Dynamics of ornamental fish catch in Bio FADs, spatially and temporary, at Uloulo coastal waters, Luwu District, South Sulawesi, Indonesia

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Abstract. Biological-Fish Aggregation Devices (Bio FADs) is a FADs made by utilizing seaweed or other aquatic plants as attractor. Bio-FADs in this study was made by using two species of seaweedas attractor, namely *Eucheuma cottonii* called cottonii FADs (C FADs) and *Gracillaria* sp. of gracillaria FADs (G FADs). This study aimed to analyze the catch of ornamental fish based on its species, abundance, and ecological characteristics spatially and temporary. The research was conducted in 2016, located on the waters of Uloulo, Luwu District, South Sulawesi, Indonesia. Fish samples were collected from bio-FADs deployed in three different habitats as observation stations. The result of Shannon-Wienner (H ') diversity index showed a relatively moderate value in both spatially and temporary. The highest abundance of ornamental fish was caught on coral reef habitat (CR) and in transition season-1 (TS-1). SIMPER analysis showed that *Valenciennea* sp. is the main species (identifier) in the three habitats and the highest abundance was found on the river estuary habitat, which amounted to 55.20 %. There were different kinds of identifier fish based on the season. The identifier fish found in west monsoon and transitional season - 2 was *Valenciennea* sp., while in transitional season - 1 (TP - 1), the identifier fish was *Abuddefduf* sp., and the identifier fish found in east monsoon (EM) was *Triacanthus* sp.
Key Words: atractor, seaweed, diversity index, habitat, season.

Introduction. Indonesia is an archipelagic country consisting of 17,500 islands with a coastline of about 81,000 km, and is located in tropical area. Based on these conditions, Indonesia has a huge of coastal and marine natural resources with a unique ecosystem and has high biological productivity such as coral reefs, sea grass, sea weeds, and mangroves. Nevertheless, it has the diversity of fish species with high economic and aesthetic value such as various types of ornamental fish.

Sea ornamental fish is very popular due to its unique morphology, has interesting and various colors and can be maintained in the aquarium. There are 650 species of ornamental fish in Indonesia, in which 480 species have been identified and 200 species have been utilized for trading (Kusrini 2010); while Kuncoro & Wiharto (2009) states that there are approximately around 3000 ornamental fish that have been identified. The dominant marine ornamental fish live in the most distinctive habitat of coral reefs and others live in estuary, mangrove and seagrass habitats (Umar et al 2008).

Kusrini (2010) states that marine ornamental fish comes from fishermen catches of 95%, and only 5% from cultivation. According to Kuncoro & Wiharto (2009), marine ornamental fish has begun to be cultivated in the United States and Puetro Rico such as the clownfish (*Amphiprion ocellaris*) and Ambon damselfish (*Pomacentrus amboinensis*), while in Indonesia the ornamental fish cultivation is still in the test scale such as banggai cardinal fish (*Pteropogon kauderni*), *A. ocellaris*, *P. amboinensis* and bluegirdled angelfish (*Pomacanthus navarchus*) (Hartanto 2014).

Sea ornamental fish with high economic value in international market are *A. ocellaris* and *P. navarchus*. The high demand of the market and the high selling price of marine ornamental fish became the main factor which triggers the fishermen to intensively do the fishing operation toward these ornamental fish. Fishing activity, to catch ornamental fish, by using environment unfriendly fishing gear such as electric fishing, trawling and potassium that produce cyanide for fish anesthesia and bombing are the main activities which trigger habitat destruction and overfhising. One of Central Sulawesi's endemic ornamental fishes, *P. navarchus* has been experiencing over-exploitation (Madinawati et al 2009), this has become international issues in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

One of the most effective technologies used to catch ornamental fish that are non-destructive is by using FADs technology. The FADs used in this technology are Bio-FADs which are specially designed using seaweed as attractor. Seaweed as attractor has the purpose to lure the ornamental fish to gather around FADs, making it is easy to catch. According to Suardi at al (2016), Bio-FADs can attract several species of ornamental fish such as *Triacanthus* sp., *Platax* sp., Gobiidae, blackspot sergeant (*Abudefduf* sp.), *Siganus fuscescens* and *Siganus virgatus*.

Information about the level of attraction of Bio-FADs toward marine ornamental fish is still very limited so the research related on the use of bio-FADs to analyze the dynamics of marine ornamental fish catches spatially and temporary are needed. This study aims to find out the dynamics of ornamental fish in Bio-FADs, spatially and temporary, in Uloulo Coastal waters, Luwu Regency.

Material and Method. The research was conducted in Uloulo coastal waters, Gulf of Bone, Luwu District, South Sulawesi, Indonesia (Figure 1) for 12 months (January-December 2017). The research was divided into four seasons, namely: transitional season 2 (TS-2) from January to March, east monsoon (EM) from April to June, transitional season 1(TS-1) from July to September andwest monsoon (WM) from October to December (Nontji 1987).

