



Demersal Fish Diversity Index in Cirebon Waters, West Java

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Authors' contributions

This work was carried in collaboration among all author. All author read and approved the final manuscript.

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ABSTRACT

This study aims to analyze the distance between the placement of the base fish aggregating devices (FAD) from the beach, the composition of the catch, identify fish species and determine the diversity of fish caught at different distances of the base FAD in Cirebon waters. The research method was carried out descriptively by census. Data analysis method for demersal fish diversity index value (H') using Shannon-Wiener and t-test. Sampling of respondents was carried out by census as many as 20 basic FAD fishermen. The research location is in the Cangkol Tengah Fishermen Association, Cirebon City. The results of this study indicate that the number of fish species caught on FADs with a distance of <12 miles was obtained 10 species with 6,784 fish, the largest number of fish caught was snapper (*Lutjanus Campechanus*) as many as 2,040 fish with a percentage of 30.2% of the total number of fish. The whole fish caught, while the fish with the largest weight was snapper for distances <12 miles with an average weight of 658.92 kg or 30% of other types of fish. The number of fish species caught on FADs with a distance of >12 miles obtained 10 species with 9.217 fish, the highest number of fish caught was snapper (*Lutjanus Campechanus*) as many as 2,884 fish with a percentage of 27.97% of the total number of fish

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caught, while the fish with the greatest weight is snapper with an average weight for distances >12 miles of 988.39 kg or 30% of other types of fish. The magnitude of the demersal fish diversity index value at the base FAD placement distance <12 miles was 1.6672 and more than 12 miles was 1.8137 which means that there is no significant difference and the diversity index category is small because the value of $H' \leq 2$.

Keywords: Fish diversity; fishermen; hand line fishing rods; base fish aggregating devices (FADs).

1. INTRODUCTION

Small scale fisheries business is one of the fisheries sector businesses that have the potential for the development of the nation's macro and micro economy. The national capture fishery business is still characterized by small-scale capture fisheries. This can be proven by the presence of capture fisheries in Indonesia which is still dominated by small-scale capture fisheries, which is around 96%, and only about 4% is carried out by larger scale fisheries [1]. Capture fisheries development is essentially aimed at improving the welfare of the community, especially fishermen and at the same time preserving fish resources and the environment [2]. In general, it is widely known that the level of utilization of various types of marine fishery resources in Indonesia is not evenly distributed, both according to the type of fish and its waters. The waters of the Java Sea and the Malacca Strait are waters that have been over exploited and in these waters are also centers of traditional and industrial fishing activities [3].

The use of fish aggregating devices (FADs) for fishing aids has long been known by Indonesian fishermen. The success of FADs as a fishing aid need not be doubted anymore, because FADs are very effective as a means of collecting fish, making it easier to catch [4]. FADs are a type of fishing aid installed in shallow, medium or deep seas. The installation is intended to attract fish schools to gather around the FADs so that they are easy to catch. This is in accordance with the main purpose of using FADs, namely increasing the catch rate by reducing the operational costs of the ship (increasing fishing efficiency), because fishing is sufficiently done at the FAD location which is a place where fish gather, especially demersal fish.

Biodiversity of demersal fish in a waters is very important because at the level of biological organization it has genetic, species, or ecosystem diversity that plays a very important role in maintaining life. The potential of biodiversity is also the most important part of

fisheries economic activity and to meet the protein needs of the community by utilizing the abundance for consumption and increase in production [5]. The concept of species diversity index is often applied by ecologists to predict changes in the environmental quality of the habitat due to external influences (exploitation, pollution, etc) or the influence between species in the community [6], this index value is a single value that combines indexes. species richness with a species evenness index among species. A high value of species diversity is an indication of a stable and stable environment, on the other hand a low value is an indication of an unstable and changing environment. Among the heterogeneity indices that exist, which is often used for analysis by biological researchers is Shannon-Wiener [7] which in this paper will be applied.

