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Abstract

This study aims to identify and analyze the diversity of coral fish in the marine waters of Central Tapanuli Regency, which includes the areas of Mursala Island, Binasi Beach, and Pandan Waters. The method used is a qualitative approach with field observation, visual identification of species, and interviews with coastal communities. The results showed that there were 35 species of reef fish from 12 families identified, with Mursala Island being the location with the highest diversity. The dominant families include Pomacentridae, Chaetodontidae, and Labridae. Variations in diversity between locations are influenced by coral reef conditions, human activities, and the quality of the aquatic environment. Population declines of some reef fish species were also identified, which were related to environmentally unfriendly fishing practices and habitat degradation. These results reinforce the importance of sustainable management of marine resources by involving local communities as the main actors of conservation. This research provides an initial overview of the potential for marine biodiversity in Central Tapanuli and is the basis for coral reef ecosystem conservation policies in western Indonesia.

Keywords: Reef Fish, Diversity, Coral Reefs, Central Tapanuli, Marine Conservation

INTRODUCTION

Indonesia's marine waters are known as one of the regions with the highest marine biodiversity in the world. Its strategic geographical location in the world's coral triangle makes the country home to thousands of species of marine life, including reef fish that have an important role in maintaining the balance of marine ecosystems (Wardhania & Burhanuddin, 2023). One of the regions rich in marine diversity potential is Central Tapanuli Regency, which is located on the west coast of Sumatra Island. Central Tapanuli Regency has a fairly long coastline and is directly adjacent to the waters of the Indian Ocean. This area holds the potential for marine wealth that has not yet been fully explored, including coral reef ecosystems and the various types of reef fish that live in them. The existence of reef fish not only has ecological value, but also economic and social value for coastal communities that depend on marine resources for their livelihoods.

Reef fish are an important component of coral reef ecosystems. They act as indicators of the health of the marine environment, as well as maintain the food chain and the stability of populations of other marine organisms (Citra & Samadi, n.d.). The diversity of reef fish species also shows the level of complexity and richness of a water, which is important to research and understand as the basis for sustainable management of marine resources. Research on coral fish diversity is very important, especially in areas where there is still a lack of data such as Central Tapanuli. By knowing the types of reef fish, their distribution, and their habitat conditions, conservation measures can be designed in a more targeted manner. This is crucial considering that marine ecosystems are increasingly threatened by human activities and global climate change.

Changes in sea temperatures, pollution, unsustainable fishing, and coral reef damage are real threats that can reduce coral fish populations and diversity (Salim, 2012). Therefore, the protection and sustainable management of marine areas needs to be supported by accurate scientific data, including on coral fish biodiversity. Central Tapanuli Regency, although not well known as a major marine tourism destination, has great potential to be developed. The region has many small islands and shallow waters that are ideal habitats for various species of reef fish. However, scientific information about the species of fish that inhabit these waters is still very limited. Most of the research on reef fish diversity in Indonesia is more focused on eastern regions such as Raja Ampat, Wakatobi, and Bunaken. In fact, the western region of Indonesia also has unique and important marine ecosystem characteristics to study. Central



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Tapanuli can be one of the representative areas that describes the marine biodiversity of the western part of Indonesia. By conducting a study of coral fish diversity in the waters of Central Tapanuli, it is hoped that it can add to the treasure of science about Indonesia's marine biodiversity. The data obtained can also be the basis for planning conservation areas, as well as providing direction for sustainable fisheries activities in the area.

The selection of the research location was based on the level of naturalness of coral reefs and human activities that have the potential to affect fish habitats. Some locations show damage due to fishing with explosives or the use of indiscriminate nets. This gives an idea that the coral reef ecosystem in Central Tapanuli faces serious challenges. The observation results show that the waters of Central Tapanuli still hold a fairly high diversity of reef fish species. Various species of the families Pomacentridae, Labridae, Chaetodontidae, and Serranidae have been successfully identified, indicating that coral reef ecosystems in this region still have good productivity.

However, there are also indications that some species of reef fish are experiencing a decline in the number of individuals due to environmental pressures and human activities. This condition is an important signal of the need for better management of marine ecosystems in the region, especially by involving local communities in conservation efforts. The coastal communities of Central Tapanuli in general still depend on marine products to meet economic needs. However, not all have a high awareness of the importance of preserving marine ecosystems. An educational and participatory approach is needed so that the community can participate in the conservation of marine natural resources.

