

## **SUSTAINABLE MANAGEMENT OF DOGTOOTH TUNA FISHERIES IN ECOLOGICAL DIMENSIONS IN EAST SIMEULUE, ACEH, INDONESIA**

### ***PENGELOLAAN PERIKANAN TUNA GIGI ANJING BERKELANJUTAN SECARA DIMENSI EKOLOGI DI PERAIRAN SIMEULUE TIMUR, ACEH, INDONESIA***

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#### **ABSTRACT**

Simeulue Regency is surrounded by small islands rich in diverse fish resources, namely dogtooth tuna. The interaction (reciprocity) between groups of organisms and their environment plays an important role in ecological systems. The determination of ecological status can be used to monitor, manage, and sustain waters in tuna fishing areas. Fishing activities will affect environmental changes that will impact marine biota's sustainability, existence, and diversity. This study aimed to analyze the ecological sustainability status of tuna fishing areas in East Simeulue waters. The research was conducted in May-July 2021. The method used in this research was observing and measuring the characteristics of the aquatic environment and conducting interviews. The attributes seen include the condition of the aquatic environment, conservation of pelagic resources, fishing activities, utilization of pelagic resources, environmental carrying capacity, type of fishing gear, the volume of fishing gear, level of suitability for fishing. The sustainability status of the ecological dimension obtained a value of 79.74. The results obtained are classified as well sustainable.

**Keywords:** carrying capacity, diversity, environment, sustainability, tuna

#### **ABSTRAK**

*Kabupaten Simeulue dikelilingi oleh pulau-pulau kecil yang kaya akan keanekaragaman sumberdaya ikan yakni tuna. Interaksi (timbang balik) antara kelompok organisme terhadap lingkungannya merupakan peran penting dari sistem ekologi. Penentuan status ekologi dapat dijadikan sebagai dasar dalam upaya pemantauan, pengelolaan dan keberlanjutan perairan terhadap daerah penangkapan ikan tuna. Aktifitas penangkapan perikanan tangkap akan memengaruhi perubahan lingkungan yang akan berdampak pada keberlanjutan, keberadaan dan keragaman biota laut. Tujuan dari penelitian untuk menganalisis status keberlanjutan ekologi daerah penangkapan ikan tuna di Perairan Simeulue Timur. Penelitian dilakukan pada bulan Mei-Juli 2021. Metode yang dilakukan pada penelitian ini dengan cara pengamatan dan pengukuran karakteristik lingkungan perairan serta melakukan wawancara. Atribut yang dilihat meliputi: kondisi lingkungan perairan, konservasi wilayah laut, aktivitas penangkapan, pemanfaatan sumberdaya pelagis, daya dukung lingkungan, jenis alat tangkap, volume alat tangkap, tingkat kesesuaian penangkapan. Status keberlanjutan dimensi ekologi didapatkan nilai sebesar 79,74. Hasil yang diperoleh tergolong dalam baik berkelanjutan.*

**Kata kunci:** berkelanjutan, daya dukung, keanekaragaman, lingkungan, tuna

## I. INTRODUCTION

Geographically, Simeulue waters are surrounded by small islands situated in the southwest region of Aceh Province and directly adjacent to the Indian Ocean. Simeulue waters have abundant water resources (Zulfadhli *et al.*, 2017). Various fishery resources are found in Simeulue waters, one of which is dogtooth tuna. Tuna fish can be found in tropical and sub-tropical waters. Differences in longitude and latitude do not affect the spread of tuna fish (Burhanis *et al.*, 2018). Tuna fish can be found in most Indonesian waters (Burhanis *et al.*, 2019).

The aquatic ecological system is a science that suggests the interaction (reciprocity) between groups of organisms and their environment. In Simeulue waters, dogtooth tuna is generally found around coral reefs based on the spatial and temporal of tuna caught in the Indian Ocean. In terms of ecology, it plays an important role in the distribution, abundance, presence, and death of marine organisms. Furthermore, this role is a source of life, which should be used in responsible manners to create a prosperous, independent society for the better.