The effort to develop and manage the area with basic FAD technology based on fish apartments in Cirebon waters is one of the steps in handling and protecting the presence of demersal fish. The development of a basic FAD area combined with this fish apartment is a spawning area for adult fish (spawning ground) or a protection area, an area of care and rearing for fish eggs and young fish with the aim of restoring the availability (stock) of fish resources and collecting fish. which has high economic value can also increase the diversity of fish species around the apartment. The use of artificial habitats, including basic FADs as a fishing aid and a fish house that functions more as a conservation fish barn, is one of the breakthroughs in fishing activities. The success of FADs as a fishing aid need not be doubted anymore, because FADs are very effective as a means of collecting fish, making it easier to catch. The design and construction that the basic FAD uses as artificial reefs are usually for materials that use concrete, the design is cube-shaped, while those that use used tires have a pyramid shape. Through the use of basic FADs, large/consumption-sized fish around the bottom FAD area can be caught by fishermen with a long line of fishing rods, while fish / shrimp /

squid / crab puppies can avoid fishing nets because they take cover.

2. METHODOLOGY

This research was conducted from July to September 2017. The method used in this study analyzed the demersal fish diversity index in Cirebon waters which was processed descriptively. The method of sampling as respondents was carried out by census. According to Subana [8] the census method is a way of collecting data from the population by taking all members of the population for data collection. In order to obtain the number of sample units/respondents of small-scale fishing using FADs as many as 20 people (twenty) [8]. Data collection methods used in this study were observation, interviews, literature study and documentation. Types and sources of data include primary data which includes the types of fishing gear used, catches and secondary data which includes the shape and design of basic FADs and their use by fishermen as well as other supporting information.

2.1 Data Analysis

This research begins with the process of data collection obtained from the Department of Food Agriculture Marine and Fisheries of Cirebon City (2017) namely in the form of small-scale fisheries production data based at PPI Cangkol, with the number of basic rumpon FAD fishermen responden as many as 20 (twenty) people and the number of boats there is. In addition, the procedure distance between the installation of FADs from the coast by looking at the composition of the catch, identifying and analyzing fish species caught and the diversity index value based on the different distances of FADs in Cirebon waters.

2.2 Fish Diversity Index

Demersal fish is one of the potential fishery resources and is the target of fishermen's catch. These fish generally live in areas near the bottom of the water, where the habitat is not far away and form groups that are not so large that their distribution is relatively more even than pelagic fish which form large groups [9]. Diversity index is a measure of community wealth seen from the number of species in an area along with the number of individuals in each species [10]. The

more species there are, the more diverse the community is. This index also assumes that the more members of a species, the more important the role of that species is in the community, although this is not always the case [11]. The most commonly used diversity index is the Shannon-Wiener index which is applied to random communities of large size, where the total number of species is known [10]. Natural logarithms (ln) are used for fish around the base of FAD because reef fish are mobile biota which have relatively high abundance and have certain preferences [11]. The formula for the Shannon-Wiener diversity index (H') is:

$$H' = - \sum_{i=1}^s p_i \ln p_i$$

Information:

H' = diversity index

S = Number of species

P_i = Proportion of the number of individuals / samples in that species

For more details, the criteria for diversity are presented in Table 1.

Table 1. Diversity criteria

H'	Criteria
$H' \leq 2$	Little diversity
$2 < H' \leq 3$	Moderate diversity
$H' > 3$	Great diversity

Source: Shannon-Wiener

3. RESULTS AND DISCUSSION

The data of fish caught on FADs within <12 miles from the coast during the study are presented in Table 2 below:

Based on Table 2. above the number of fish species caught on FADs with a distance of <12 miles, there were 10 species with 6.784 fish, the largest number of fish caught was snapper (*Lutjanus Campechanus*) as many as 2.040 fish with a percentage of 30.2% of the total the whole fish caught. A more complete description of fish species caught in bottom FADs with a distance of <12 miles is presented in Fig. 1.

To find out the weight of fish caught on FADs that are <12 miles away, it can be seen from Fig. 2.

