THE IMPLEMENTATION OF THE RGB LAMP SPECTRUM ON THE FISH BEHAVIOR IN THE LIFT-NET FISHERY

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Abstract. The use of lamp in the lift net is the success determinant in fishing. The RGB (red, green, blue) light, with the control system based on Arduino Uno microcontroller, is able to produce the PWM (Pulse Width Modulation) value in adjusting the light intensity. The produced light intensity can be used to lure the target fish to the lift net. The aim to implement the RGB light is to find out the movement, density changes, and the fish behavior, to the changes of light colors and the different PWM value. The observation method and acoustic descriptor use Scientific Echo Sounder SIMRAD EK15, with the statistical test of the RGB lamp implementation conducted in the lift net with the initial condition of 250 OWM, until 5 PWM with the minimum energy limit of 3E-008 watt/m^2. The difference of the PWM value and the color spectrum, from blue to green (250-0 PWM), influence the fish existence particularly on the color spectrum of the blue-green light, the fish density is the highest, forms the fish herd up to 495 fish/m^3; the fish herd is in the depth of 6.7±1.9 m, and the fish uniformity test is in the acoustic area. The certain PWM value will influence the fish behavior of approaching the light; the uniformity test shows that the detected fish do not exceed the UCL (Upper Control Limit) and LCL (Lower Control Limit). The length of fish, averagely (FL±std) 13.49±3.09, for the group of small pelagic fish such as selar fish (Selaroides leptolepis), squid (Loligo sp), flying fish (Decapterus), and mackerel (Rastrelliger). The uniformity test on the data shows the uniformity of the fish sizes on every treatment. This is supported by the obtained catch with the obtained density average value (Dens±std) 1.045±0.64 f/m^3. This research proves that the changes of light color from blue to green smoothly can keep the fish behavior, whereas the fish are not surprised and remain in the catchable area.

***Keywords* :** RGB Lamp, Microcontroller, acoustic, PWM, Lift-net.

INTRODUCTION

The lamplight in the lift-net fishery is the success factor in fishing. The lift net is operated at night, and need lamplight to attract the fish (Waluda, *et al.* 2004; Cahyadi and You 2017). The types of lamplight used by the lift-net fishermen are neon (Sudirman, *et al.* 2013) and LED (Light Emitting Diode) (susanto, *et al.* 2018; Yadudin, *et al*. 2018; Satriawan, *et al*. 2017) as the attractants (Arif, *et al.* 2015). By adjusting the certain intensity of the LED lamplight, it can allow the fish to approach the light source (Lopez-Lopez, *et al.* 2017; Sukardi, *et al.* 2017). The lamp use in the lift net is not only by one light color, but more than one light color, and adjusting the intensity, can attract the fish to get closer. The changes of the light color and intensity accepted by the fish eyes will change the fish behavior movement (Smithers, *et al*. 2018; Balaban *and* Alcicek. 2015).

The technology used by the lift-net fishermen to control the lamplight intensity is by the dimmer (Taufiq, *et al*. 2015). Dimmer is the electronic equipment to control the light intensity, however it still creates trouble for the fishermen; one of which is when controlling the light intensity which are irregular and non-continuous. Therefore it requires a kind of light intensity controller technology which is able to adjust the very regular light intensity with the PWM value adjustment (Karsid, *et al.* 2018). There have been many technologies to control an electronic, developed and utilized in researches and industries. According to Docekal *and* Golembiovsky (2018), a controller has already included the circuit board and Arduino microcontroller. An electronic system control device can be made automatically, resulting in the regular changes in energy (Philips, *et al*., 2018). The controller modification for electronic circuit must be adjusted to the needs, capabilities, and ease of use. The HPL (High Power LED) type of the RGB lamp with the manipulation system of PWM value can solve the problem above. The use of the LED in the lift-net fishery, with the HPL of 50 Watt, the green colour has the light intensity of 142 Lux at 0.20 Ampere; and with the HPL of 50 Watt, the blue colour has the light intensity of 86 Lux at 0.20 Ampere (Sumardi 2018).

The Arduino Uno microcontroller is a digital electronic device which has the input and output with a computer command program inside the chip which is used to control electronic equipment (Oktafianto, *et al*. 2015; Fatehnia, *et al*. 2016; Hendri, 2017). According to Roman and Hensen (2018), that using microcontroller is built to control the electronic equipment operation. The RGB lamp by inserted with the digital analogue program technic of Arduino microcontroller to eject the PWM value, thus it shows the system capability (Lee, *et al.* 2018; Singh, *et al*. 2018; Hung, *et al*. 2011). The Arduino-microcontroller-based RGB lamp provides the light intensity control system development with the PWM value manipulation command to increase the light intensity use.