Three locations are chosen as observation stations based on the habitat as presented in Table 1. The locations were determined by using the method of zoning (segmentation) considering to the characteristics of water based on the difference of typology for each station (habitat). The determination of each research station (habitat) as a location for FADs placement was based on the assumption that: (1) the obtained fish samples will represent fish distribution spatially and temporary, (2) habitat in accordance with the distribution of the fish, and (3) differences in physical and chemical parameters of water.

Based on the characteristics of habitat above, three locations (habitats) were defined as shown in Table 1.

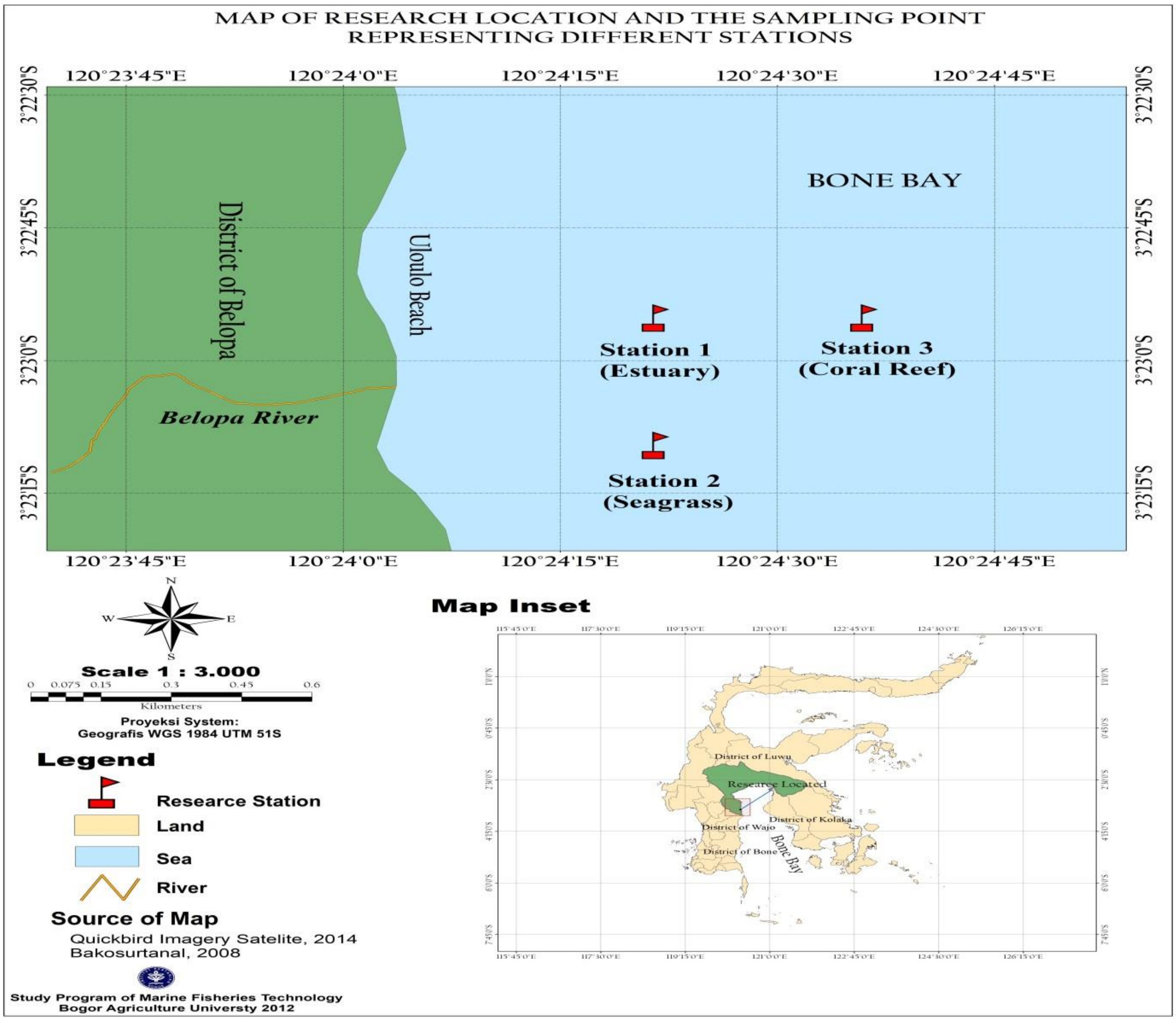


Figure 1. Research location and the sampling point representing different stations (habitat) (Station 1 = estuary, Station 2 = seagrass and Station 3 = coral reef).