Table 2. Fish Species caught in FADs Base <12 miles

No	Species	Frequency (tail)	Percentage (%)
1.	Snapper (<i>Lutjanus Campechanus</i>)	2.040 tail	30.20
2.	Grouper (<i>Epinephelus malabaricus</i>)	682 tail	10.00
3.	Snapper (<i>Lutjanus russelli</i>)	2.026 tail	29.80
4.	Malabar Snapper (<i>Lutjanus malabaricus</i>)	1.357 tail	20.00
5.	Bigeye Trevally (<i>Caranx Sexfasciatus</i>)	136 tail	2.00
6.	Barred Queenfish (<i>Scomberoides tala</i>)	102 tail	1.50
7.	Barred Spanish Mackerel (<i>Scomberomorus commersoni</i>)	251 tail	3.70
8.	Barracuda (<i>Sphyræna barracuda</i>)	90 tail	1.30
9.	Bigeye Trevally (<i>Carangoides spp</i>)	69 tail	1.00
10.	Sunrise Goatfish (<i>Upeneus sulphureus</i>)	31 tail	0.50
Total Catch Result		6.784 tail	100

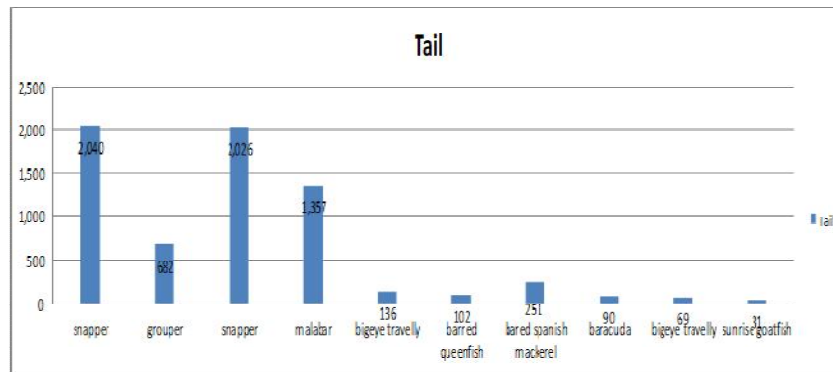


Fig. 1. Captured demersal fish species Distance <12 miles

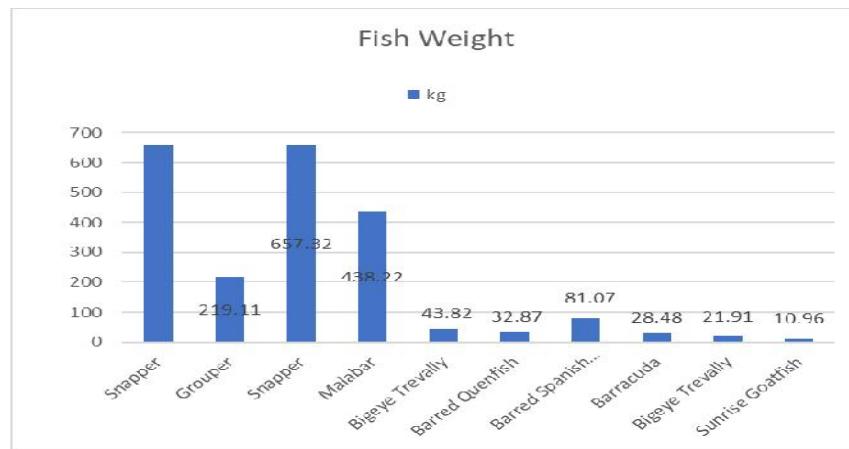


Fig. 2. Percentage of total caught fish weight at base FAD distance <12 miles

The fish caught on the bottom FAD with a distance of <12 miles, obtained by the fish with the largest weight is snapper with an average weight of 658.92 kg or 30% of other types of fish. Fish species caught on the bottom FADs at a distance of >12 miles from shore are presented in Table 3.

Based on Table 3. above the number of fish species caught on FADs with a distance of >12 miles, there were 10 species with 9.217 fish, the largest number of fish caught was snapper (*Lutjanus Campechanus*) as many as 2.884 fish with a percentage of 27.97% of the total number of fish. the whole fish caught. A more complete

description of fish species caught in bottom FADs with a distance of >12 miles is presented in Fig. 3.

To find out the weight of fish caught on FADs that are >12 miles away, it can be seen from Fig. 4.