The RGB lamp implementation which is based on the Arduino Uno microcontroller, with the PWM value manipulation system, thus it can produce the light intensity which is in uniform when operated in the lift net. The RGB light while fishing in the lift-net directly occurs the movement of the fish approaching the light because they like the light colour intensity (Purbayanto, *et al*. 2010). The interaction process of the fish behavior with the RGB lamplight, with different intensity values, is something that needs to be known in the process of attracting the fish movement to the RGB lamp. Hopefully there is no problem in determining the light intensity value that is needed for the fishing activity.

The observation method and acoustic descriptor method are used to find out the fish behavior movement around the RGB lamplight. The hydro-acoustic is a capable underwater detection method to assume the fish stock (Achmadi, *et al.*, 2014). The assistance of the acoustic transducer tools of the Single Beam type (Beamish *and* Rothschild 2009). The single beam hydro-acoustic can distinguish objects such as fish, seaweed, and the bottom of the waters, by developing the algorithm value (Manik, *et al*. 2014; 2015; 2017). The latest Hydro-acoustic Single Beam is the Scientific Echo-sounder SIMRAD EK15. This tool uses the frequency of 200 kHz. In real time, it does not damage or even disturb the studied objects.

Based on the previous research (Sulaiman, *et al*. 2015b), when the light changes from blue to green, the fish behaviour suddenly changes; that there are some fish that are shocked and stay away in the catchable area. This research proves that the light color which softly changes from blue to green can keep the fish behavior in the catchable area.

This study aims to analyze the movement and changes of the fish density to the light colour change and the PWM values in the lift net. As a benefit, this research can propose the making of automatic lamp with the subtle changes of the blue-green light for the fishermen of the lift-net fishery to the local government.

MATERIALS AND METHODS

The lab research was started on July 2017 until August 2018. The field research as the on-site tool implementation was done on September 2018, and located in the waters of Bokor Island, the administrative region of Kepulauan Seribu Regency, Capital City Special Region of Jakarta (D. K. I. Jakarta) (Figure-1).

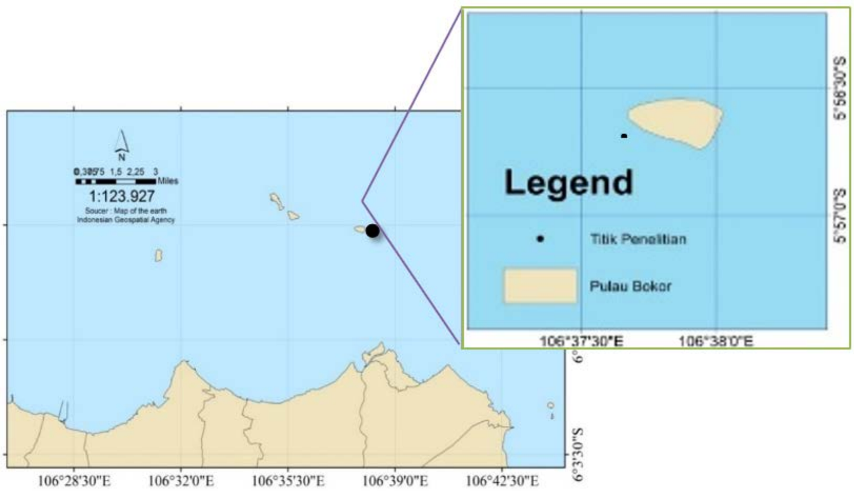

Figure 1. Research Map

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Data Collection and Technic

The data collection uses the latest single beam hydro-acoustic, the Scientific Echo-sounder SIMRAD EK15, Radian meter, and lift net, with the main material consists of the *nibung* tree trunk, with the width of the lift net is 12 x 12 m^2, with the waters depth of 21 m.

Figure 2. The lift net used for the research

The result is the acoustic descriptor data of each treatment which has been designed previously. The data used in the research comes from that data, which is later reduced to be value and other information. The data required in this research such as the required time to collect the fish, fish existence, and their behaviour, size, type, and the fish density. The acoustic data collection is recorded by the single beam transducer instrument, the Scientific Echo-sounder SIMRAD EK 15, which is installed in the middle spot in the lift net. The recording of the acoustic data is done overnight.