Local governments also have a strategic role in formulating marine management policies based on data and science. With this research, it is hoped that it can provide practical recommendations for decision-making, such as the determination of conservation areas, the regulation of capture zones, and the restoration of damaged habitats. In addition, the results of this study can also be used as learning materials for educational institutions and as a reference for further research in the marine sector. Students and researchers can make the Central Tapanuli area a natural laboratory rich in ecological phenomena and biodiversity.

The potential for marine ecotourism development is also one of the great opportunities that can be taken from the results of this research. By promoting the underwater beauty and richness of Central Tapanuli, this area can attract tourists and provide additional economic value for the local community, while maintaining the preservation of its environment. However, all of this potential can only be realized if there is synergy between the government, academia, the community, and the private sector. Research on coral fish diversity is one of the important first steps in building the foundation of knowledge-based and sustainability-based ocean management.

As one of the regions that still holds relatively natural marine wealth, Central Tapanuli deserves more attention in the context of national marine resource management. The sustainability of marine ecosystems in this area is not only a local responsibility, but also part of a shared responsibility to protect Indonesia's biological heritage. Thus, the study of coral fish diversity in the waters of Central Tapanuli is expected to be able to make a real contribution to the management and preservation of marine resources. More than that, this research is also part of a collective effort to care for the earth and its biodiversity for future generations.

LITERATURE REVIEW

Research on coral fish diversity cannot be separated from several basic concepts in marine ecology, fisheries biology, and biodiversity conservation. The foundation of this theory aims to provide a scientific framework that underlies the study of coral fish diversity in the waters of Central Tapanuli.

1. Marine Biodiversity

Marine biodiversity encompasses all the variations of life found in the marine environment, from microorganisms to large organisms such as marine mammals and fish. According to (Groombridge & Jenkins, 2002), biodiversity consists of three main levels, namely genetic, species, and ecosystem diversity. In the context of this study, the main focus is on the diversity of species, particularly reef fish species found in coral reef ecosystems.

2. Coral Reef Ecosystems

Coral reefs are one of the most productive marine ecosystems and have a high level of biodiversity. According to (Spalding et al., 2001), coral reefs provide habitat for more than 4,000 species of fish and thousands of other marine invertebrate species. Coral reefs also serve as shelters, foraging, and breeding grounds for various types of reef fish.

Coral Reef Fish

Reef fish are a group of fish that live and depend on coral reef ecosystems. They are made up of various orders and families, such as Pomacentridae (betok fish), Labridae (wrasse fish), Chaetodontidae (kepe-kepe fish),



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and Serranidae (grouper). These fish play an important role in maintaining ecosystem balance, such as controlling invertebrate populations, aiding the process of coral reef regeneration, and supporting the seafood chain (Randall et al., 1998).

4. Diversity Index

To measure the level of species diversity in an ecosystem, diversity indices such as the Shannon-Wiener index and the Simpson index are used. The Shannon-Wiener Index (H') takes into account the number of species and the relative proportion of each species within a community. A high H' value indicates that the community has a high diversity of species and a relatively even distribution of individuals (Magurran, 2013).

5. Factors Affecting Reef Fish Diversity

The diversity of reef fish is influenced by various factors, both natural and anthropogenic. Natural factors include the complexity of coral reef structures, food availability, ocean currents, and depth. Meanwhile, anthropogenic factors include overfishing, the use of destructive fishing gear (such as bombs and cyanide), pollution, and climate change (C. Wilkinson & Souter, 2008)

6. Marine Resources Conservation and Management

Efforts to conserve coral reef ecosystems and reef fish diversity are carried out through an ecosystem-based management approach and the participation of local communities. One form of effective conservation is the establishment of marine conservation areas (KKL), no-catch zones, and habitat rehabilitation activities (Rustam, 2014). This approach must also be accompanied by education and community empowerment so that they can become the main actors in preserving marine resources.

7. Potential and Economic Utilization of Reef Fish

Reef fish have high economic value, both as a food source and in the marine tourism sector. Many species of reef fish are the main commodities in the capture fishery and ornamental fish trade. However, this utilization must be carried out in a sustainable manner so as not to damage the natural population and the structure of fish communities in their natural habitat (Sadovy & Vincent, 2002).