The fish caught on the bottom FAD with a distance of >12 miles, obtained by the fish with the largest weight is snapper with an average weight of 988.39 kg or 30% of other types of fish.

3.1 Value of Fish Diversity (Test - t)

To determine the diversity index of fish species, it was carried out using the Shannon-Wiener diversity index (H') and the t-test, the results are as shown in Fig. 5.

Based on Fig 5, it can be seen that the average diversity of fish at a distance of <12 miles with the diversity value obtained is 1.6672 not significantly different from the diversity of fish >12 miles with the diversity value obtained is 1.8137. Complete explanation data regarding the results of the t-test diversity is presented in the Appendix. In general, fish diversity in the bottom FAD area in Cirebon waters has a small diversity category, namely $H' \leq 2$. This is presumably because the distribution of demersal fish is caught on average at a distance of 6 miles from the coast and with almost the same species. This is in accordance with the research of Supriadi (2012) who conducted research in Cirebon waters that the average diversity of fish at a distance of >12 miles with a diversity value of 2.08 is not significantly different from the diversity of fish <12 miles with the diversity value obtained 2.01 [12]. Meanwhile, according to Aksari [13]

the distance to place the basic FADs of 16.630 miles gave better catches compared to the basic FADs with a distance of 6.803 miles and 9.017 miles [13]. Based on Suprpto's [14] research on the Diversity Index of Demersal Fish Species in Tarakan Waters, it is stated that the structure of the demersal fish community in Tarakan has changed due to high exploitation pressure [14]. The status of species diversity is in the medium category, the number is 86 species. Distribution nature Partly evenly and not many species dominate the abundance. Furthermore, Suprpto's [14] research on the biodiversity index of demersal fish in Arafura waters stated that the level of demersal fish species diversity in Arafura waters is in the medium category. Community conditions are unstable and tend to decline. Up to 2006, the status of biodiversity has a Shannon-Wiener (H') species diversity index ranging from 2.22 - 2.79. According to Hidayat and Nurulludin [15] the waters of Southern Java have a richness of demersal fish, 70 species belonging to 36 families, the status of biodiversity is in the medium category, the nature of distribution between types is moderate and not many species dominate [15]. Furthermore, according to Ardina et al. [16] who conducted a study on the study of the diversity of demersal fish species associated with Fish Apartments in the sea waters of Konawe Regency, said that the demersal fish found during the study were 37 species with 1224 individuals [16]. The composition of demersal fish ranged from 11.4% -0.41%. The diversity of demersal fish species in the sea waters of Lalonggasumeeto District, Konawe Regency, especially in apartment locations, is categorized as high, followed by moderate uniformity and low dominance values, while the frequency of presence is acted upon very often.

Table 3. Species of Fish Caught on FADs at a Distance > 12 miles

No	Species	Frequency (tail)	Percentage (%)
1.	Snapper (<i>Lutjanus Campechanus</i>)	2.884 tail	27.97
2.	Grouper (<i>Epinephelus malabaricus</i>)	955 tail	9.26
3.	Snapper (<i>Lutjanus russelli</i>)	2.822 tail	27.37
4.	Malabar Snapper (<i>Lutjanus malabaricus</i>)	1.906 tail	18.49
5.	Bigeye Trevally (<i>Caranx Sexfasciatus</i>)	606 tail	5.88
6.	Barred Queenfish (<i>Scomberoides tala</i>)	146 tail	1.43
7.	Barred Spanish Mackerel (<i>Scomberomorus commersoni</i>)	424 tail	4.11
8.	Barracuda (<i>Sphyrnaena barracuda</i>)	251 tail	2.43
9.	Bigeye Trevally (<i>Carangoides spp</i>)	256 tail	2.48
10.	Sunrise Goatfish (<i>Upeneus sulphureus</i>)	60 tail	0.58
Total Catch Result		9.217 tail	100

