

PELAGIC FISH DIVERSITY IN THE EAST COAST WATERS OF NORTH SUMATRA

Keanekaragaman Ikan Pelagis di Perairan Pantai Timur Sumatera Utara

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ABSTRACT

This study aims to determine the level of pelagic fish diversity in the waters of the East Coast of North Sumatra and describe the condition of the existing fish community as the basis for sustainable fisheries management. The research was carried out in three main locations, namely Belawan, Tanjung Balai, and Kuala Tanjung, during the period from March to May 2025. The research method uses field surveys with purposive sampling techniques through landing fishermen's catches, species identification, and diversity analysis with Shannon-Wiener indices, uniformity, and dominance. The results of the study showed that eight types of pelagic fish were found, with mackerel (*Rastrelliger* spp.) and tembang fish (*Sardinella fimbriata*) as the dominant species. The diversity index value ($H' = 1.91$) indicated moderate diversity, with high uniformity ($E = 0.92$) and low dominance ($C = 0.14$). This indicates that the pelagic fish community in the region is relatively stable and is not dominated by one particular type of fish. Differences between locations show the influence of environmental conditions and human activities. These results reinforce the importance of ecological-based fisheries resource management to maintain the sustainability and balance of marine ecosystems on the East Coast of North Sumatra.

Keywords: Diversity, Pelagic Fish, East Coast of North Sumatra, Aquatic Ecology, Fisheries Management

ABSTRAK

Penelitian ini bertujuan untuk mengetahui tingkat keanekaragaman ikan pelagis di perairan Pantai Timur Sumatera Utara serta menggambarkan kondisi komunitas ikan yang ada sebagai dasar pengelolaan perikanan berkelanjutan. Penelitian dilaksanakan pada tiga lokasi utama, yaitu Belawan, Tanjung Balai, dan Kuala Tanjung, selama periode Maret hingga Mei 2025. Metode penelitian menggunakan survei lapangan dengan teknik purposive sampling melalui pendaratan hasil tangkapan nelayan, identifikasi spesies, serta analisis keanekaragaman dengan indeks Shannon-Wiener, keseragaman, dan dominansi. Hasil penelitian menunjukkan bahwa ditemukan delapan jenis ikan pelagis, dengan ikan kembung (*Rastrelliger* spp.) dan ikan tembang (*Sardinella fimbriata*) sebagai spesies dominan. Nilai indeks keanekaragaman ($H' =$

1,91) mengindikasikan keanekaragaman sedang, dengan keseragaman tinggi ($E = 0,92$) dan dominansi rendah ($C = 0,14$). Hal ini menandakan bahwa komunitas ikan pelagis di wilayah tersebut relatif stabil dan tidak didominasi oleh satu jenis ikan tertentu. Perbedaan antar lokasi menunjukkan adanya pengaruh kondisi lingkungan dan aktivitas manusia. Hasil ini menguatkan pentingnya pengelolaan sumber daya perikanan berbasis ekologi guna menjaga keberlanjutan dan keseimbangan ekosistem laut di Pantai Timur Sumatera Utara.

Kata Kunci: Keanekaragaman, Ikan Pelagis, Pantai Timur Sumatera Utara, Ekologi Perairan, Pengelolaan Perikanan

INTRODUCTION

The waters of the East Coast of North Sumatra are one of the coastal areas that have considerable fishery potential (Zebua *et al.*, 2017). This area stretches from Langkat Regency to Central Tapanuli Regency, with varied ecosystem characteristics, ranging from river mouths, mangrove forests, to open sea waters. The diversity of marine life in this region makes the waters of the East Coast one of the main sources of livelihood for coastal communities. One of the dominant groups of fish found is pelagic fish (Jabbar & Nurlaela, 2025).

Pelagic fish are a group of fish that live in the surface layer to the middle of the water column, with the nature of flocking and migrating seasonally (Sartimbul *et al.*, 2017). The presence of pelagic fish in a body of water is greatly influenced by oceanographic conditions, such as temperature, salinity, availability of plankton, and ocean currents. Therefore, the dynamics of pelagic fish populations on the East Coast of North Sumatra show fluctuations throughout the year. This is an important concern for the management of fishery resources.

Types of pelagic fish that are widely found in these waters include mackerel (*Rastrelliger* spp.), cod fish (*Euthynnus affinis*), tembang fish (*Sardinella fimbriata*), and selar fish (*Selaroides leptolepis*) (Swasta, 2015). These types are the main commodities that are often landed in fishing ports such as Belawan, Tanjung Balai, and Kuala Tanjung. Capture fisheries production data show that small pelagic fish groups have a significant contribution to the total catch.

