***Original Research Article***

**Composition and biodiversity of fish captured in the bioreeftek installation area in the waters of the Makassar Strait, Indonesia**

**ABSTRACT**

Demersal fishing has been intensively carried out so that it has an impact on population changes and ecosystem damage. Based on this, the study was conducted to determine composition of fish species, species diversity, species uniformity, and dominance of fish species caught around the bioreeftek and has been installed for 3 years. This study was conducted in the waters of the Makassar Strait from June to September 2023. This study used a survey method through direct observation and capture around the installation of the bioreeftek using a trammel net fishing gear. The results showed that the fish samples caught at the research location were 721 individuals. The composition of fish species obtained during the study consisted of 11 species, namely *Lethrinus lentjam*, *Caranx* sp, *Epinephelus merra*, *Epinephelus spilotocep*, *Cephalopholis* sp, *Therapon therap*, *Lutjanus monostigma*, *Nemipterus tumbuloide*, *Siganus doliatus*, *Parachaetodon ocellatus*, and *Lutjanus* sp. The highest composition of japanese threadfin bream is 26.07% and the lowest is sixspine butterflyfish 5.13%, diversity ranges from 5.87-74.02 with high category, uniformity 0.38-4.84 with low, medium and high categories and low dominance (0.003-0.068). The composition of the catch in bioreeftek is dominated by japanese threadfin bream, while diversity is classified as high and uniformity varies with low dominance as evidence that restoration is effective in restoring ecosystem function.

Keywords: fish composition; biodiversity, bioreeftek, Makassar Strait

1. **INTRODUCTION**

Coral reefs are one of the coastal ecosystems that have the potential for quite diverse aquatic resources (Ikhsan and Syahrival 2014) and as a fishing area for traditional fishermen. However, the existence of coral reefs in waters is an ecosystem that is vulnerable to disturbances and threats. The vulnerability of coral reefs is increasing along with the increasing population and activities in coastal areas (Alhadad *et al* 2022).

Coral reef damage as a result of human activities through environmentally unfriendly fishing and coral bleaching as a result of global warming. Corals that have been damaged take a long time to repair themselves. The long time for recovery causes a decline in environmental quality so that fish migrate to other places to find food. One solution to anticipate that aquatic resources do not migrate to other places is to provide a new habitat as a place to find food. The new habitat is in the form of an artificial reef commonly known as bioreeftek. Bioreeftek is a type of artificial reef with natural raw materials in the form of coconut shells as a medium for attaching coral planula larvae to become new individual colonies.

Artificial reefs of the bioreeftek type are a medium for coral reef conservation (Tumion *et al* 2017), as a place for coral planula larvae to attach naturally so that they are environmentally friendly (Nadia *et al* 2016), as a place to increase coral fish communities (Yudizar *et al* 2019), increase macroalgae communities (Suharjo *et al* 2018), increase the diversity of aquatic resources and support ecosystem function and stability (Kantun *et al* 2020; Kantun et al 2021 dan Kantun et al 2022ab).

Bioreeftek acts as a central area for fish gathering, a new fishing ground, forming a new ecosystem, increasing the diversity of fish species, bringing the distance between fishing grounds and fishing villages closer, improving environmental quality, forming and restoring food webs in coastal areas so that in the long term it can maintain ecosystem stability (Kantun *et al* 2020) and artificial reefs can be used for various purposes (Yanuar and Aunurohim 2015). This study aims to analyze the composition of fish species, diversity, and uniformity as well as the dominance of fish species caught in bioreeftek. The results of this study are expected to be basic information as a reference material in the management of fishery resources in coastal areas based on ecosystem restoration.

1. **MATERIALS AND METHODS**

**2.1 Time and place of research**

This research was conducted from June to October 2023 at the bioreeftek installation location that had been installed for 3 years in the waters of the Makassar Strait, Indonesia. The bioreeftek installation location is at position S: 4°40'7"; E: 119°30'20”

**2.2 Research Procedures**

Bioreeftek is installed at a depth of 5 m with a distance of 2000 m from the coastline. The capture around the bioreeftek uses a trammel net fishing gear. The capture is carried out every week for four months so that there are 16 captures. The fish that are successfully caught are separated by type and identified by referring to the fish identification book.

