheries management that remains sustainable in the long term.

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