For the first time, the acoustic descriptor was introduced by Rose and Leggett (1988); it could describe the character of the acoustic reflection. Furthermore, Lawson, *et al.* (2001), successfully identified the pelagic fish species using the acoustic descriptor with the identification accurate reaching at 88.3%. The acoustic descriptor involves the Morphometric, Bathymetric, and Energetic. The morphometric describes the shape and size of the fish schooling in the waters column. The energetic is the sound intensity energy which hits the fish schooling (back-scattering strength volume). The bathymetric describes the fish schooling position in the waters column. The shape of the fish schooling is oval or elliptical (Fauziyah, *et al.*, 2010).

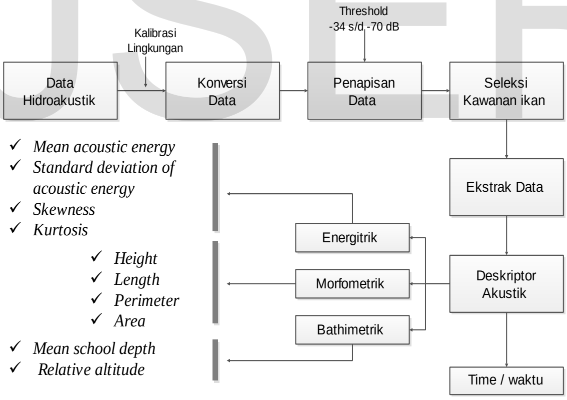


Figure 3. The Process of the hydro-acoustic data

This research uses electronic device, the RGB lamp control system installation process is done, in order to control the PWM value. The performed instrumentation, after finishing the test by watching the current source needs, voltage, and energy, and also the program inside the Arduino Uno microcontroller. This is to prove that the RGB lamp control system which uses the Arduino Uno microcontroller works as well as its function, and the electronic component durability inside the RGB lamp control system works well (Sumardi, *et al*. 2018). The electronic component in the RGB lamp and control system can be seen on Figure-4.

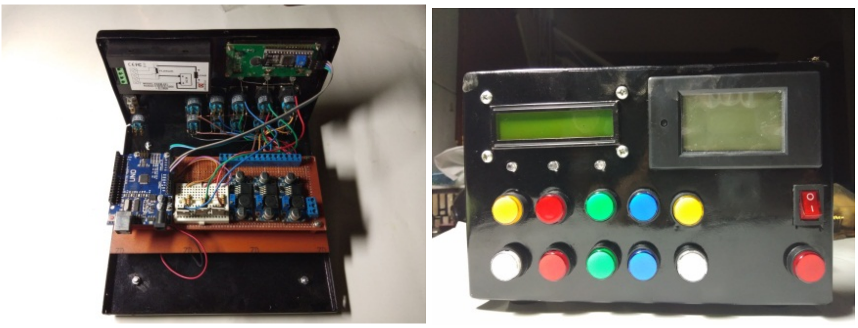


Figure 4. The PWM Value Control System and RGB (*Red*, *Green and Blue*) Lamp

Method of RGB lamplight intensity measurement

The light intensity measurement is done to find out the light distribution in the water medium, and is done when operating the lift net. The light distribution measurement method in the water is suitable with the one that was done by the previous research (Susanto, *et al.* 2017; Kairul, 2017). The used tool is radian meter with Watt/m^2 unit.

Statistical Analysis of Uniformity Test

The uniformity test is done to see whether the data is uniform between one and the other in one given treatment group. Some terms used in the uniformity analysis are the UCL (Upper Control Limit) and the LCL (Lower Control Limit) (Heizer *and* Render, 2006).