**2.3 Data Analysis**

Data obtained from the catch were analyzed based on species composition (Kj), Diversity (H’), Uniformity (E), and Species Dominance (D). Species composition was determined by counting each species of fish caught and then comparing it with the total number of species. To calculate the species composition of fish, the formula according to Odum, (1993) was used.

Where:

KJ : fish species composition (%)

ni : number of individuals of each fish

 species

N : number of individuals of all fish

 species

The diversity of fish species was analyzed using the Shannon-Wienner index proposed by Basmi (2000). The range of Shannon-Winner diversity values ​​can be categorized as follows:

H’ < 1 = Low diversity

1 - 3 = Medium diversity

H’> 3 = High diversity

Fish species diversity can be calculated using the Evennes formula (Basmi, 2000).

Where:

H’ = Shannon-Wiener diversity index

Ni = Number of individuals of each

 species

N = Total number of individuals

 pi = Proportion of individuals of each

 species

The range of Shannon-Winner diversity values ​​can be categorized as follows:

H’ < 1 = Low diversity

1 – 3 = Medium diversity

H’> 3 = High diversity

Fish species uniformity can be calculated using the Evennes formula (Basmi, 2000).

Where

E = uniformity index

H’maks = diversity index Shannon

 Wiener

H = Number of species found

The range of Evennes uniformity values ​​can be categorized as follows:

0.00 < 0.50 = Low uniformity

0.50 < E < 0.75 = Medium uniformity

0.75 < E < 1.0 = High uniformity

The dominance index is calculated using the Simpson dominance index (Basmi, 2000)

Where,

D = Simpson's dominance index

ni = Number of individuals of each

 species

N = Number of individuals of all species.

The dominance index value ranges from 0–1. If the dominance index value approaches 0 (D < 0.5) then there is no species that dominates the waters and if the index value approaches 1 (D > 1) it means there is a species that dominates the waters.

1. **RESULT AND DISCUSSION**

**3.1 Catch composition**

The catch obtained in this study amounted to 721 fish consisting of 11 species with the highest catch composition obtained in japanese threadfin bream totaling 188 individuals (26.07%) and the lowest in sixspine butterflyfish totaling 37 individuals (5.13%) (Figure 1). The number of fish found in this study was higher when compared to the results of the study by Kantun *et al*. (2020) at the same location which obtained 209 fish with nine species of fish. This shows that there was an increase in the types and numbers of fish at the bioreeftek installation location after 3 years of installation. Nadia *et al*. (2017) found 27 species of reef fish from 1 family in the bioreeftek installation area in the waters of Puasana village. Suaib and Salman (2019) only found 2 species of fish, namely ray-finned fishes (*Leiognathus* sp) and rabbitfishes (*Siganus* sp). However, on the original coral reefs, 9 species were found, namely crochet butterflyfish (*Chaetodon guentyheri*), honeycomb grouper (*Epinephelus merra*), marine ray-finned fish (*Pomacathus xanthomethopon*), Chocolate surgeonfish (*Acanthurus* sp), burrito grunt (*Anisotremus* sp), four stripe damselfish (*Dascylus melanurus*), cocktail wrasse (*Stethojulus* sp), rabbitfish (*Siganus* sp) and vagabond butterflyfish (*Chaetodon cagabundus*).



Figure 1. Composition of fish species caught at the bioreeftek installation location.

