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Catching flying fish (*Hirundichthys oxycephalus*) in the central Makassar Strait fishing ground using drifting gillnet

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Abstract. Catching flying fish (*Hirundichthys oxycephalus*) in the central of Makassar Strait using drifting gillnet with a mesh size of 2.54 and 3.18 cm was carried out in west and east season. Drifting gillnets with mesh size of 2.54 cm and 3.18 cm caught *H. oxycephalus* with a number of catches that varied every month throughout the season. The objective of this study was to compare CPUE rates of two different mesh size of gillnet and to describe the sea surface temperature conditions at the fishing ground locations. We conducted this research during east season (April-June). The study used satellite SST data combined with experimental fishing by operating one experimental unit of drifting gillnets with mesh size of 2.54 cm and 3.18 cm in the fishing area for 30 fishing trips. CPUE (kg hauling⁻¹) was the amount of catch per hauling. The difference in catch between the mesh size of 2.54 and 3.18 cm was assessed by t-test analysis using SPSS software package. The results showed that CPUEs per piece of gillnets with the mesh size of 2.54 cm were ranged from 0.23 to 2.90 kg hauling⁻¹ with 1.38 kg hauling⁻¹ on average, while the CPUEs for the mesh size of 3.18 cm were ranged from 0.47 to 8.93 kg, with 3.28 kg hauling⁻¹ on average. The t-test showed that mesh size of 3.18 cm was significantly different from the mesh size of 2.54 cm. CPUE of drifting gillnets with the mesh size of 3.18 cm higher than the mesh size of 2.54 cm and occupied the potential fishing grounds with relatively warmer SST of 29-31°C. This suggests that the gillnet mesh size of 3.18 cm is better than the other size for catching flying fish within the potential fishing grounds during April-June.

1. Introduction

Hirundichthys oxycephalus is an important drifting gillnet's fish in West Sulawesi with a unique characteristic of having relatively long pectoral fins, allowing them to fly at the sea surface. This fish has important economic value not only as an edible fish, but it also produces eggs whose prices are much higher than the selling price of the fish [1,2]. Therefore, *H. oxycephalus* became one of the main fishery export commodities in West Sulawesi due to its eggs.

The capture of *H. oxycephalus* in the central part of the Makassar Strait commonly using drifting gillnet with a mesh size of 2.54 and 3.18 cm where the fishing activity are very intensive throughout the year [1]. A fishing activity using drifting gillnet 2.54 cm of mesh size cause the net also capture the immature small size of *H. oxycephalus* which not spawn yet, thus the fish production will decline due to overfishing. The level of utilization of this commodity is categorized as full to over-exploited with the CPUE indicator [2].



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CPUE is the number of catches per fishing effort [3,4], while [5] suggested that for gillnet fishing, CPUE is the number of catches in kilograms captured per set of gillnets. CPUE gillnets is an unclear fish density index. In many studies, a positive relationship but non-linear between gillnet CPUE and estimates of fish density have been found that indicate a decrease in catch-ability with the increasing of fish density [6,7]. In addition, the temperature seems to be important variable in determining CPUE [6].

Some researchers used CPUE to assess resource abundance in lakes [8] and level of exploitation as stated by [9] that high CPUE values and low catches will reflect the resources of the commodity is still under-exploited, whereas high CPUE values and high catch reflects the commodity have been fully exploited. Meanwhile, if CPUE decreases but catches are still high reflecting restructuring of the fish population and if both CPUE value and catches decreases, it reflects the degree of over-exploitation. While [10] stated that gillnet CPUE can be used as a rough index of relative abundance in lakes. In this study, however, the CPUE was used to assess the capture ability of a drifting gillnet based on the size of the mesh.

One of the main problems for catching flying fish in the study area is the uncertainty of the effective mesh size as well as the preferred sea surface temperature (SST) conditions at the fishing ground. Hence, the purpose of this study was to compare the value of CPUE between drifting gillnets with mesh size of 2.54 cm and the mesh size of 3.18 cm and to describe the sea surface temperature at the fishing ground locations.