$$UCL = p + 3\frac{\sqrt{p(1-p)}}{n}$$

$$LCL = p - 3\frac{\sqrt{p(1-p)}}{n}$$

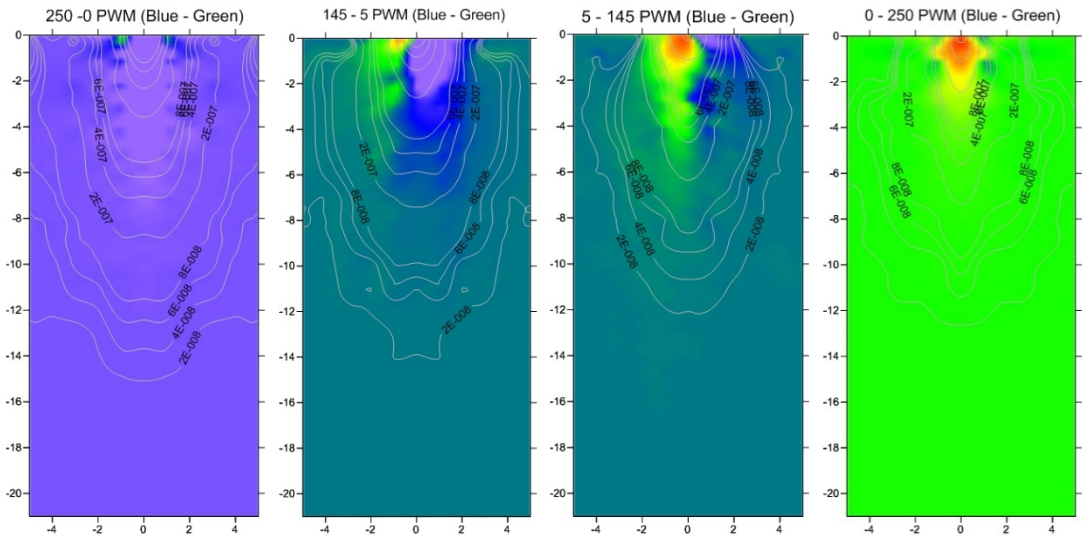
As for the analysis results, if there is data that exceeds the UCL or LCL, then it is not considered as uniform. If the data is within the UCL and LCL, then the sample is considered uniform.

RESULTS AND DISCUSSION

The results shown are the light distribution data of the seawater medium, and the hydro-acoustic data analysis results from the on-site data collection. By the order of the on-site result, the finding out the light distribution on the water medium, and discussing the analysis result of the hydro-acoustic data using the SIMRAD EK 15.

RGB lamplight distribution in seawater medium

The results of the RGB lamplight distribution measurement in seawater medium are shown vertically (from the surface to the bottom of the sea). The result of the RGB lamplight distribution with the different colours and PWM values are shown on Figure-5.



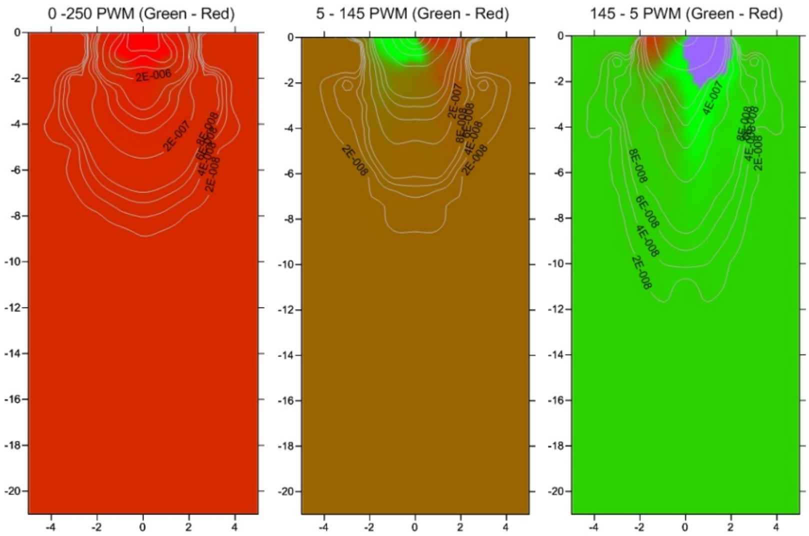


Figure 5. The distribution of the RGB light in seawater medium

The value of 250 PWM on the RGB LED, which produces the blue colour, shows a wide light characteristic with the depth of 15 m, while an energy value is still obtained at 2E-008 Watt/m^2. If the light colours of blue and green are combined with the PWM value composition of blue is 145 and green is 5, it produces the light distribution until the depth of 14 m, and gains the energy value of 2E-008 Watt/m2; if the three blur light colours are decreased again, and the green light colour is increased to be blue at 5 and green at 145 PWM, then the light distribution will reach the depth of 12 m. There is a difference from the two different PWM values combination that is the difference of the 2-m depth. The fully green light colour with the value of 250 PWM produces the light distribution up to 12-m depth, and still gains the energy of 2E-008 Watt/m^2. The difference of the 250 PWM values of the green and blue colours is the 2-m depth difference and the different distribution shape. The results of the blue and green colour difference can be seen on the light distribution modelling in the seawater medium in Figure-5. The light passing the water medium in the area of lift net experiences energy decreasing; the more the depth, the less the detected energy by the radian meter. This in accordance with (Puspito, *et al.*, 2015) that the lamp illumination value decreases as the waters depth increases.