Table 1

Characteristics of research location site at estuaries, seagrass and coral reefs habitats

Characteristic	*Habitat (location)*		
	Estuary (E)	*Seagrass (S)*	*Coral reef (CR)*
Geographical position	E 120° 24' 09.304" - L 3° 22' 37.064"	E 120° 24' 0.447" - L 3° 22' 56.243"	E 120° 24' 21.20" - L 3° 22' 36.140"
Depth	3 - 10 m	3 - 10 m	5 -15 m
The specificity of habitat	The supply of fresh water directly from the river, close to the settlement of fishermen, adjacent to transit routes for fishermen, low clarity level, high mixing intensity, high salinity fluctuations[a)]	The supply of fresh water from the mainland, overgrown by seagrass and macroalgae, low clarity levels, salinity 10-25‰	Crystal clear waters, Overgrown by macro-algae, high current, salinity between 30-36‰ [b)]
Substrates	Mud and sand	Mud and sand	Rocks, sand and dead coral

Source: [a)] - Widodo & Suadi (2008), [b)] - Nybakken (1988).

Bio-FADs used in this study were using seaweed as attractor. *Eucheuma cottonii* and *Gracillaria* sp., utilised as attractor, were referred as cottonii FADs (CF) and Gracillaria FADs (GF). Both FADs consist of 3 units of CF and 3 GF. Each type of Bio-FADs was installed at 3 stations (habitat). Fish sampling to collect fish accociated with FADs were performed by using scoopnet (local name: bunde). Materials used in bio-FADs and scoopnet (fish sampling tools) are presented in Tables 2 & 3, construction of living FADs and scoopnet are presented in Figure 2 & 3.

Table 2

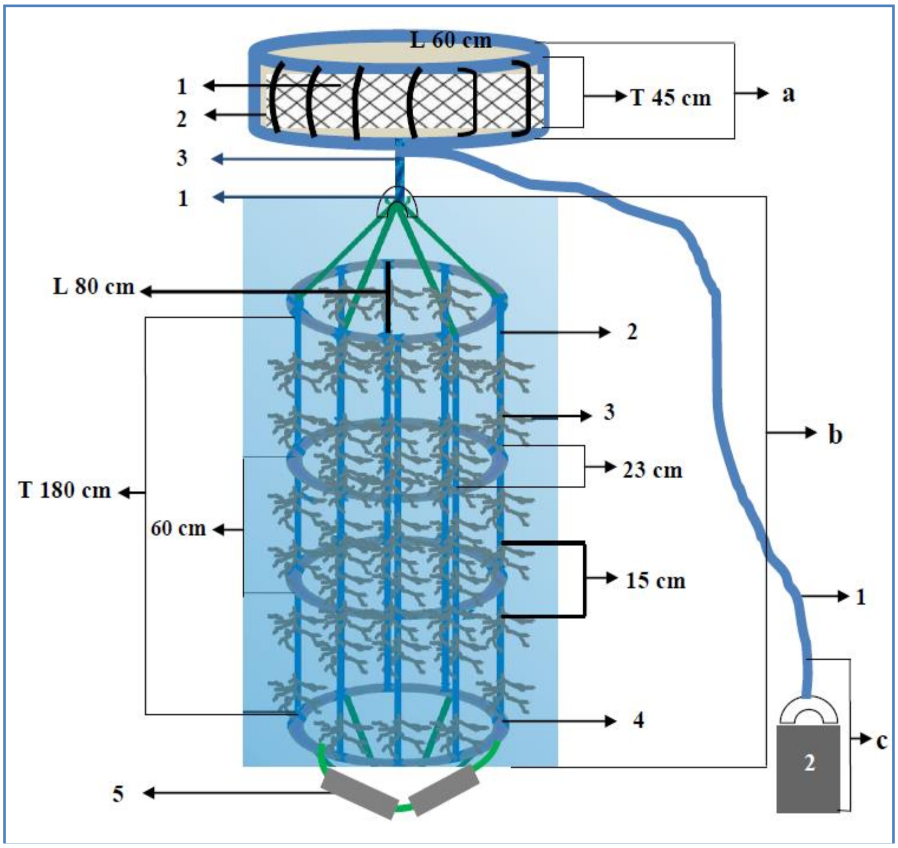
Materials used in the construction of Bio-FADs

Component	*Materials*	*Size (length/weight)*	*Quantity*
Buoy	Styrofoam	Width: 60 cm and height: 45 cm	6 units
	Net	Mesh size 0.5 cm	12 m
FADs frame	Bamboo	Length: 180 cm and width: 2 cm	36 pieces
	Ratan	Length: 160 cm and Ø = 1.5 cm	24 pieces
Attractor	Seagrass (*Eucheuma cottonii*)	1.4 kg/FADs	8.4 kg
	Seagrass (*Gracillaria* sp.)	1.4 kg/FADs	8.4 kg
Ropes	Buoy line (PE) no. 8	4 m/FADs	24 m
	Sinker line (PE) no. 10	15 m/FADs	90 m
	Streching rope (PE) no. 6	24 m/FADs	144 m
	FADs adhesive line (PE) no. 6	12 m/FADs	72 m
	Strap (PE) no. 2.5	15 m/FADs	90 m
	Etenar wire Ø 1.5 mm	5 m/FADs	30 m
Swivel	Iron	1 unit/FADs	6 units
Sinker	Anchor sinker	45 kg/FADs	270 kg
	FADs sinker	2.5 kg	15 kg