The majority of the people of Simeulue live on the coast of Simeulue Island, and the dominant livelihood is a fisherman. Fishing activities carried out by fishers must pay attention to and maintain the stability of the ecological dimension. Furthermore, the interaction between living things and the environment is very dynamic; it needs to be developed so that it is expected to have a good impact on living things and their environment. Finally, there is an effort to maintain the stability of the ecological dimension. The potential of the marine and fishery sector requires efforts to build and increase marine and fishery productivity that have yet to be fully utilized. Land-use conflicts in coastal areas can affect the sustainability of fishing activities (Radarwati *et al.*, 2010). Future opportunities and

challenges enable valuable contributions to research activities, service, and sustainable Indonesian fisheries and marine resources management.

The existence of ecological status can be determined from the state of water quality and the diversity of ecosystems in these waters. The determination of ecological status can be used to monitor, manage, and sustain waters in fishing areas. Tuna management policies can ensure the sustainability of fishing in Simeulue waters to manage them in optimal and sustainable manners. The management policy should be based on scientific information (Burhanis, 2021). Fishing activities/pressures will affect environmental changes that will impact marine biota's sustainability, existence, and diversity. Therefore, research needs to be carried out to analyze the sustainability status of the dogtooth tuna fishing area in Simeulue Waters.

## II. RESEARCH METHODS

### 2.1. Research Location

This research has been conducted from May to July 2021 at the fish landing site and East Simeulue waters which are fishing activities for fishers in East Simeulue (Figure 1).

### 2.2. Method of Collecting Data

The research was conducted by utilizing the direct observation method, which refers to the ecological sustainability status of the fishing area for dogtooth tuna. The data used during the study included primary data and secondary data. The Primary data were obtained from surveys and monitoring of respondents/informants by distributing questionnaires using the purposive sampling method. The eight attributes include the condition of the aquatic environment, conservation of pelagic resources, fishing activities, utilization of pelagic resources, environmental carrying capacity, type of fishing gear, the volume of