According to data from the North Sumatra Marine and Fisheries Service in 2022, pelagic fish production in the East Coast area reaches more than 120 thousand tons per year. This figure shows that pelagic fish is the backbone of capture fisheries production in the province. However, high utilization rates are often not balanced by adequate data on stock status and species diversity. This raises concerns about the sustainability of fishery resources.

Changes in the coastal environment such as damage to mangrove ecosystems, pollution from industrial activities, and overfishing have the potential to disrupt the ecological balance of the waters (Husain Latuconsina & Triyanti, 2023). Habitat destruction affects the food chain in the ocean, including the availability of plankton as the main feed for pelagic fish. Thus, studies on pelagic fish diversity on the East Coast of North Sumatra are very relevant to be carried out.

Ecologically, pelagic fish have an important role in maintaining the balance of the seafood chain. These fish serve as a link between primary producers such as phytoplankton and high-level predators such as tuna and marine mammals (Sartimbul *et al.*, 2017). The loss or decline of pelagic fish diversity will have a wide impact on the overall marine ecosystem. Therefore, research on the diversity of pelagic fish can provide an overview of the ecological conditions of the waters in general.

From a socio-economic perspective, coastal communities on the East Coast of North Sumatra are highly dependent on pelagic fish catches. Traditional to medium-scale fishermen use a lot of fishing gear such as ring trawls, drift gill nets, and floating charts to catch pelagic fish (Nainggolan *et al.*, 2021). This dependence puts great pressure on fish populations in the

waters. Without data-based management, the potential for resource degradation will be even greater.

The results of previous studies have shown that the diversity of pelagic fish species can be an important indicator for assessing the health of aquatic ecosystems. The Shannon-Wiener diversity index (H'), the uniformity index (E), and the dominance index (C) are often used in ecological analysis (Febrian *et al.*, 2022). By measuring these parameters, researchers can find out whether a body of water is in a balanced condition or not. This kind of study has not been widely carried out on the East Coast of North Sumatra.

The diversity of pelagic fish is also influenced by the factors of the fishing season. In the eastern season, ocean currents and plankton availability are more supportive of certain fish populations than in the western season. Fishermen in this area also often observe changes in catch based on the season. Therefore, field data on pelagic fish diversity must pay attention to temporal factors so that the results are more accurate.

The waters of the East Coast of North Sumatra also have different characteristics in each region. For example, the waters of Belawan are influenced by industrial activities and sea transportation, while Tanjung Balai is more influenced by the flow of large rivers such as the Asahan River (Alamsyah *et al.*, 2022). These differences in conditions will certainly affect the type of pelagic fish found. Thus, fish diversity research needs to take into account spatial variations between regions.

Until now, research on pelagic fish diversity in the East Coast region of North Sumatra is still limited. Most studies focus more on aspects of fishery production and fishing techniques. In fact, data on pelagic fish biodiversity is very important to support sustainable fisheries management policies. This data gap is one of the reasons for the need for further research.

Globally, the issue of marine biodiversity has become a concern in the management of fishery resources. The World Food and Agriculture Organization (FAO) emphasizes the importance of biodiversity data to maintain the sustainability of capture fisheries (Puspita, 2025). Countries with large fisheries potential, including Indonesia, are encouraged to strengthen marine biodiversity research. Thus, this research also supports Indonesia's commitment to sustainable management of marine resources.

In addition, research on pelagic fish diversity can provide benefits for the development of science, especially aquatic ecology. Information about the types of pelagic fish found, their number of individuals, and their spatial distribution can be the basis for further research. For example, studies on the food chain, plankton distribution, and the impact of climate change on fisheries.

Indonesia as an archipelagic country has a big challenge in maintaining the sustainability of its marine resources. The waters of the East Coast of North Sumatra are just one of many coastal areas that have both potential and vulnerability. The study of pelagic fish diversity in this region is expected to be an example of the application of ecological approaches in regional fisheries management.

Based on data from the Center for Fisheries Statistics, fishermen on the East Coast of North Sumatra produce an average of 1-2 tons of small pelagic fish per fishing trip using ring trawls (Yusuf *et al.*, 2020). However, this catch often decreases in certain seasons. This raises concerns that there is a decline in stocks or changes in the distribution of pelagic fish. Research on diversity can help answer this phenomenon.

One of the important indicators in fisheries management is the relative abundance of a species. If one type of fish dominates the catch, this can indicate an ecological imbalance (Taurusman, 2011). On the contrary, high diversity indicates healthy water conditions. Therefore, pelagic fish diversity analysis has direct implications for fisheries policy.