Manembu *et al*. (2014) found an abundance of 228 species of fish in the installation of butan reefs with a research duration of 3 (three) years from 2009-2011 using the transect method in the waters of Ratatotok, North Sulawesi. Yanuar and Aunurohim, (2015) obtained 72 species with 1243 individuals in the Pasir Putih Situbondo Waters, East Java. Kantun *et al*, (2022) obtained 358 individuals of fish caught in the bioreeftek installation area which were grouped into 11 species. The composition of the least caught fish species was the *Nemipterous thedorei* species at 4.75% and the highest was the *Lutjanus malabaricus* species at 17.04%

The most commonly caught fish is the japanese threadfin bream (Nemipterus tumbuloide) compared to other types of fish. It is suspected that japanese threadfin bream have a habitat preference with a muddy sand base such as the location of the bioreeftek installation which provides an attractive structure for japanese threadfin bream to take shelter and find food. Japanese threadfin bream may be better able to adapt to the bioreeftek environment than other types of fish. In addition, there is likely less competition from other species that are not suitable for the bioreeftek habitat, causing japanese threadfin bream to be more numerous in that area. Kantun *et al.* (2020), argue that japanese threadfin bream are economical fish and are widely found on the market so that the presence of this bioreeftek can certainly help provide benefits in providing food that is a daily need for the community.

Furthermore, it is stated that the high and low composition of species that are successfully caught likely depends on the biological characteristics of the fish related to feeding time, competition, food availability, fish that are successfully caught, types of fishing gear and fishing methods. Pardede (2012) argues that the composition of fish species on artificial coral reefs is still lacking, it is estimated that the composition of fish species on artificial coral reefs will increase with the increasing age of the artificial coral reefs on the seabed.

Sixspine butterflyfish (*Parachaetodon ocellatus*) is the fish that is least caught in the bioreeftek installation area. This is thought to be because sixspine butterflyfish have habitat specialization so that they have a strong preference for complex coral reefs that are rich in biodiversity, but are not fully provided by the bioreeftek habitat structure. Sixspine butterflyfish are classified as polyfiltration fish, namely they often eat coral polyps and small organisms that live on coral reefs. Sixspine butterflyfish have strong territorial behavior and prefer areas with natural coral reefs that offer more protection and resources than bioreeftek which is simpler in its composition structure.

Sixspine butterflyfish are more sensitive to environmental changes and water quality and the presence of bioreeftek with unstable and optimal environmental conditions as needed by sixspine butterflyfish. Sixspine butterflyfish may face competition with other species that are more dominant or more aggressive around the bioreeftek, causing them to move away and look for habitats that are more suitable for their needs. Sixspine butterflyfish may have special adaptations such as specific needs for certain types of coral that only suit their natural environment. It is possible that the bioreeftek has not been able to support the population of coral polyps which are the main food, so these fish will not be interested in being around the bioreeftek.

**3.2 Diversity**

The diversity index value (H’) of fish species caught in the area around the bioreeftek installation ranged from 5.87 to 74.02 in the high category, while Danendra *et al*. (2021) obtained a fish diversity value at the artificial reef installation location in Jemeluk Bay, Amed, Karangasem, Bali ranging from 1.2 to 1.57. Yanuar and Aunurohim, (2015) obtained a diversity value ranging from 2.643 to 2.904 and included in the moderate category in the Pasir Putih Waters of Situbondo, East Java. Kantun *et al*. (2022) obtained a diversity value ranging from 2.460 to 18.394 in the moderate and high categories. The uniformity index value of fish species caught in the area around the bioreeftek installation ranged from 0.38 to 4.84 in the low, moderate and high categories.

The uniformity value obtained in this study was classified as low. Kantun *et al*. (2022b) obtained a uniformity value of 0.134-1.00 with low, medium and high categories. The dominance index value of fish species caught in the area around the bioreeftek installation ranged from 0.003-0.068 and was included in the low category. Yanuar and Aunurohim, (2015) obtained a dominance value ranging from 0.077-0.108 and was included in the low category in the Pasir Putih Situbondo Waters, East Java. This shows that no particular fish species is more dominant than others. Kantun *et al*. (2022) obtained a low dominance value (0.002-0.029).