2. Materials and methods

This research was conducted using experimental fishing methods, namely one experimental unit of drifting gillnet with the mesh size of 2.54 cm and 3.18 cm, which was operated in a fishing area of 30 trips in April-June 2017. We combined the field data and satellite SST data to assess the preferred surface temperature at the fishing locations. The choice of the fishing ground was carried out in 1 area in the center of Makassar Strait. The main variables observed were *H. oxycephalus* weight captured on each mesh size of the tested gillnets as well as the length of the variable catch of *H. oxycephalus*. The difference in catchweight for each mesh size of gillnets was assessed by t-test analysis through the SPSS program. In analyzing Catch Per Unit Effort (CPUE), the catch data was used (kg) and the amount of effort (hauling) is the catch per unit effort [3,4]:

$$CPUE = C/f$$

Where:

C = catches (kg)

f = effort (hauling)

Somba is a fishing base of this research is the capital of Sendana Subdistrict, one of the coastal sub-districts in Majene Regency, West Sulawesi Province, which is located at coordinates 03° 22' 51.8" S and 118° 50' 47.8" E. The fishing area of drifting gillnets for the capture of *H. oxycephalus* is in the central of Makassar Strait, in areas with coordinates of 2° 57' 50.40" - 3° 53' 45.60" S and 118° 7' 4.8" - 118° 46' 19.20" E as shown in figure 1.

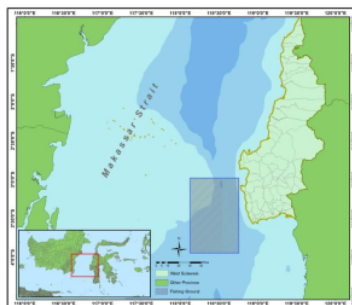


Figure 1. Fishing area of drifting gillnet in the central of Makassar Strait

The design of drifting gillnet which was operated in the trial of fishing *H. oxycephalus* has the mesh size of 2.54 cm with specifications and designs as shown in figure 2. We used the same specifications and designs for the gillnet mesh size of 3.18 cm.

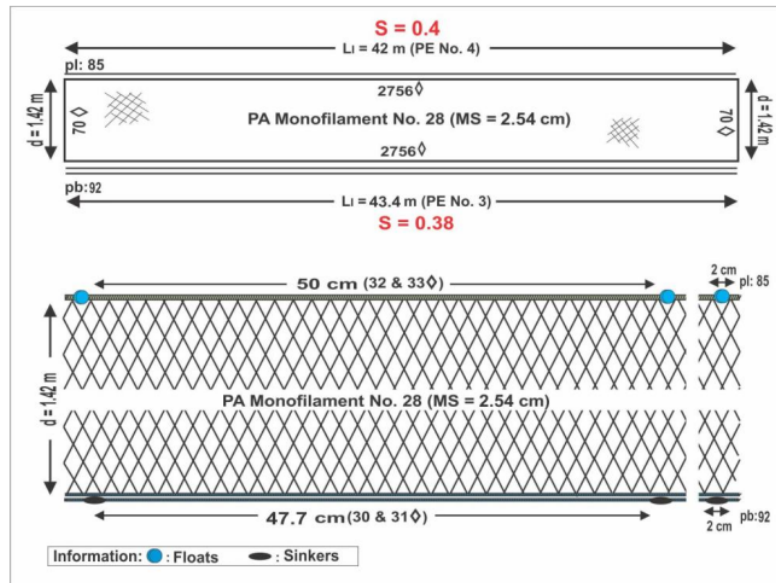


Figure 2. The drifting gillnet design of mesh size 2.54 cm was tested

3. Results and discussion

The weight of the catches per hauling (CPUEs) of gillnet of mesh size 2.54 cm and 3.18 cm were in the range of 0.17-2.9 kg hauling⁻¹ and 0.47-8.93 kg hauling⁻¹ respectively with an average of 0.9489 kg hauling⁻¹ and 3.1123 kg hauling⁻¹. Figure 3 shows the comparison of the CPUE based on the mesh size. The results of the t-test analysis found that the mesh size had a significant effect on the weight of the catch (CPUE). The t-test also showed a significant difference between the catch weight of the mesh size of 3.18 cm with the mesh size of 2.54 cm. The fishing effort of the gillnet was indicated by hauling (trip), one trip was equal to one hauling.