8. Diversity Studies as a Basis for Management

Species diversity research is very important in developing natural resource management strategies. Data on the composition and distribution of reef fish species can be used to set conservation priorities, assess ecosystem health, and monitor the impact of human activities. Therefore, the study of diversity is a crucial scientific basis in efforts to preserve the ocean

METHOD

This study uses a descriptive qualitative approach with the aim of describing and understanding the diversity of reef fish in the marine waters of Central Tapanuli Regency in depth. The qualitative approach was chosen because it allows researchers to explore ecological phenomena holistically, taking into account the local context, social interaction of coastal communities, and perceptions of marine ecosystems (Sutopo, 2006).

1. Research Location and Time

This research was carried out at several points in the location of marine waters in Central Tapanuli Regency which are known to have coral reef ecosystems. The selection of the location was carried out purposively, namely based on initial information from the fishing community, local figures, and the results of initial field observations that showed the existence of active coral reefs and relatively abundant coral fish species

2. Data Collection Techniques

Data is collected through several techniques, including:

- Participatory Observation. Researchers conducted direct observations of marine ecosystems, especially areas that have coral reefs and reef fish populations. Observations are made by diving using snorkeling or scuba diving equipment. This observation includes visual recording of fish species, reef fish behavior, habitat conditions, and human activities around the location.
- In-depth Interview. Interviews were conducted with several key informants, such as local fishermen, coastal community leaders, professional divers, and marine service officers. This interview aims to



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explore local knowledge about the types of reef fish that are often seen, changes in fish numbers over time, as well as public views on the importance of marine conservation.

- Visual Documentation. Documentation was carried out in the form of underwater photos and videos to support the observation results and strengthen the visual data on the types of reef fish found. In addition, documentation of the surrounding environment such as coral reef conditions, water quality, and fishermen's activities was also carried out (Miles & Huberman, 1994).
- 3. Data Analysis Techniques

The data obtained were analyzed qualitatively by descriptive method. The stages of the analysis include (Miles & Huberman, 1992):

- Data reduction, which is sorting out relevant information from the results of observations, interviews, and documentation.
- Data presentation, in the form of narratives, interview excerpts, and visual documentation.
- Drawing conclusions, which are carried out inducively based on patterns of findings in the field.

The analysis also considers the linkage between ecological findings and the social aspects of local communities. The results are expected to provide a complete picture of the condition of coral fish diversity and the factors that affect it.

4. Data Validity

To ensure the validity of the data, the researcher uses triangulation of sources and techniques. Source triangulation is carried out by comparing data from various informants, while technical triangulation is carried out by comparing the results of observations, interviews, and documentation. In addition, member checks are carried out by asking for provisional confirmation of results from several informants to ensure that the researcher's interpretation is in accordance with the reality they are experiencing.

RESULTS AND DISCUSSION

Research conducted in the marine waters of Central Tapanuli Regency has succeeded in identifying various types of reef fish that live around coral reef ecosystems. Based on underwater visual observations at several dive points, it was found that this region still has a fairly good diversity of reef fish, although some locations show signs of ecological stress due to human activities. From the results of observations and visual documentation in three main locations, namely Mursala Island, Binasi Beach, and Pandan Waters, a total of 35 species of reef fish were found belonging to 12 families. The most dominant families found are Pomacentridae (scallops), Chaetodontidae (kepe-kepe fish), and Labridae (wrasse).

Yes	Family	Common Species (Example)	Location of Mursala Island	Location of Binasi Beach	Pandan Location	Total Species
1	Pomacentridae	Abudefduf vaigiensis	6	4	5	15
2	Chaetodontidae	Chaetodon Auriga	3	2	4	9
3	Labridae	Thalassoma lunare	4	2	3	9
4	Serranidae	Cephalopholis Miniate	2	1	1	4
5	Acanthuridae	Acanthurus triostegus	3	1	2	6
6	Scaridae	Scarus niger	2	1	2	5
7	Holocentridae	Myripristis murdjan	1	1	1	3
8	Mullidae	Parupeneus Barberinus	1	1	1	3
9	Zanclidae	Zanclus cornutus	1	1	1	3
10	Blenniidae	Ecsenius midas	1	-	1	2
11	Stuart O'Neill	Apogon imberbis	1	-	-	1
12	Tetraodontidae	Arothron hispidus	-	1	-	1

The following are the data from the identification of reef fish species at three observation locations:



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Total Species	25	15	21	35	

Based on the table above, it can be concluded that the location of Mursala Island is the location with the highest number of species, followed by Pandan Waters and Binasi Beach. The diversity of species on Mursala Island is influenced by the relatively intact condition of coral reefs, clear waters, and lower human pressure compared to other locations.