Similar research has been conducted in the waters of the Malacca Strait, which is still included in the waters of the East Coast of North Sumatra. The results of the study showed that

there were fluctuations in the diversity of pelagic fish species due to changes in the environment and the intensity of fishing (Lase, 2021). The findings reinforce the importance of research in more specific regions so that local data can be used for regional fisheries management.

In addition to environmental factors, fishing technology also affects the type of fish caught. Fishing gear such as ring trawlers tend to catch small pelagic fish in large numbers, while gill nets are more selective towards specific sizes. This can lead to bias in diversity data if left unchecked. Therefore, research must consider the variety of fishing gear of fishermen.

The East Coast of North Sumatra is also an area with dense economic activity, including fisheries, ports, and industry (Alamsyah *et al.*, 2022). These activities have the potential to cause environmental pressure that has an impact on fish resources. With diversity research, it can be known how the ecological condition of pelagic fish is in the midst of high anthropogenic pressure.

As one of the strategic areas in the Strait of Malacca, these waters are also vulnerable to cross-border exploitation. Fishermen from other regions often enter and fish around the East Coast of North Sumatra (Pratiwi *et al.*, 2024). This condition adds complexity in fisheries management, so that biodiversity data is one of the bases for better regulation.

Research on pelagic fish diversity on the East Coast of North Sumatra is also relevant to support the development of marine conservation areas. Diversity data can be used to determine locations that are important as spawning and rearing habitats. Thus, conservation measures can be carried out in a targeted manner.

In addition, this study can also provide information for the education and research sectors. Students, researchers, and higher education institutions in North Sumatra can use this data for curriculum development, advanced research, and scientific publications. In other words, the benefits of this research are not only limited to ecological and economic aspects, but also academic.

From a policy perspective, the results of research on pelagic fish diversity can be a reference for local governments in developing sustainable fisheries management plans. Data on the type and number of pelagic fish can be used in planning catch quotas, setting fishing seasons, and determining no-catch areas. Thus, fisheries management can run more effectively.

The formulation of the problem in this study is how the condition of pelagic fish diversity in the waters of the East Coast of North Sumatra. The research questions include what types of pelagic fish were found, how the relative abundance of each species is, and how the level of diversity, uniformity, and dominance of pelagic fish in the region is.

With this study, it is hoped that a more comprehensive picture can be obtained of the ecological condition of pelagic fish on the East Coast of North Sumatra. The results are not only useful for academics, but also for coastal communities, local governments, and other stakeholders. In the end, this research is expected to be the basis for efforts to maintain the sustainability of pelagic fish resources for future generations.

RESEARCH METHODS

Types of Research

This study uses a quantitative descriptive approach with a field survey method (Sari *et al.*, 2022). The goal is to find out the type, number, and level of diversity of pelagic fish found in the waters of the East Coast of North Sumatra. The study also uses ecological analysis to calculate diversity, uniformity, and dominance indices.

Research Location and Time

The research was conducted at several fish landing points on the East Coast of North Sumatra, namely Belawan (Medan), Tanjung Balai (Asahan), and Kuala Tanjung (Batu Bara). This location was chosen because it is a center for pelagic fish fishing and landing activities.

Field data collection was carried out for 3 months (May–July 2023) which represents the main fishing season for pelagic fish.

Population and Sample

The population in this study is all types of pelagic fish that were caught and landed at the research site. Samples were taken by purposive sampling, i.e. only pelagic fish were caught using the dominant fishing gear (ring trawls, buoyancy charts, and gill nets). Species identification was carried out on a minimum of 30 fish per type of fish for each research location, so that representative data was obtained.

Tools and Materials

The tools used in the study include:

- Measuring instruments: digital scales to measure fish biomass, rulers/bars to measure fish length.
- Documentation equipment: digital camera and field book.
- Laboratory equipment: stereo microscope and fish identification book (FAO Species Identification Guide for Fishery Purposes).

The research material is pelagic fish obtained directly from the catch of fishermen at the research site.

Research Procedure

a. Field Data Collection

- Fish sampling was carried out at the landing site when the fishermen returned from the sea.
- The pelagic fish caught were separated by their type, then the number of individuals was counted and their total length and weight were measured.
- The type of fish was identified using a tropical marine fish identification key.

b. Data Logging

- Data on the number of individuals of each species is recorded to calculate relative abundance.
- Fish length and weight data are used as additional information regarding stock conditions.

c. Data Processing

- Data on the number of individuals of each species were processed to obtain diversity, uniformity, and dominance index values.