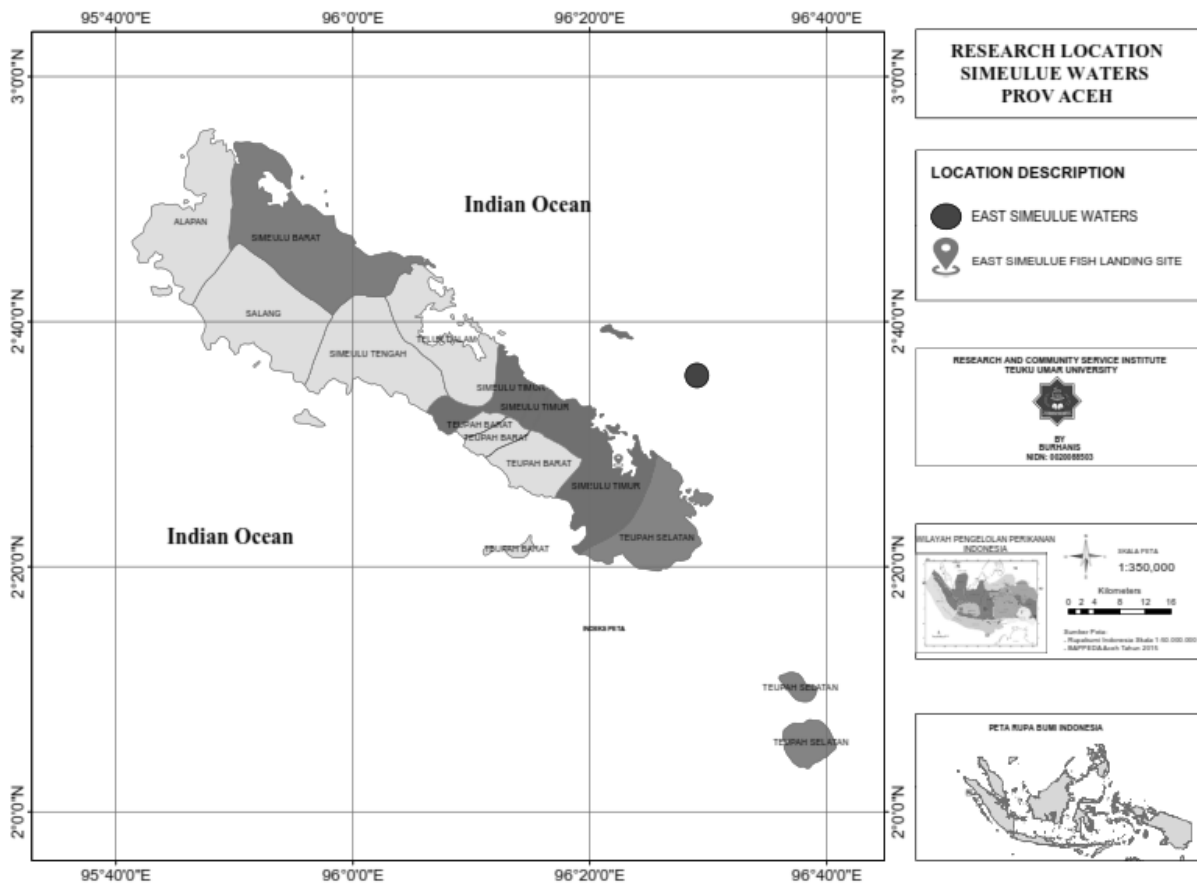


Figure 1. Research location at the fish landing site and East Simuelue waters.

fishing gear, level of suitability for fishing—the attributes used as parameters to analyze the sustainability of the dogtooth tuna fishery.

This sustainability approach was carried out through interviews (depth interviews) using questionnaires. From the attributes used, each value is obtained, which will be analyzed to assess the ecological sustainability of the waters of the dogtooth tuna fishing area. The data obtained were analyzed descriptively. Nazir (2005) suggests that the descriptive method predicts systems or events in survey and case study methods. Several indicators are used as parameters to analyze the sustainability of fisheries.

### 2.3. Data Analysis

The data to determine the sustainability status of dogtooth tuna is descriptive qualitative by collecting primary

data and secondary data. The observations and interviews of ecological water sustainability data from dogtooth tuna fishing areas were then analyzed using the MDS method with the Rapfish (Rapid Appraisal of Fisheries) application. Rapfish is a multidimensional method for evaluating fisheries sustainability (Pitcher *et al.* 1998; Pitcher 1999; Pitcher & Preikshot 2001). The sustainability index scale has a range of 0-100. Determining the value of the sustainability status of the Rapfish analysis is grouped into four parts: (1) 0-25 (bad or unsustainable), (2) 26-50 (less sustainable), (3) 51-75 (enough sustainable), and (3) 76-100 (good/very sustainable) (Erwina *et al.*, 2015). Determination of sensitive attributes that affect sustainability using sensitivity analysis (leverage analysis) (Wibowo *et al.*, 2013). The most sensitive attribute shows changes to the index and sustainability status

based on the highest values of Root Mean Square (RMS).

### III. RESULTS AND DISCUSSION

The improvement of the condition of the aquatic environment starts from understanding the aquatic environment. Water quality management is an effort to maintain water sources to create water quality according to its designation. The benchmark for determining an aquatic environment is in good condition or not at a specific time depends on the quality of the water. Keputusan Menteri Lingkungan Hidup Nomor 51 Tahun 2004 concerning physical and chemical parameters which include temperature 28-32°C, salinity 33-34‰, pH 7-8.5, and DO >5 mg/l. A good biodiversity zoning is a particular area with roles and functions for the biota and their ecosystems.

The productivity of waters is determined by its limiting factors, including temperature, salinity, dissolved oxygen content, and availability of nutrients. The factors that affect the characteristics of the aquatic environment, such as salinity, temperature, and wind direction, are seasons (Burhanis *et al.*, 2018). The producers in aquatic ecosystems are phytoplankton. The availability of adequate nutrients is the primary condition for the existence of phytoplankton. Habitat damage can be seen in correlation with the decline in species populations. Community participation in environmental protection and management is an essential pillar to achieving sustainable development. The criteria for the sustainability of fishery resource management are assessed from the community's attitude in maintaining productivity, the resource's ecological characteristics, and the system's flexibility (Nikijuluw, 2002).