Interviews with fishermen and local communities show that there has been a decline in certain reef fish populations in the last five years. Some informants mentioned that fishing activities in environmentally unfriendly ways such as bombs and poisons still occur occasionally, especially in areas far from supervision.

The community also said that there are certain seasons where some types of reef fish are difficult to find. This shows that the presence of reef fish is not only influenced by ecosystem conditions, but also by seasonal factors such as water temperature, ocean currents, and fish reproductive cycles.

Visual documentation taken during the observation process shows that some of the coral reefs on Binasi Beach are in a damaged or algae covered condition, which may be caused by sedimentation and domestic waste. This condition has an impact on the decline of coral fish populations that depend on corals for shelter and shelter.

In contrast, the area around Mursala Island shows a wider range of live corals, complex coral structures, and more diverse fish populations. Fishing activities around the island are also more controlled, and some communities have even started implementing environmentally friendly fishing practices such as the use of bubu and basic fishing rods.

In general, the diversity of reef fish in the waters of Central Tapanuli is still quite high and shows the potential for further development, both in the context of conservation and sustainable use. However, more serious efforts are needed in habitat management and protection so that this diversity is maintained.

The results of research on coral fish diversity in the marine waters of Central Tapanuli Regency show that the coral reef ecosystem in this region still supports the life of various types of coral fish. A total of 35 species of fish from 12 families were successfully identified, spread across three main observation locations, namely Mursala Island, Binasi Beach, and Pandan Waters. These findings reflect a fairly good level of diversity for coastal areas that are still under pressure from human activities, but still have areas with relatively maintained environmental conditions.

Specifically, Mursala Island is the location with the largest number of species, namely 25 species from various families, including Pomacentridae, Labridae, and Chaetodontidae. The dominance of these families is in line with research (Randall et al., 1998) which states that the fish from this family are the dominant group in the reef fish community in the Indo-Pacific region, including in Indonesia. The presence of species such as Abudefduf vaigiensis (sea fish), Thalassoma lunare (moon fish), and Chaetodon auriga (kepe-kepe fish) indicates that the habitat on Mursala Island still has a complex reef structure and provides ample space for fish to shelter, forage, and reproduce.

The high number of species found, especially on Mursala Island, corroborates the (Burke et al., 2011) that the western coastal region of Sumatra, although not much explored, is part of an important marine diversity corridor in a regional context. The complexity of the coral structure and the clarity of the waters at this location provide a diverse microhabitat for reef fish, which is consistent with the findings (Bellwood & Hughes, 2001) regarding the positive relationship between habitat heterogeneity and the abundance of reef fish species.

The dominance of the families Pomacentridae, Chaetodontidae, and Labridae in the observation results supports the results of the study (HumpHries et al., 2023) in FishBase, which notes that these families do dominate reef fish communities in the Indo-Pacific region. This group of fish has a wide habitat tolerance and is able to survive in a wide range of ecosystem conditions, although it remains sensitive to environmental damage if it occurs in the long term (Allen et al., 2005).

The difference in the number and composition of species between locations indicates that there is variation in habitat conditions in each place. Binasi Beach, which recorded only 15 species, shows more degraded environmental conditions. Visual observations show that most of the coral reefs at this location are in a damaged condition, covered by algae, and undergoing high sedimentation. This is in accordance with the theory (C. C. R. Wilkinson, 2004), which states that the quality of coral habitats greatly determines the diversity of coral fish species. Habitat destruction due to human activities such as waste disposal and fishing with unenvironmentally friendly tools can lead to a drastic decline in fish populations.

The differences in diversity levels between locations, where Mursala Island recorded 25 species and Binasi Beach only 15, provide a strong indication of the direct influence of environmental conditions on species abundance and distribution. (C. Wilkinson & Souter, 2008) emphasizes that pressures from human activities such as sedimentation, pollution, and destructive fishing can lead to habitat fragmentation and a decline in the number of

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species capable of survival. This is also reflected in the condition of the coral reefs on Binasi Beach which looks more damaged and dominated by algae, which is usually a marker of coral degradation (Fabricius, 2005).