Table 3

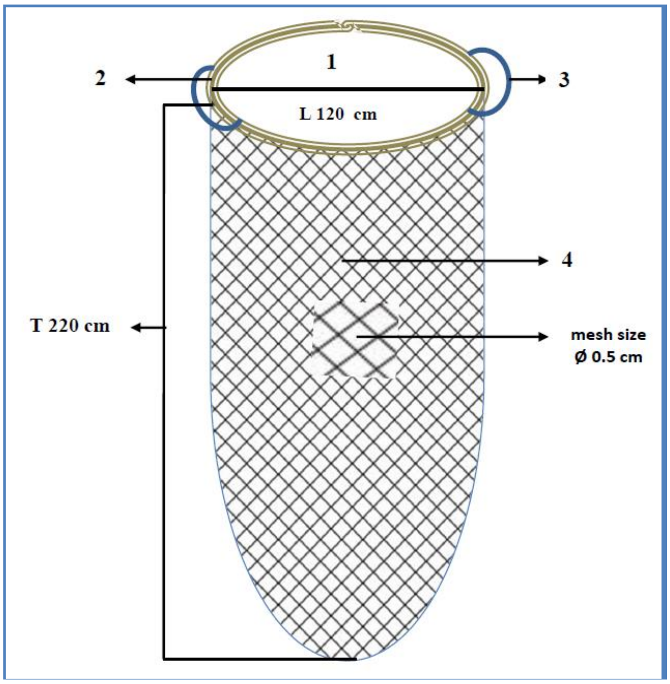
Materials used in the construction of a scoop net (ornamental-fish sampling tool)

Component	*Materials*	*Dimensions (Length/weight)*	*Quantity*
Frame	Ratan	Length: 160 cm and Ø = 1.5 cm	1
	Net	Mesh size of 0.5 cm	4 m
Ropes	Rope hilt (PE) no. 10	0.5 m/scoop net	0.5 m
	Etenar wire	1 m/scoop net	1 m



Description: (a) Buoy (styrofoam) 1. Net, 2. Ropes to tie the net, 3. Buoy line; (b) FADs 1. Swivel, 2. Frame (bamboo), 3. Attractor (seagrass), 4. Circle (ratan), 5. Sinker (cast); (c) Sinker 1. Sinker line, 2. Main sinker.

Figure 2. Construction of Bio-FADs used in the present research (Suardi et al 2016).



Description: 1. Mouth; 2. Frame (ratan); 3. Hilt (nylon PE. No. 10); 4. Net.

Figure 3. Construction of scoop net for collecting fish on Bio-FADs (Suardi et al 2016).

FADs deployment locations in each habitat were determined by considering the characteristics of the location, namely; 1) minimum depth of the water at lowest tide is 2.5 m, 2) safe from fishing lane, 3) high current speed and 4) high water clarity. Bio-FADs in the water column was positioned in vertical standing, parallel to the coastline, the distance within the body of FADs with surface waters of 15 cm and the distance between FADs from each station (habitat) were approximately 25 m.

Data collection. Sample fishes were collected by using scoop net from both types of bio-FADs installed on three study sites. Sampling was held 4 times in different seasons.

Fish sampling on living FADs was performed by using a scoop net in several stages; 1) sampling was performed by two people who dived simultaneously on the side of FADs, 2) after arriving at the lower end of FADs, then FADs were encased by the scoop net, 3) Bio-FADs contained within the scoop net was then pulled up on the boat, 4) The FADs was then shaken to make all the fish get into scoop net, 5) FADs was released from scoop net and ornamental fish caught were collected in a container and then sorted based on species, abundance on habitat and seasonal.

Data analysis. The measurement of ornamental fish community structures associated with Bio-FADs were grouped spatially (habitat) and temporary (season). Ornamental fish catch was analyzed by the number of species, abundance and diversity index. Next, parameters of diversity, the correlation between parameters, species characteristics and similiritas were analyzed by using multivariate statistics with the help of PRIMER (Plymouth Routines In Multivariate Ecological Research) version 5.2 software (Clarke & Gorley 2001; Taurusman 2007). In detail the analyses used are:

Abundance analysis (A). The abundance level of ornamental fish is grouped by species. Each group was analyzed by comparing the average abundance of ornamental fish in both spatially (habitat) and temporary (season). The abundance can be defined as the number of individuals per area (Odum 1998) which calculated with the formula of:

$$A = \frac{Xi}{ni}$$

Descriptions: *A* =individual abundance (ind/m^2), *X*i = the number of individual ofspesies-i, *ni* =the number of quadrant area where species –iwas found