The results of field measurements on the quality of several physical and chemical parameters of East Simuelue showed that the

dissolved oxygen content ranges from 5.4 to 7.1 mg/l, the salinity of the waters ranges from 31 to 35 ppt, and the water temperature ranges from 28.6 to 30.1°C. Based on these results, the overall marine environment of East Simeulue is still within the normal range and still within the tolerance range of marine biota, including suitable for the life of tuna fish. Simanjuntak (2007) states that the concentration of dissolved oxygen (DO) in seawater in Indonesian waters generally ranges from 4.50 to 7.00 mg/l. Furthermore, the abundance of tuna catches was found at salinity between 34.2-35.3 ppm. Yahya *et al.* (2001) stated that the water temperature favored by tuna ranges from 17 to 31°C.

The analysis of the sustainability of the dogtooth tuna fisheries management in East Simeulue waters is carried out through an assessment of eight ecological dimensions of sustainability attributes, including aquatic environmental conditions, conservation of marine areas, fishing activities, utilization of natural resources, environmental carrying capacity, types of fishing gear, the volume of fishing gear, and level of suitability for fishing. The results of the Rapfish analysis using the ordination technique through the MDS method obtained the sustainability status of the ecological dimension with a value of 79.74, which is shown in Figure 2. The results of the analysis of the sustainability value of dogtooth tuna management from the ecological dimension in the waters of East Simeulue are classified in the good/very sustainable category. This value is in the range of 76-100.

Based on Monte Carlo Analysis is used to examine the magnitude of the error factor or error in the sustainability analysis, which comes from differences in each respondent's assessment of attributes, errors in data entry, and incomplete or missing data (Kavanagh, 2001). Based on the analysis results, the Monte Carlo sustainability index refers to Tabel 1.

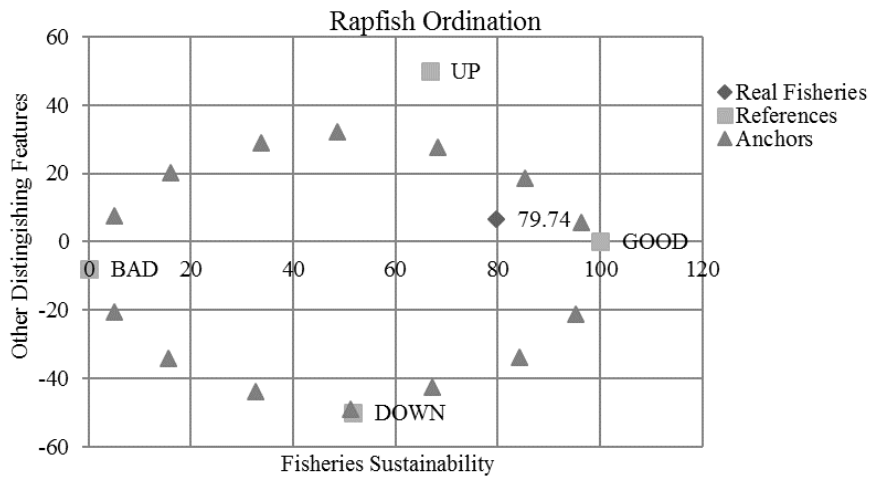


Figure 2. Index value and sustainability status of ecological dimension.

Table 1. Result of MDS analysis, monte Carlo analysis, and statistical analysis.

| Dimension | Sustainability Indexes |             | Difference | Statistical |                |
|-----------|------------------------|-------------|------------|-------------|----------------|
|           | MDS                    | Monte Carlo |            | Stress      | R <sup>2</sup> |
| Ecology   | 79.74                  | 80.59       | 0.85       | 0.138       | 0.950          |

Table 1 shows that the results of the Monte Carlo analysis with a confidence interval of 95% (the results do not experience much difference) are less than one between the results of the Monte Carlo analysis and the MDS analysis. The low difference in these values proves that the error effect can be avoided. The analysis results using the RAP-Multidimensional analysis tool show that the Stress value is 0.138 and R<sup>2</sup> is 0.95, indicating that the results obtained can be accounted for continued analysis.