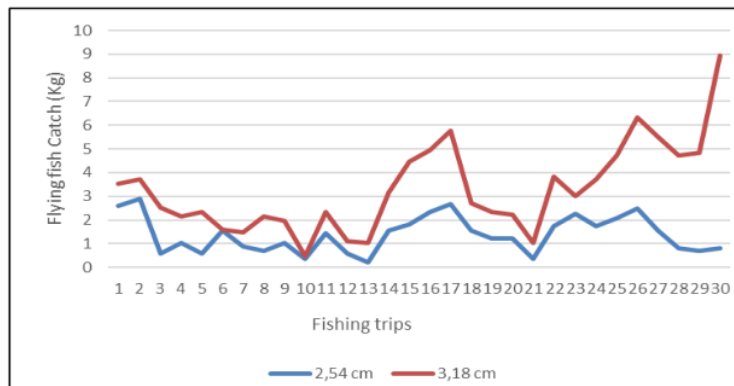


Figure 3. The Comparison of the flying fish weight of the catch (kg) in mesh size of 2.54 cm and 3.18 cm for all trips.

The average of flying fish CPUE (kg hauling⁻¹) in Figure 4 for mesh size of drifting gillnet 3.18 cm was 3.11 kg hauling⁻¹. It was greater than mesh size of 2.54 with the CPUE respectively of 0.95 kg hauling⁻¹. It was clearly showed that the CPUE of the gillnet mesh size of 3.18cm was significantly higher than that of 2.54cm.

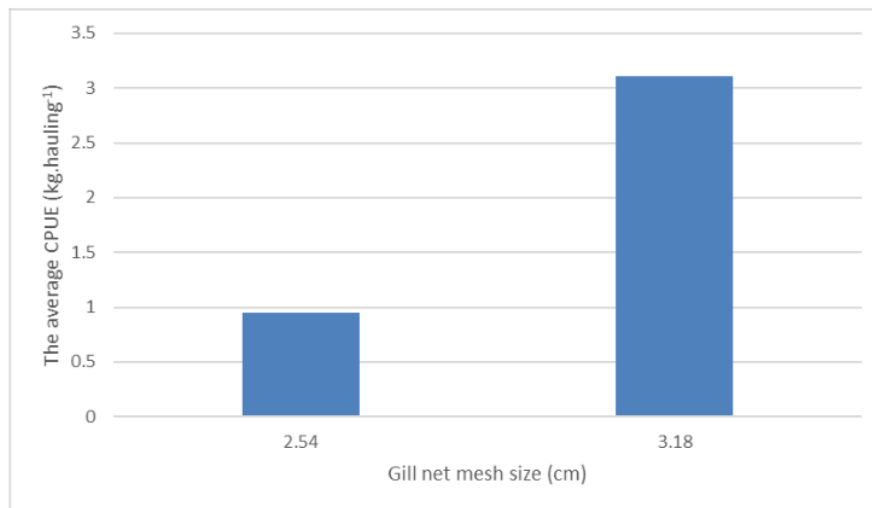


Figure 4. Flying fish CPUE (kg hauling⁻¹) rates of mesh size of 2.54 cm and 3.18 cm

The highest Flying fish CPUEs concentrated in areas (118°20'-118°40' E and 3°20' -3°40; S) of relatively warm SST in April (30-31.5°C) (Figure 5). In May, the fish occupied the waters of relatively lower SST of 29.5-30.5°C in the same area than the previous month. In June, the fish CPUEs tended to increase again and spread widely by both longitude and latitude.