Diversity index. Diversity index (H ') analysis was performed by using Krebs (1989) formulation. This analysis consists of the number of species (s) the number of individuals (N), Margalef's species richness (d) Pielou's evenness index (J '), Shannon-Wiener's diversity index (H'). The calculation of H' value is based on the number of individuals of each species (N) caught on Bio-FADs as used by Krebs (1989) in determining the value of H', equations (2) and (3). Diversity index is formulated as follows:

$$\boldsymbol{H' = -\sum_{i=1}^{s} P_i \, Log_2 P_i}$$

$$\boldsymbol{H' = -\sum_{i=1}^{s} (\frac{ni}{N}) Log_2 (\frac{ni}{N})}$$

Descriptions : H' = Shannon-Wiener diversity index, *s*= number of taxa, *Pi* = ni/N, n_i= number of individual-i, *N* = total amount of individual. H'will have maximumvalue if all species or genus are homogeneously distributed, namely :

$$\boldsymbol{H' maks = Log_2 s}$$

Cluster analysis. Cluster analysis was conducted to find out the relation of ornamental fish structures associated with bio-FADs in both spatially and temporary. Bray-Curtis similarity index was performed to create similarity score matrix between catch data based on habitat and season. The data are first standardized with root transformation 4 (4h-root transformed). Furthermore, cluster analysis was plotted in dendogram form and statistical tests were performed.

Analysis of similarities (ANOSIM). Analysis of similarity (ANOSIM) was used to test the significant differences of abundance toward ornamental catches between habitat and season. ANOSIM is a non-parametric analysis such as analysis of variance (ANOVA), which is based on a ranking of values in a similarity matrix (Quinn & Keough 2002;

Taurusman 2011). Taurusman (2011) recommends using ANOSIM to test different hypotheses between groups in statistical multivariates. The similarity relationship based on the change of R value is shown in the following equation:

$$R = \frac{aver.\ rb - aver\ .rw}{M\ \ 2}$$

$$M = \frac{n(n-1)}{2}$$

Descriptions: *aver. rb* = the average rank of similarity data between group, *aver. rw* =the average of similarity data in a group or in a particular habitat, month / season.

The interpretation of R (Clarke's R) values describes the degree of difference between groups, with a scale of 0 (indistinguishable) to 1 (all data in the group is less than the similarity of intergroup data).

Similarity percentage (SIMPER). This analysis was used to see the identifier species (ornamental fish species) which determine the characteristics of a data set (in this case habitat and season), usually determined by the value of the number of individuals or weights that spread in similarity.

Results and Discussion

Diversity index (H ') of ornamental fish caught based on habitat and season. Based on the number of ornamental fish associated with cottonii FADs (CF) and gracillaria FADs (GF) deployed in estuary, seagrass and coral reef habitat, the data related to dynamics or community structure of ornamental fish were acquired. The number of species, individual abundance, and diversity index of ornamental fish in three habitats are presented in Table 4.

Table 4

The structure of ornamental fish caught in Bio-FADs in three habitat

Habitat	*S (sp)*	*N (ind/m²)*	*J'*	*H´(log$_2$)*	*d*
Estuary (E)	6	6.45	0.82	2.19	0.86
Seagrass (S)	4	4.82	0.92	1.83	0.87
Coral reef (CR)	6	15.55	0.84	2.16	0.79
Average	5.3	8.94	0.86	2.06	0.84

S - Number of species, *N* - abundance (ind/m²), *J'* - Pielou's evennes index, *H'* - Shannon-Wienner index, *d* – Margalef index.

Distribution of ornamental fish species associated with bio-FADs showed different number of species associated in three habitats, whereas there are 6 species caught in estuary and coral reef habitat and only 4 species caught in seagrass habitat (Table 4). The high number of ornamental fish species associated in bio-FADs in both estuary and coral reef habitat is allegedly due to a higher water productivity compared to seagrass habitat. The high productivity of waters is influenced by currents, nutrients, light and chlorophyll content. According Muhtadi (2018), a habitat has a high productivity if there were circulation process by the current, nutrient input, light penetration and the amount of chlorophyll. Other factor that allegedly affects the number of species to be more associated in bio-FADs deployed in both coral reef (CR) and estuary (E) habitats is due to the similar function of bio-FADs and seagrass habitat, where herbivorous fish foraging and takes shelter from predators, thus causing the ornamental fish to be scattered around seagrass beds and less centered on bio-FADs. Samples & Sproul (1985) states that the fish lured around FADs is caused by several factors, namely: 1) FADs is functioning as shading place for certain fish species; 2) FADs as feeding ground, 3) FADs as the substrate for laying their eggs, 4) FADs as a shelter to hide from predator fish and 5) FADs as a meeting point for a school of fish.