Leverage analysis is used to see the effect on the sustainability score of fishing technology. The analysis results of leverage attributes for the ecological dimension are presented in (Figure 3); there are several sensitive attributes and indicate the magnitude of the value of the sustainability index of dogtooth tuna. These attributes include the level of suitability of fishing and aquatic environmental conditions.

The results of the analysis of the sustainability of the ecological dimension as shown in Figure 3. attributes including the

volume of fishing gear, type of fishing gear, fishing activity show values that do not affect the un-sustainability of dogtooth tuna. Simeulue. Fishers currently and generally use environmentally friendly fishing gear and activities, namely one-day fishing. Simeulue fishers carry out the fishing of dogtooth tuna by hand line fishing gear using fresh fish bait with a depth of 10 to 35 meters. Thus, several other attributes need to be studied and considered correctly to increase the index value in the future.

Simeulue fishers go fishing around the coral reef island waters. It is done because the presence of dogtooth tuna dominates these waters. Silas (1963) mentions that dogtooth tuna small dominate around coral reefs to look for food in the form of small fish. Large fish are found in the open sea. One of the parameters that affect the abundance of fish in waters is the presence or absence of the required food source. On the other hand, weather factors (sea waves and wind) affect tuna fishing. The integrated system will positively impact the

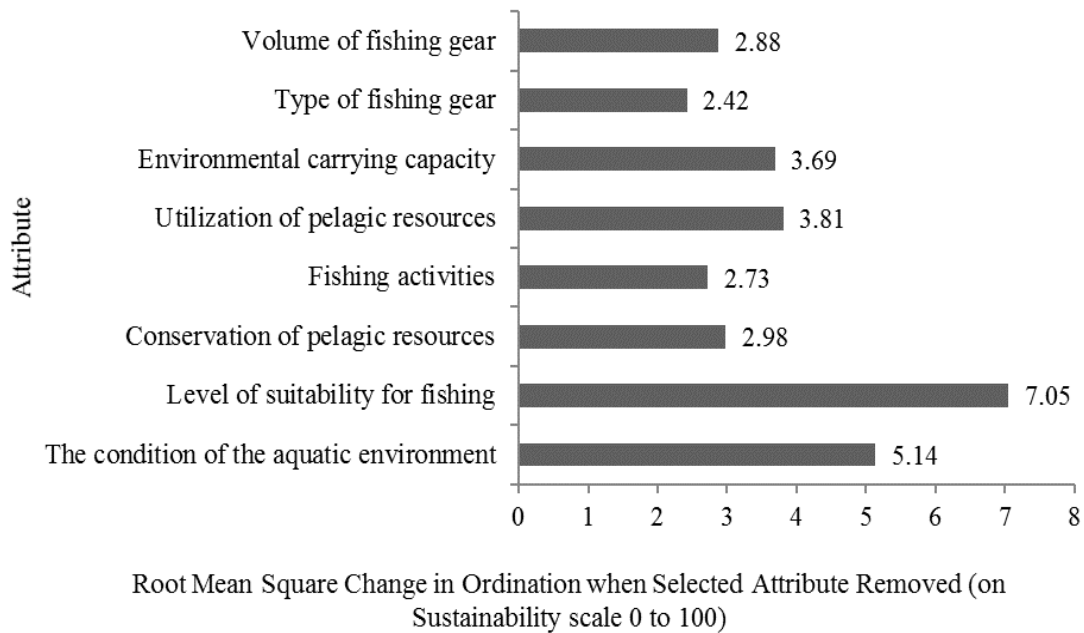


Figure 3. The analysis result of leverage attributes of ecological dimensions.

utilization, optimization, and sustainability of the fishery and marine resources to become a foreign country in the world (Burhanis *et al.*, 2021).

#### IV. CONCLUSION

A sustainability index value of dogtooth tuna fisheries management in East Simeulue with multidimensional analysis using the Rapfish method obtained a value of 79.74 on a sustainability scale of 0-100 (good sustainable). Attributes that are sensitive to sustainability are used to identify efforts or recommendations to improve future fisheries' sustainability.

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