The results of the interviews also show that the community has felt a decline in the reef fish population in recent years. It supports the findings (McClanahan et al., 1999) which mentions that overfishing pressure can gradually disrupt the structure of fish communities, especially key species and species with high economic value such as Serranidae and Scaridae. This decline not only has an impact on the balance of the ecosystem, but also on the economic sustainability of coastal communities.

Meanwhile, Pandan Waters recorded 21 species of reef fish, occupying the middle position in terms of diversity. Although not as high as Mursala Island, this area still shows a relatively stable reef fish community. This is supported by the results of interviews with local fishermen, who stated that this area has not been fully touched by massive fishing activities and is still used as a fishermen's reserve location in certain seasons.

The discovery of species from important families such as Serranidae (Cephalopholis miniata – grouperfish), Acanthuridae (Acanthurus triostegus – botana fish), and Scaridae (Scarus niger – cockatoo) shows that the waters of Central Tapanuli are still able to support the life of reef fish that play an important role in the structure of reef communities. The presence of herbivorous fish such as cockatoos and botana is very important in maintaining the balance of the ecosystem, especially in controlling the growth of algae that can dominate corals if not controlled (TP, 2003).

In the context of functional ecology, the existence of herbivorous species such as Scarus niger and Acanthurus triostegus has an important role in keeping ecosystems healthy. They function to control the growth of algae that can inhibit coral regeneration. This is in accordance with research (Mumby et al., 2007) which states that the loss of herbivorous species can drastically alter the dynamics of reef ecosystems, leading to a phase of algae dominance.

In addition, the socio-ecological aspect of this study emphasizes the importance of community involvement in coastal resource management. Participatory and local wisdom-based approaches, such as those that have begun to be implemented around Mursala Island, are in line with the concept of Community-Based Marine Management (CBMM) driven by (Pomeroy et al., 2007). This strategy has proven effective in many studies because it combines conservation interests with the economic needs of local communities. From a policy perspective, the results of this research can be an important input for local governments to develop adaptive marine management strategies. MPAs (Marine Protected Areas) or marine conservation areas based on science and socio-culture are one of the key recommendations, as stated in a report by IUCN (2020), which states that conservation based on local data can increase the effectiveness of coastal ecosystem protection.

From a socio-ecological perspective, the in-depth interviews revealed the community's concern about the decline in the population of certain fish that were once widely found. This decline has been felt in recent years and is attributed to the use of destructive fishing gear as well as overfishing. This reinforces the findings of the (Sadovy & Vincent, 2002), which highlights the serious impacts of reef fish exploitation without a sustainable management approach, especially for species of high economic value such as grouper and napoleon.

In general, the results of this study show that the diversity of reef fish in Central Tapanuli still has the potential to be maintained and developed as part of high-value marine biological resources. However, the sustainability of these ecosystems will depend heavily on community participation, effective monitoring, and targeted conservation policies. This research also emphasizes the importance of routine monitoring and education to coastal communities as part of a locally-based conservation strategy.

CONCLUSION

This study shows that the marine waters of Central Tapanuli Regency, especially in the areas of Mursala Island, Binasi Beach, and Pandan Waters, have a relatively high level of coral fish diversity. From the results of observation and visual identification, it was found that as many as 35 species of reef fish are classified into 12 families, with the dominance of species from the families Pomacentridae, Chaetodontidae, and Labridae. This diversity is an indicator that coral reef ecosystems in the region are still functioning well in supporting the life of coral fish communities, although in some locations there are signs of ecological stress due to human activities. Mursala Island is recorded as the location with the highest number of species, which reflects healthier marine environmental conditions and minimal disturbances. In contrast, Binasi Beach shows the lowest diversity, which is closely related to the condition of damaged coral reefs and the high level of human activity around them. This strengthens the understanding that the quality of coral habitats has a great influence on biodiversity in tropical marine waters. Interviews with local communities revealed that some reef fish species have experienced population declines in recent years, especially in locations close to settlements. Environmentally unfriendly fishing practices, such as the use of bombs and poisons, as well as pollution from land, are major factors that threaten the sustainability of marine ecosystems. Overall, the



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results of this study reinforce the theory and findings of previous research that the diversity of coral fish is highly dependent on habitat quality, reef structure, and anthropogenic stress. Therefore, the protection and sustainable management of coral reef ecosystems is very important. Community involvement in conservation activities, increasing environmental awareness, and enforcing rules in fisheries practices are strategic steps that must continue to be strengthened so that the diversity of reef fish in this region can continue to be maintained and provide ecological and economic benefits for future generations.

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