The abundance of ornamental fish caught on bio-FADs varied spatially (habitat). The highest abundance of ornamental fish caught in coral reef habitat (CR) was 15.55 ind/m^2, followed by estuary (E) by 6.45 ind/m^2 and seagrass habitat (S) by 4.82 ind/m^2. The high abundance of ornamental fish in the coral reef habitat is allegedly due to a high diversity of fish species associated in that habitat. The abundance value obtained in the present research is relatively higher compared to the result of research taken by Mauli and Sulkifli (2013) wheres the abundance of yellowface angelfish (*Pomacanthus xanthometopon*) was 0.016 ind/m^2.

The result of diversity index (H'log2) of ornamental fish spatially (based on habitat) ranged between 1.83 and 2.19 with an average value of 2.0. H' values of ornamental fish catches in three habitats based on Shannon-Wienner index and correlated with Pielou's (J') similarity index values were considered as moderate with an average value of 2.0 and inversely proportional to dominant index (D) of Simpson. Diversity index value (H') in three habitats are considered moderate (1.8-2.19). This value is lower than diversirty index level of coral reef fish found in Semak Daun Island, Seribu Islands where there are 27 species found in the waters (Mujiyanto 2014) and relatively even compared to research performed by Sugianti & Mujiyanto (2013) with coral reef fish diversity index (H') of 2.46 (Table 5).

Table 5

Diversity of ornamental fish caught in FADs in each season

Season	*S (sp)*	*N (ind/m²)*	*J'*	*H´(log$_2$)*	*d*
West Monsoon (WM)	6	13.33	0.78	2.03	0.76
Transitional Season 2 (TS-2)	6	7.33	0.88	2.27	0.88
East Monsoon (EM)	6	5.00	0.77	1.99	0.83
Transitional Season 1 (TS-1)	6	10.67	0.69	1.79	0.66
Average	6	9.08	0.78	2.02	0.78

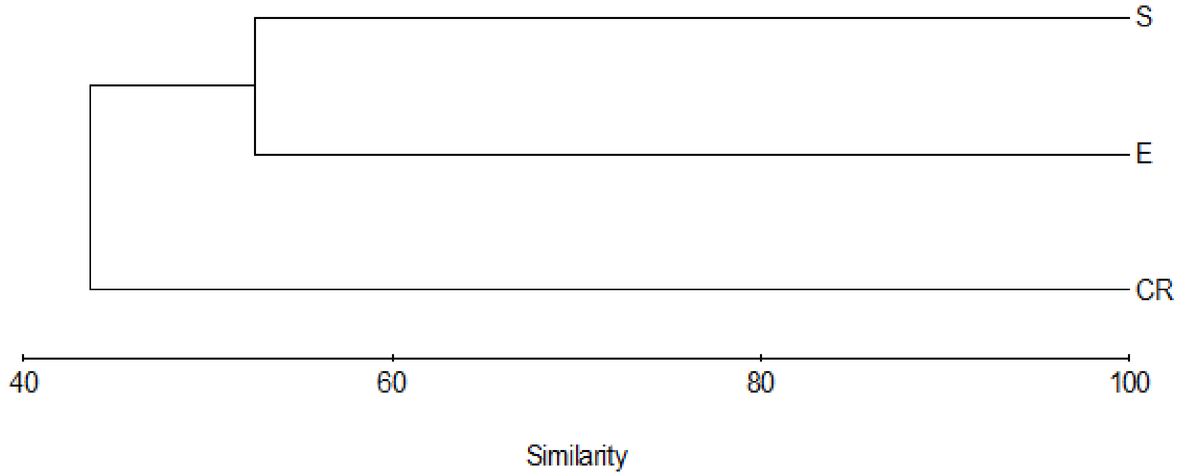
S - Number of species, *N* - abundance (ind/m²), *J'* - Pielou's evennes index, *H'* - Shannon-Wienner index, *d* - Margalef index.

Distribution of ornamental fish species associated with bio-FADs temporary (seasons) showed a relatively equal amount of catch. Six species of ornamental fish were caught in four research seasons. The seasons have no effect on the distribution of ornamental fish in the coastal areas. This result was different from the research held by Satria et al (2016) whereas Australian bonytongue (*Scleropages jardinii*) were caught higher in rainy season from October to February or West monsoon (WM) until the Transitional Season-2 (TS-2).

The distribution of ornamental fish catches abundance (ind/m²) varied temporary (season). The abundance of ornamental fish catches ranged from 5.00 ind/m² to 13.33 ind/m² with an average value of 9.08 ind/m². The lowest abundance of ornamental fishes happened in east monsoon (EM) while the highest abundance was noted in west monsoon (WM) (Table 5). The abundance of ornamental fish catches in west monsoon was higher compared to other seasons which are allegedly due to the influence of food and spawning. According to Priatna & Natsir (2007), in December (west monsoon) fish abundance is almost twice the abundance of other seasons due to the huge abundance of food. Wiyono & Mahiswara (2013) states that in December (WM), the condition of Bone Bay waters has been relatively calm so that fishing activities also tend to increase. The research conducted by Laga et al (2015) showed that Bombay-duck (*Harpadon nehereus*) fishing rate is quite high in December - January (late WM and early TS-2) in the waters of Tarakan Island.

