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Wan Muhammad Luqman Wan Rosdi
Fisheries Research Institute Kampung Acheh, Department of Fisheries Malaysia, Sitiawan, Perak, Malaysia

Syed Mohamad Azim Syed Mahiyuddin
Fisheries Research Institute Langkawi, Department of Fisheries Malaysia, Langkawi, Kedah, Malaysia

Muhammad Amirullah Al Amin Ayob
Southeast Asian Fisheries Development Centre, Department of Fisheries Malaysia, Kuala Terengganu, Terengganu, Malaysia

Correspondence
Wan Muhammad Luqman Wan Rosdi
Fisheries Research Institute Kampung Acheh, Department of Fisheries Malaysia, Sitiawan, Perak, Malaysia

The efficiency aggregating of fish toward the different fads (fish aggregating device: tukun & unjam)

Wan Muhammad Luqman Wan Rosdi, Syed Mohamad Azim Syed Mahiyuddin and Muhammad Amirullah Al Amin Ayob

Abstract
Artisanal fishers have developed various types with different designs and material of Fish Aggregating Devices (FADs) to create new fishing ground near with their villages for fishing activities. The most popular FADs in Malaysia and commonly deployed in coastal are bottom FADs (tukun) and midwater FADs (unjam). There are different types of fish with different species was aggregate near FADs depend on their structure and materials. The objectives of the study is to improve the better FADs aggregate fish between bottom FADs and midwater FADs. Artificial lure made from metal known as Metal jig is use during sampling to attract the fish. All the data collected was identified and total length, standard length and weight recorded. The data was run in Multivariate Statistical Package (Cluster and Diversity Analysis).

Keywords: FAD, tukun, unjam, jig and Multivariate Statistical Package

1. Introduction
Fish has high of price and value to people for food consumption, ornaments and recreation. Fisheries activities become one of the important sector because it has potential generating the national economy. Millions tonnes of fish included aquatic marine was exported every year to many parts of the world worth reach until billions Ringgit. While, more than 1.5 million Malaysian anglers each spend not less than RM 1500.00 per year on this activity for fishing equipment, lure, bait, and fishing trips [1].

FADs is an acronym name for Fish Aggregating Devices. FADs is any method, object or construction used for the purpose of facilitating the harvesting of fish by attracting and thus aggregating them. The Ancient Greeks and Romans already study about aggregative behaviour of pelagic fishes on dolphin fish (*Coryphaena hippurus*) and they applied this discovery to improve their fisheries [2]. The research tendency of fish to aggregate around floating object has been discover for some time [3]. The first introducing commercial fish aggregating devices (FADs) were deployed in the water of the Philippines in the early 1970s [4]. FADs was classified by different type followed by water depth that is bottom FADs, surface FADs and midwater FADs [5]. FADs also classified by drifting natural, drifting artificial or moored artificial [6]. Bottom FADs usually located at the bottom with negative buoyancy known as 'tukun'. Generally 'tukun' made from solid structure such as concrete and metal. The unused materials likes old tires and wrecked ship will be sinking to the bottom ocean to make bottom FADs [7]. There are human made of bottom FADs make from concrete in cuboid shape.

In Malaysia, surface FADs and mid water FADs was called as 'unjam' [8] while, in Filipina it was called 'payao' [9], in Indonesia and Japan was called 'rum pun' [10] and 'tsukegi'. 'Unjam' generally made from plant materials such as coconut fronds and bamboo [11]. The leaves of coconut tree used to attract fishes and plankton. Actually, fish has some special features known as 'Thigmotropism' that is the desire to be close to a solid object and temperament fish like to hang around floating objects such as logs, branches and leaves [12, 13]. Aggregations of fishes have been recorded extensively around both natural drifting objects, such as logs, jellyfish and drift algae and artificial floating structures, that may be either moored or drifting, including rubbish, rafts, man-made fish aggregation devices,

oil platforms, and coastal sea-cage fish farms [6]. Midwater FADs use in shallow waters covered from bottom to Surface Ocean.

The concept was used in FADs is firstly, FADs encourage the microalgae grow on FADs. Second, it will attract small animals (zooplankton). Third, attract smaller pelagic fish species. Finally, attract larger fish species [6]. The schooling of fish generally aggregate, from these advantages, fishermen used to catch fish during aggregating of fish at FADs.

Data and Methods

Data of this study is a sample which composed of eight FADs location. Namely FADs are as in Table 1.