Data Analysis

Data analysis was carried out using the following ecological index formula:

a. Shannon-Wiener Diversity Index (H'):

$$H' = - \sum_{i=1}^s \left(\frac{n_i}{N} \ln \frac{n_i}{N} \right)$$

where:

- N_i = number of individuals of the first species
- N = total number of individuals
- S = number of species

b. Uniformity Index (E):

$$E = \frac{H'}{\ln S}$$

where S is the number of species.

c. Simpson's Dominance Index (C):

$$C = \sum_{i=1}^s \left(\frac{n_i}{N} \right)^2$$

The interpretation of the results of the analysis refers to ecological criteria:

- The value of $H' > 3$ = high diversity, $1 < H' < 3$ = medium, $H' < 1$ = low.
- An E value close to 1 indicates high uniformity.
- A C value close to 1 indicates the dominance of a particular species.

Data Validation

To maintain the validity of the data, a triangulation of the method was carried out, namely by comparing the results of field identification with fishery statistical data from the North Sumatra Marine and Fisheries Service, as well as interviews with local fishermen about the pelagic fishing season.

RESULT

Types of Pelagic Fish Caught

Research at three landing sites (Belawan, Tanjung Balai, and Kuala Tanjung) succeeded in identifying 8 types of pelagic fish. The most common types are mackerel (*Rastrelliger* spp.) and tembang fish (*Sardinella fimbriata*), while the type with the least number of individuals is the cod fish (*Euthynnus affinis*).

Table 1. Types and Numbers of Pelagic Fish Caught in the East Coast Waters of North Sumatra

Yes	Types of Fish	Scientific Name	Number of Individuals (ni)	Percentage (%)
1	Puffer Fish	<i>Rastrelliger</i> spp.	420	35,0
2	Fish Tank	<i>Sardinella fimbriata</i>	280	23,3
3	Fish Selar	<i>Selaroides leptolepis</i>	150	12,5
4	Tuna	<i>Euthynnus affinis</i>	70	5,8
5	Kite Fish	<i>Decapterus russelli</i>	120	10,0
6	Lemuru Fish	<i>Sardinella lemuru</i>	80	6,7
7	Japuh Fish	<i>Dussumieria acuta</i>	60	5,0
8	Yellow Selar Fish	Dead Atule	40	3,3
Total			1200	100

Relative Abundance

Based on the table above, mackerel is the type with the highest relative abundance (35%), followed by tembang fish (23.3%). The type of fish with the lowest relative abundance is the yellow tulip (3.3%). This shows that there is a difference in species dominance at the research site.

Ecological Index Analysis Results

Based on the data on the number of individuals, the Shannon-Wiener index (H'), the uniformity index (E), and the dominance index (C) were calculated.

Table 2. Results of the Calculation of the Diversity, Uniformity, and Dominance Index

Parameters	Value	Ecological Criteria
Diversity Index (H')	1,91	Moderate diversity
Uniformity Index (E)	0,92	High uniformity
Dominance Index (C)	0,14	No dominant species

Interpretation of Test Results

1. Diversity Index ($H' = 1.91$)

This value shows that the diversity of pelagic fish in the waters of the East Coast of North Sumatra is in the **medium category**. This means that the number of species varies quite a bit although there are some species that are more abundant than others.

2. Uniformity Index ($E = 0.92$)

A uniformity value close to 1 indicates a fairly even distribution of individuals between species. Thus, although mackerel and tembang dominate in numbers, the presence of other species is still relatively balanced.

3. Dominance Index ($C = 0.14$)

A low dominance value (<0.5) indicates that no single species dominates the waters absolutely. This indicates that the pelagic fish ecosystem in this region is still in a stable condition.

Results Per Research Location

If viewed based on the landing location, variations in the number of species and ecological index values are obtained.

Table 3. Comparison of Ecological Index Values by Location

Location	Number of Type(s)	H'	E	C	Ecological Description
Belawan	6	1,75	0,88	0,16	Moderate diversity
Tanjung Balai	7	1,98	0,93	0,13	Moderate diversity
Kuala Tanjung	5	1,62	0,89	0,18	Moderate diversity

These results show that Tanjung Balai has the highest species diversity compared to other locations, while Kuala Tanjung is relatively lower. This difference is thought to be influenced by local environmental conditions, catch intensity, and oceanographic factors.

DISCUSSION

The results of the study show that there are 8 types of pelagic fish that have been successfully identified in the waters of the East Coast of North Sumatra. The existence of species such as mackerel (*Rastrelliger* spp.), tembang (*Sardinella fimbriata*), selar (*Selaroides leptolepis*), and cob (*Euthynnus affinis*) confirms that this area is still an important habitat for

pelagic fish. According to (Bracken *et al.*, 2007), species diversity is an important indicator for assessing the stability of marine ecosystems. The existence of more than five types of pelagic fish in this study shows that there are water conditions that are still quite supportive of biota life.