The value of Shannon-Wienner diversity index (H ') shows a relatively moderate values between 1.79 to 2.27 with an average value of 2.02 (Table 5). The H' value of ornamental fish catches in the four seasons based on the Shannon-Wienner index value when correlated with Pielou's (J ') evennes index values is also categorized as moderate diversity index with an average value of 2.02 and inversely proportional to Simpson's dominant index (D). The diversity index value (H') of ornamental fish found in three habitats in four seasons are relatively lower compared to the diversity index of ornamental fish found in Buluh China Village, Kampar Riau in the transition season-2 (MP-2) (H '= 3.50) (Efizon et al (2015). Wahyudewantoro & Haryono 2011 (2011) states that diversity index of fish in mangrove area observed during rainy season (in November) or west monsoon (WM) in Ujung Kulon Pandeglang showed H' value of 1.99, which is categorized as moderate. This condition showed that ornamental fish catch in FADs indicates that Bio-FADs serve to be a stable habitat.

Cluster analysis. The result of analysis of similarity (ANOSIM) showed spatial (habitat) and temporal (season) variation of ornamental fish caught on bio-FADs in Uloulo coastal waters of Luwu Regency (Figure 4 & 5).

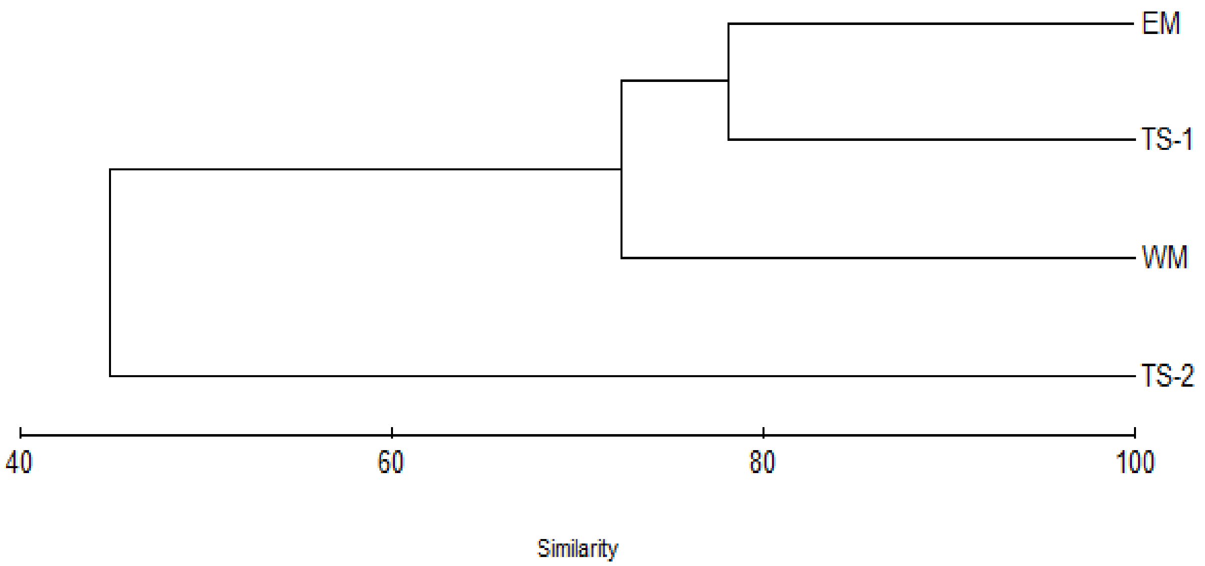


Description: S - Seagrass, E - Estuary, CR - Coral reef.

Figure 4. Dendogram of ornamental fish abundance caught in each habitat.

The result of ornamental fish caught by station or habitat showed that, in general, there are two variations of groups, namely 1) estuary (E) and seagrass (S) and 2) coral reef (CR) (Figure 4). Statistical test results (ANOSIM) showed a very significant difference of catch abundance between habitat in FADs deployment location, with the value of Global R = 0.268 and p = 0.001. The result of LSD test showed that the estuary (E) and seagrass (S) habitat were significantly different with R = 0.011, p = 0.028, while the estuary (E) and seagrass (S) habitat have a very significant different from coral reef (CR) habitat (R = 0.064; p = 0.001). The highest abundance of ornamental fish catches on coral reef habitat (CR) is allegedly due to the high ornamental fish productivity in that habitat. Umar et al (2008), states that the result of survey indicates that the majority of fishermen in south Lampung catch ornamental fish in coral reefs.