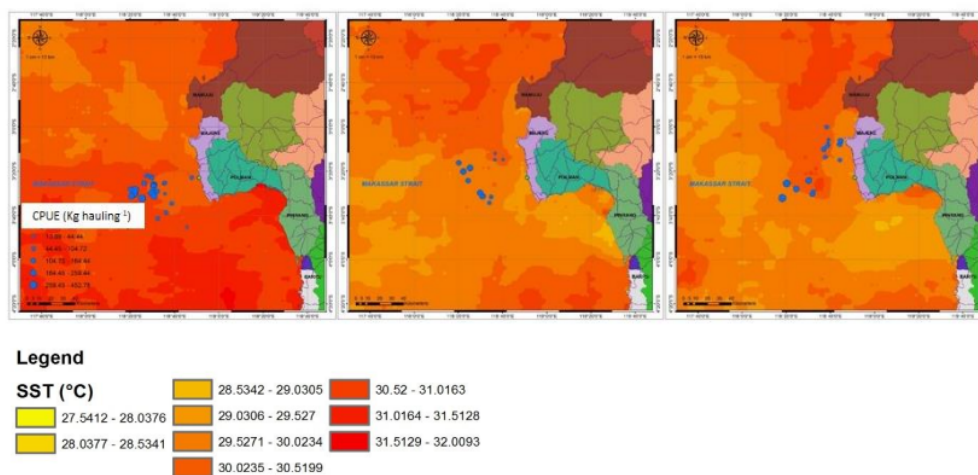


Figure 5. Distribution of flying fish fishing grounds denoted as blue dots for April-June overlain on SST images.

Flying fish captured by drifting gillnets during the study were dominated by *H. oxycephalus* as the target of this study. A similar finding was stated by [11] in waters of Ambon Maluku Province. [12] stated that one species flying fish that are predominantly associated with Kuroshio currents in the South China Sea is *H. oxycephalus*. Besides, [13,14] who also found that species of *H. oxycephalus* dominating gill net of catching fish in the waters of Kaimana and Fak-Fak.

The average weight of catch per trip for the mesh size of 3.18 cm was 3.11 kg larger than the catch for the mesh size of 2.54 cm which was only 0.95 kg. The result was different from [15] in Barbados who obtained the highest average catch occurring in net mesh size of 3.81 cm for flying fish, *H. affinis*.

CPUE value (kg. Hauling⁻¹) per piece of drifting gillnets 42 m in length and 1.42 m net height with mesh size of 3.18 cm was greater than the mesh size of 2.54 cm (figure 4). The results of t-test showed a significant difference between the two mesh sizes. The CPUE value of drifting gillnets with mesh size of 3.18 cm was also still greater than CPUE value for flying fish fishermen in the northwest coast of Sri Lanka who used gillnets with mesh size of 3.4 cm [16].

CPUE value of drifting gillnets with a mesh size of 3.18 cm was also greater than CPUE value gillnet for *Labeo rosae* captured at Flag Boshielo dam, Limpopo Province, South Africa at 0.9 ± 0.1 kg.100 m-net¹.hr⁻¹ [17]; while CPUE value of gillnets for swordfish (*Xiphias gladius*) in Aegean Turkey with an average of 56.3 ± 10.2 kg. km⁻¹ [18]; drifting gillnets for tuna PA multifilament 210D / 30 mesh size of 14.5 cm for *Scomberomorus commerson*, *Euthynnus affinis*, *Scomberoides commersonnianus*, *Rachycentron canadum*, *Carcharhinus pleurotaenia* and *Sphyrna jello* with CPUE ranging from 0.03 - 2.99 kg.net⁻¹, except for *Thunnus tonggol* (Long tail tuna) with CPUE value of 5.18 kg.net⁻¹ [19]. The differences in CPUE values mentioned above were in line with those proposed by [20] that the factors affecting the relationship between CPUE of gillnet and fish density including species and size distribution, characteristics of fishing gear, sample habitat, environmental conditions, fish density, and behavior.

Considering the environmental condition, the highest CPUEs occurred in areas of the warm SST. It reflects that the flying fish associated with warm SST where that could probably stimulate a good feeding opportunity for the fish [6][12]. Therefore, our findings suggest the fishing activity in the study area should use gillnet mesh size of 3.18 cm and operate the fishing gear within the warm SST as a better-flying fish habitat.

4. Conclusion

CPUE of drifting gillnets with the mesh size of 3.18 cm higher than the mesh size of 2.54 cm. The highest-flying fish CPUE occupied relatively warm SST.

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