Table 1: Description of Data

Name Of Fads	Types Of Fads	Coordinates
Tukun 1 (T1)	Bottom Fads	N 05° 37 027' E 103° 02 943'
Tukun 2 (T2)	Bottom Fads	N 05° 37 465' E 103° 0 862'
Tukun 3 (T3)	Bottom Fads	N 05° 38 750' E 103° 02 896'
Tukun 4 (T4)	Bottom Fads	N 05° 34.609 E 102° 55. 457'
Unjam 1 (U1)	Midwater Fads	N 05° 40 222' E 103° 06 429'
Unjam 2 (U2)	Midwater Fads	5°40.187 'N 103°6.400 'E
Unjam 3 (U3)	Midwater Fads	5°41.645 'N 103°5.629 'E
Unjam 4 (U4)	Midwater Fads	5°39.106 'N 103°13.701 'E

Fishing gear have been selected to collect the sample are lines and hooks by using the jigging technique. Nowadays, jigging technique become most popular technique especially for the anglers because it is a very efficient to catch predatory and bigger fish. Sometimes small fishes include pelagic fishes such as *Selaroides leptolepsis* also was caught using jigging technique. Artificial lure made from hard metal covered with the shiny colour at the surface known as metal jig was used in this technique to attract the fish. The metal jig or lure will be set up with double or single hook at the upper side or down side. A set of reel, rod and line are the important requirement in this jigging technique. The main concept of jigging are based the movement of metal jig in the water. Basically, the action of metal likes a fish was injured and drowned in water. This situation would attract the fish to attack or going near to the metal jig and the hook would attach to the part of fish. There were one type of jigging technique was apply in this sampling, which is fast jigging. Fast jigging is a technique where the activity jerk the rod and stroke the reel was do in fast motion. This activity repeated to create the motion of metal jig in the water likes a fish injured.

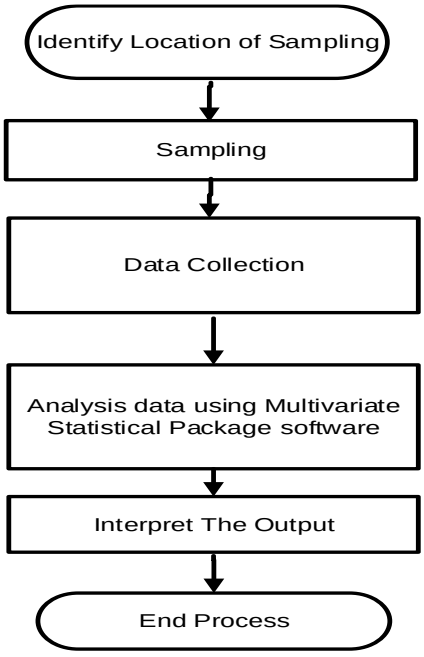

Fig 1: Flow Chart of Data Analysis

Fig. 1 showed the flow chart of the method for data analysis procedure.

Every number of species and number of fishes caught in each of FADs was recorded. To achieve the first objectives, Independent T-test was used to determine whether there is significant different among mid water FADs and bottom FADs toward the number of fish caught. All of these data was run in Multivariate Statistical Package software to analyse similarity distance by Cluster analysis Unweighted Pair Group Method with Arithmetic Mean (UPGMA) method. The rooted tree (dendrogram) was created to compare percent similarity between midwater FADs (U1, U2, U3 and U4) and bottom FADs (T1, T2, T3 and T4). After that, the data was run in diversity analysis by Shannon to get Shannon's index, species evenness and number of species, which species of fish present in different FADs specific by using jigging method.

Results

Figure 2 and table 1 shows the percent similarity between midwater FADs and bottom FADs when the data analysed from the total number species caught by jigging technique. U1 and U2 (Figure 12 show the highest percent similarity that is about 60.60% (Table 1) in group 2. Besides, T1 and T4 showed also the second high percent similarity that is 50.00% followed by T2 and T3, 41.02% include in group 2. U3 – Node 3 and Node 1 – U4 include in group 3, each show 28.36% and 15.91% percent similarity. While, Node 4 and Node 2 classed in group five with 16.88 percent similarity. The lowest percent similarity is in group is about only 7.26% percent similarity.

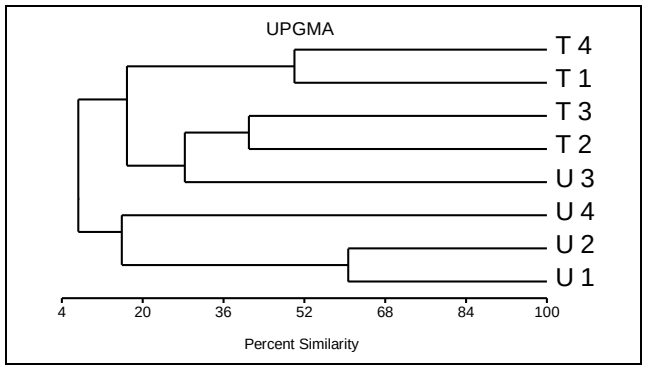

Fig 2: Shows dendrogram percent similarity between midwater FADs (U1, U2, U3, U4) and bottom FADs (T1, T2, T3, T4) analysed by UPGMA method.

Table 1: Show percent similarity, node and group among the midwater FADs (U1, U2, U3, U4) and bottom FADs (T1, T2, T3, T4).

Node	Group 1	Group 2	Percent similarity (%)	In group
1	U1	U2	60.606	2
2	T1	T4	50.000	2
3	T2	T3	41.026	2
4	U3	Node 3	28.367	3
5	Node 4	Node 2	16.880	5
6	Node 1	U4	15.918	3
7	Node 6	Node 5	7.263	8

Table 2 show the species diversity present in mid water FADs (U1, U2, U3 and U4) and bottom FADs (T1, T2, T3 and T4). U1 has the highest value of Shannon's Index that is 0.828 followed by U3 and T3 that is 0.736. While, for evenness showed U4 and T4 has highest value that is 1.000 followed by T3 (0.946) and T2 (0.919). The most number of species present is in U1 for 10 species of fish. U3, U2 and T3 each recorded 8 and 6 species of fish caught. The rest are below than 5 species.