Furthermore, based on analysis of similarity (ANOSIM), temporary (season) caught ornamental fish showed an abundance variation in groups (Figure 5). In general, there are 2 abundance variation groups of ornamental fish, namely 1) west monsoon (WM), transition season-1 (TS -1) and east monsoon (MT) group and 2) transition season-2 (TS-2) which formed its own group. ANOSIM statistical test results showed that fish abundance between seasons was significantly different (Global R = 0.110 and p = 0.001). The highest abundance of ornamental fish occured in west monsoon (WM). This is presumably due to the huge abundance of food availability in December, causing the fish abundance to increase for almost twice of the abundance from other seasons (Priatna & Natsir 2007). Moreover, Laga et al (2015) states that the fishing operation rate of *H. nehereus* is quite high in December - January (late WM and early TS-2) in Tarakan Island Waters.



Description: TS-1: Transition season-1, EM: East monsoon, TS-2: Transitional season-2 and WM: West monsoon.

Figure 5. Dendogram of ornamental fish abundance based on season.

Furthermore, SIMPER analysis was performed to determine the characteristics of identifier species of ornamental fish in each habitat and season (Table 6 & 7). Percentage of contribution of ornamental fish species from Gobiidae family was dominating in three habitats with contribution between 45.33 and 55.16%. Highest abundance percentage of Gobiidae family occured in estuary habitat by 55.16% (Table 6). The percentage of contribution for Gobiidae family in three habitats is quite similar. This is presumably because Gobiidae spread relatively even in both three habitats. According to Poernomo et al (2009), Gobiidae family lives along the coast of the bay and estuary or even into the rivers and coral reefs. Gobiidae family is very dominant in both diversity and abundance in mangrove area (Wahyudewantoro & Haryono 2011).

Table 6

Types of ornamental fish caught in each habitat

Fish species	*Habitat (% of contribution)*		
	Estuary (E)	*Seagrass (S)*	*Coral reef (CR)*
Gobiidae	55.16	46.05	45.33
Triacanthus sp.	10.59	31.09	20.83
Abuddefduf sp.	0	20.36	19.96
Siganus virgatus	9.52	0	10.51
Siganus fuscescens	9.85	0	0
Platax sp.	9.56	0	0

Species contribution percentage of ornamental fish varied according season. Ornamental fish from the Gobiidae family were highly contributed in transition season-2 (TS-2), transitional season-1 (TS-1) and west monsoon (WM) whereas in the east monsoon (EM) the highest contribute was dominated by *Triacanthus* sp. The detail of fish species contribution in temporary (season) are shown in Table 7.

Table 7
Characteristics of ornamental fish species caught by season and their contribution

Fish species	*Season (% of contribution)*			
	West monsoon (WM)	*Transitional season-2 (TS-2)*	*East monsoon (EM)*	*Transitional season-1 (MP-1)*
Gobiidae	38.59	88.13	0	40.18
Triacanthus sp.	21.65	11.11	68.89	7.51
Abuddefduf sp.	0	0	22.37	44;57
Siganus virgatus	0	0	0	0
Siganus fuscescens	0	0	0	0
Platax sp.	32.69	0	0	0

Table 7 shows that the main catch (identifier) of ornamental fish by season is the Gobiidae family with the contribution percentage of 88.13%. The high percentage of Gobiidae family in bio-FADs observed during the transition season-2 (TS-2) is presumably due to the spawning season of Gobiidae fish which occurs in July to September (rainy season). According to Wahyudewantoro & Haryono (2011), the spawning season of mudskipper fish is the months where the rainy season occurs. The goby fish (*Glossogobius matanensis*) belong to the Gobiidae family and live in the lake, these fish spawn twice a year, namely in March - April (end of transition season-2 / TS-2) and the beginning of east monsoon (EM) and August - October or end of transition season-1 (TS-1 and the beginning of west monsoon / WM) (Sulistiono et al (2017).

Conclusions. The distribution of ornamental fish in bio-FADs varies spatially (habitat), while temporally (season) does not show any significat variation. The results showed that there are 6 types of ornamental fish species found in two kinds of bio-FADs which spread in different habitats and seasons. Shannon-Wienner diversity index (H') in three habitats and the four seasons showed a relatively moderate value. The result of ANOSIM statistic test showed that the abundance of ornamental fish caught in three different habitats (spatially) was significant (R = 0.268; p = 0.028), as for the abundance level of ornamental fish in different season (temporary) also showed a significant different (R = 0.110, p = 0.001). The main species (identifier) of ornamental fish based on habitat and season is the Gobiidae family. SIMPER analysis showed that Gobiidae family contributed to 55.16% in estuary habitat (E) and 95.02% during transition season-2 (TS-2).

Suggestions. Bio-FADs deployed in the estuary habitat and operated during Transitional season 2 (TS-2) should be developed if the aim is to collect the juvenile of ornamental fish from the Gobiidae family. Furthermore, to maintain the sustainability of Gobiidae fish, it is highly recommended to preserve the habitat of the estuary (mangrove).

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