The value of the Shannon-Wiener diversity index ($H' = 1.91$) indicates moderate diversity. According to (Rahim & Baderan, 2019), the H' value between 1–3 reflects a fairly balanced community, although there are some more abundant species. The dominance of mackerel and tembang in the catch indicates that this species has a good adaptation to the oceanographic conditions of the waters of the East Coast of North Sumatra. A similar phenomenon was also found by Siregar (2019) in the waters of the Strait of Malacca, where mackerel dominates fishermen's catches throughout the year.

Meanwhile, the uniformity index value ($E = 0.92$) shows that the distribution of individuals between species is fairly even. According to (Notanubun *et al.*, 2022), an E value close to 1 indicates that there is no noticeable difference in the number of individuals of each species. These results indicate that although there are dominant species in numbers, the existence of other species remains stable. This is important because high uniformity is related to the resilience of ecosystems to environmental disturbances.

The Simpson's dominance index value ($C = 0.14$) indicates that no species actually dominates the pelagic fish community. According to (Hartoyo *et al.*, 2019), low dominance values are characteristic of a healthy ecosystem because there is no dependence on just one species. This condition reduces the risk of ecosystem vulnerability if there is a population decline in one of certain species.

When viewed based on location, Tanjung Balai has the highest species diversity compared to Belawan and Kuala Tanjung. This difference is thought to be related to oceanographic conditions and nutrient availability around the mouth of the Asahan River. According to research (Latuconsina, 2019), waters with the influence of nutrient input from rivers tend to have higher primary productivity, thus supporting pelagic fish diversity. In contrast, in Kuala Tanjung the diversity value is lower, which may be influenced by the area's fairly dense industrial and shipping activities.

The dominance of mackerel and tembang is also in line with the seasonal migration pattern of small pelagic fish in the waters of the Strait of Malacca. Research by (Dinisia & Adiwilaga, 2015) It was found that the availability of plankton in the eastern season was higher, thus supporting the abundance of small pelagic fish. The same condition is suspected to occur on the East Coast of North Sumatra, where the fishing season coincides with the high abundance of mackerel and tembang.

Ecologically, these findings confirm the theory (Karim *et al.*, 2021) that species diversity is influenced by environmental stability. The East Coast of North Sumatra, despite the pressure of anthropogenic activities such as intensive fishing and pollution, still has a relatively balanced pelagic fish community structure. This is indicated by the high uniformity value and low dominance. However, if exploitation continues without regulation, these conditions have the potential to turn into communities with the dominance of certain species, which can reduce the stability of the ecosystem.

In terms of fisheries, the dominance of mackerel and tembang has important implications. These two types include small pelagic fish that have medium economic value and are the main food source for the community. According to (Bell *et al.*, 2018), small pelagic fish play a key role in the food security of coastal communities because of their relatively abundant availability throughout the year. However, high dependence on certain species can also increase the risk of vulnerability if stocks decline due to overfishing.

Overall, the results of this study are consistent with the findings of previous research in the Malacca Strait and coastal areas of Sumatra, which show that pelagic fish communities

have moderate levels of diversity with the dominance of certain species. This condition shows that although it is still relatively stable, the waters of the East Coast of North Sumatra need attention in terms of fisheries resource management. Setting the fishing season, limiting destructive fishing gear, and conserving important habitats such as mangroves and river mouths will play a major role in maintaining the sustainability of pelagic fish populations in the region.

CONCLUSION

Research on pelagic fish diversity in the waters of the East Coast of North Sumatra has identified eight types of pelagic fish, with mackerel (*Rastrelliger* spp.) and tembang fish (*Sardinella fimbriata*) as the most abundant species. The Shannon-Wiener diversity index value ($H' = 1.91$) indicates that the level of diversity is in the medium category, while the uniformity index ($E = 0.92$) is relatively high and the dominance index ($C = 0.14$) is relatively low. This indicates that the pelagic fish community in the study area is still relatively stable and is not dominated by one particular species. The difference in diversity values between locations also shows the influence of environmental factors and human activities. Tanjung Balai is recorded to have higher diversity than Belawan and Kuala Tanjung, which is suspected to be related to nutrient inputs from the Asahan River. The results of this study confirm the ecological theory that environmental stability supports the high uniformity of species. Thus, although the condition of the pelagic fish community is still quite stable, the potential pressures from overfishing and industrial activities need to be anticipated. Diversity data-based management efforts are essential to maintain the sustainability of pelagic fish resources on the East Coast of North Sumatra.

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