Table 2: show the diversity of fish present in mid water FADs (U1, U2, U3 U4) and bottom FADs (T1, T2, T3, T4).

	Midwater FADs			
Sample	**U1**	**U2**	**U3**	**U4**
Shannon's Index	0.82	0.50	0.76	0.30
Evenness	0.82	0.65	0.84	1.00
Number Species	10.00	6.00	8.00	2.00

	Bottom FADs			
Sample	**T1**	**T2**	**T3**	**T4**
Shannon's Index	0.00	0.00	0.00	0.00
Evenness	0.00	0.00	0.00	0.00
Number Species	1.00	1.00	1.00	1.00

According to the figure 2, U1 and U2 showed the highest percent similarity by UPGMA method about 60.60% (table 1). U4 also has similarity with node 1 (U1 and U2), that is 15.91%. So, assume that U1, U2 and U4 has similar aggregate of fish for *Selaroides leptolepis* because most commonly caught in U1, U2 and U4. Figure 4.1 showed also, T1-T4 and T2-T3 also present high percent similarity of fish caught. There are 50.00% percent similarity (Table 1) has recorded for T1 and T4, the common fish caught is from family Serranidae, *Cephalopholis boenack*. While, for T2 and T3 has 41.02% percent similarity (Table 1) for common species caught; *Lutjanus lutjanus*, *Cephalopholis boenack* and *Cephalopholis formosa*. From this result, the aggregating of fish in midwater FADs and bottom FADs are not similar (Ben-Yami, 1989).

Based on the table 2, midwater FADs U1 and U3 has high value of Shannon's Index that is 0.828 and 0.767 compared to the bottom FADs T2 and T3 each show only 0.642 and 0.736. The majority midwater FADs also show the value evenness index less than 1 for U1 (0.828), U2 (0.651) and U3 (0.849) (Table 4.6). For species evenness bottom FADs is T2 (0.919), T3 (0.946) and T4 (1.000). This showed that, the midwater FADs has high diversity fish with more variation of fish species present than bottom FADs. The present of fish in FADs also depend on fish behaviour and their habitat [7]. There are two types of fish aggregate midwater FADs that is pelagic fishes and demersal fishes. The most pelagic species present in midwater FADs are *Scomberomorus commerson*, *Scomberoides commersonnianus*, *Thunnus tonggol*, *Coryphaena hippurus* and *Sphyraena jello*. Meanwhile, there are also demersal fishes caught at midwater FADs in a small scale especially from family Serranidae such as *Cephalopholis boenack*, *Cephalopholis formosa*,, *Cephalopholis argus* and *Epinephelus areolatus.* The present of anchor at seabed attach to midwater FADs possible acts as artificial reefs and become habitat to demersal fishes. In this case, midwater FADs was successive to aggregate both pelagic and demersal fishes. According to the previous study by Ahmad Ali [4], the species has been caught in midwater FADs included groupers, red snappers, sweetlips, Indian mackerel, barracuda, scads, yellow snapper, nemipterids, trevally, starry trigger fish, dolphin fish and sharks. It is quite similar to the results. In bottom FADs, there are rarely aggregate pelagic fishes and only 1 of pelagic fishes has been caught that is *Sphyraena jello* because of structure bottom FADs not covered until surface seawater. Mostly high diversity of demersal fishes caught in bottom FADs which for species *Lutjanus lutjanus*, *Cephalopholis boenack*, *Cephalopholis formosa*, *Cephalopholis argus* and *Epinephelus areolatus.* The result fish caught for bottom FADs are quite similar to previous study by Husain [14], when the demersal fish majority found near artificial reefs bottom FADs especially for *Plectorhinchus* sp. (Kaci), *Lutjanus lutjanus* (Remong), *Ephinephelus* sp. (Kerapu), *Siganus argenteus* (Dengkis) and family Labridae (Bayan).

Finally, based on the all results the midwater FADs are successive aggregate more species compared to bottom FADs. There are 16 species caught at midwater FADs pelagic and demersal fishes. Whiles, 7 species caught at bottom FADs are mostly from demersal fishes.

Summary and Conclusion

This paper explained on how mid water FADs can aggregate more species of fish included pelagic and demersal fishes. While, for bottom FADs, the most species present are demersal fishes such as grouper and rarely for pelagic fishes. Due to the structure of mid water FADs which is covered from surface until bottom of sea, midwater FADs has extra ability to aggregate fish compared bottom FADs only covered at Bottom Sea. The fish present in mid water FADs commonly are pelagic and schooling fishes. The demersal fishes are minor in mid water FADs. For bottom FADs, only certain species pelagic fishes aggregate near bottom FADs such as barracudas, but majority demersal fish aggregate near to bottom FADs such as grouper.

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