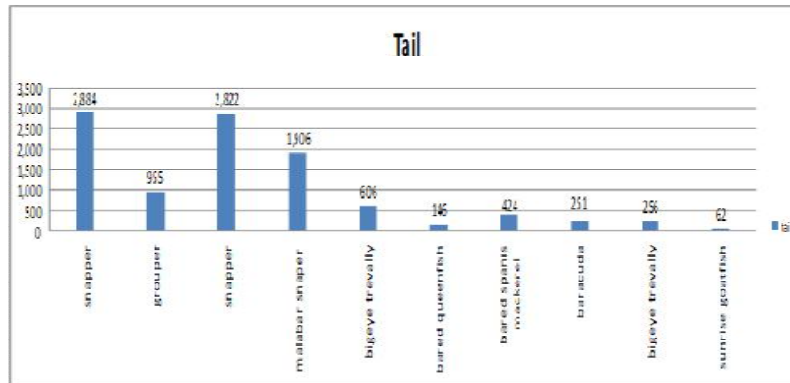


Fig. 3. Demersal fish species caught > 12 miles

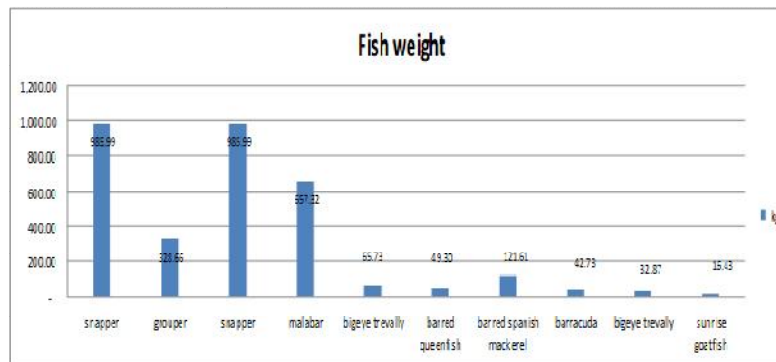


Fig. 4. Percentage of total caught fish weight with a base FAD Distance > 12 miles

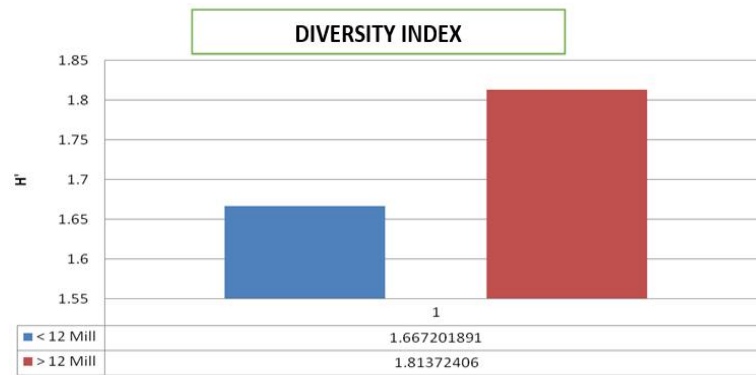


Fig. 5. Graph of average fish diversity in basic FAD locations in Cirebon waters

4. CONCLUSION

The results of this study indicate that the number of fish species caught by fishing rods in the bottom FADs with a distance of <12 miles was obtained 10 species with 6.784 fish, the largest number of fish caught was snapper (*Lutjanus Campechanus*) as many as 2.040 fish with a

percentage of 30.2% of the total number of fish caught, while the fish with the largest weight is snapper with an average weight of 658.92 kg or 30% of other types of fish. The number of fish species caught by fishing rods on the base FAD with a distance of >12 miles obtained 10 species with 9.217 fish, the largest number of fish caught was snapper (*Lutjanus Campechanus*) as many as 2.884 fish with a percentage of 27.97% of the

total number of fish caught, while the fish with the largest weight is snapper with an average weight of 988.39 kg or 30% of other fish species. The value of the demersal fish diversity index value at the base FAD placement distance <12 miles is 1.6672 and >12 miles is equal to 1.8132 which means that there is no significant difference and the category of diversity index is small because the value of $H' \leq 2$.

The advantages of fishermen in Cangkol Village who use basic FADs in the context of preserving fish resources are the use of environmentally friendly fishing gear (long-line fishing rods) catch release with a weight of less than 1 ounce in the sense that what can be taken is which weighs 1 ounce and above. In addition, there are fishermen group savings that are used as remuneration for marine wisdom. namely by replanting damaged FADs and developing them in groups.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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