The diversity obtained in this study was higher than previous studies. This is thought to be due to the high diversity of resources in this study because the bioreeftek installation area is influenced by several factors, including habitat quality related to the physical and chemical quality of the habitat, such as water clarity, temperature, and oxygen levels. The designed habitat structure mimics the natural structure of coral reefs so that it can create physical complexity that provides shelter, areas for foraging, and space for reproduction for various marine organisms. The existence of pioneer species as the first organisms to settle in newly restored areas can help attract other species to come and settle to increase diversity.

The possibility of the availability of food resources, light, and space supports species diversity. Interactions between species such as predation, competition, and symbiosis between species in the restoration area can affect community composition and diversity. The high and low diversity values ​​are greatly influenced by the number of fish species found and sampled.

Kojansow *et al*. (2013), revealed that the density of coral fish in an artificial reef area will increase over time, especially if the condition of the artificial reef location as a habitat for coral fish is getting better. Rondonuwu *et al*. (2017) stated that each species of coral fish will show a preference/suitability for a particular habitat, which will determine the abundance of the fish. Setyobudiandi *et al*. (2009) stated that the high and low diversity values ​​are greatly influenced by the number of species found or caught during the study.

The low uniformity value is thought to be caused by the installation of bioreeftek ecosystems still in the process of balancing, which may have several pioneer species that dominate, while other species have not had time to settle or reproduce optimally. Environmental conditions are not yet fully stable in relation to changes in water quality, nutrient flow, or other physical factors so that they are not yet able to support a wider diversity of species. Bioreeftek installed in locations that are less connected to other ecosystems, so that the movement of fish species entering the bioreeftek installation area is limited and is thought to contribute to the low uniformity. The low uniformity value of fish resources in the bioreeftek installation area reflects the dynamic conditions of the ecosystem that is still in the balancing stage. This is a process that requires time and continuous monitoring to achieve the expected uniformity and diversity.

Pirzan (2006), stated that if the uniformity index value obtained is close to 1, then the ecosystem is close to stable, namely the number of individuals of each species is relatively the same, conversely if the uniformity value is close to 0, it means that the uniformity between species in the community is relatively low. Fachrul (2007), explained that the uniformity index describes the number of individual sizes between species in a fish community. The more evenly distributed individuals between species, the more the ecosystem balance increases. Triandiza (2013) stated that the smaller the uniformity index indicates uneven distribution, some types are found to be more dominant than others, conversely if the uniformity index value is greater, it describes that the waters in which the types of fish are distributed relatively and evenly

In this study, there was no dominant species, thought to be caused by several factors, namely bioreeftek may create environmental conditions that support various fish species relatively balanced through the availability of food, shelter, and habitat space that is evenly available. The complex structure provided by bioreeftek creates a suitable microhabitat for many species to coexist. In areas with balanced predation, competition and symbiosis interactions, no species has a large enough advantage to dominate so that it can increase equality among existing species.

The ability to find and fill its own ecological niche without overlapping, thus creating a more diverse and balanced community. Areas that have just been restored with bioreeftek may still be in the early stages of colonization by various fish species because they are still in the process of adapting and exploring new habitats. Ramadani (2003) stated that the distribution of fish numbers approaching 0 reflects a community condition that is approaching stability so that no particular type dominates significantly. Awuy *et al*. (2017), stated that the lower the dominance index value, it will always mean that the ecological balance is getting better and indicates the stability of the coral fish community on artificial reefs.

**CONCLUSIONS**

The composition of fish species obtained during the study consisted of 11 species, namely *Lethrinus lentjam*, *Caranx* sp, *Epinephelus merra*, *Epinephelus spilotocep*, *Cephalopholis* sp, *Therapon therap*, *Lutjanus monostigma, Nemipterus tumbuloide, Siganus doliatus, Parachaetodon ocellatus*, and *Lutjanus* sp. The highest composition of japanese threadfin bream was 26.07% and the lowest was sixspine butterflyfish 5.13%. Diversity with values ​​ranging from 5.87 to 74.02 in the high category with uniformity values ​​ranging from 0.38 to 4.84 in the low, medium and high categories and dominance with values ​​ranging from 0.003 to 0.068) with a low dominance category.

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