Data uniformity of fish existence time

The results of the data uniformity of the fish existence time can be seen on Figure-6 below:

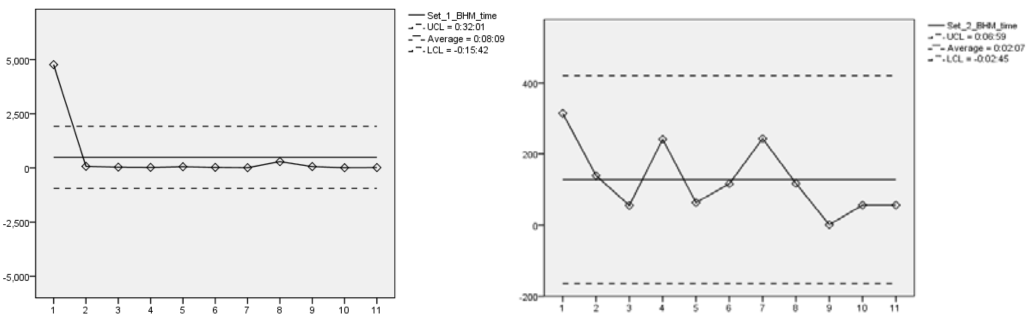


Figure 6. The test results of the data uniformity of the fish existence time

The variable of time is one matter to be calculated in the process of fishing in the lift net. The use of the RGB lamp with certain PWM value will influence the fish behaviour when they approaching the lamp. The change of light colour, the combination of two lamp colours, and the change of PWM value, softly has been done in this research. In the condition when all lamps are turned on, it needs such a relatively long time to collect the fish for the first time, due to the adjustment needed by the fish in order to adapt to the environment and the catching tool setting. In the beginning phase, the required time to collect the fish is relatively longer and varied, depends on the treatment and the environment condition.

The data analysis used to see the treatment influence of the intensity parameter to the fish existence, is started on the first transition phase until the time of hauling. The treatment results on the process of the Setting 1-2 (RGB) is obtained that the fish do not experience significant movement or do not get away from the research area, which is proven by the uniformity test result on each parameter that the fish are relatively detected continually from the acoustic observation results. The results of the uniformity test can be seen on Figure-16 in which the obtained values do not exceed the UCL and the LCL.

The fish time average can be detected by the hydro-acoustic tool which is on every (x±std) 1.04±0.03 minutes, with that values and also from the uniformity test results show that the fish do not leave the research area, and relatively continually in the range of hydro-acoustic wipe; in other words, the treatment given to each fish existence is not actually influenced

Fish existence and their behaviours

Figure-7 below are the results of the setting/treatments which have been done in order of setting 1 (RGB) and 2 (RGB).

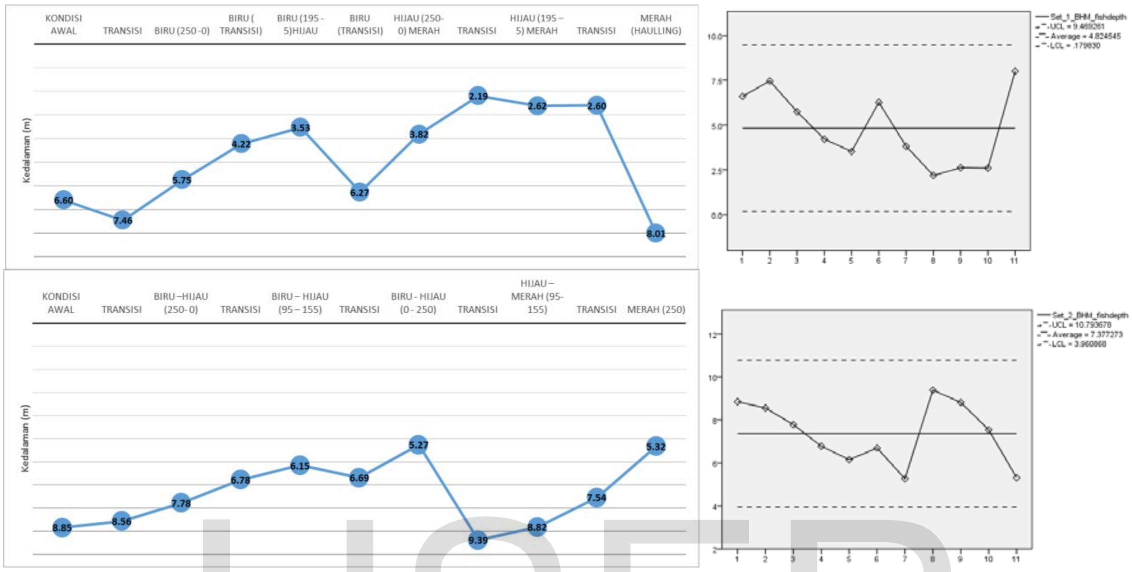


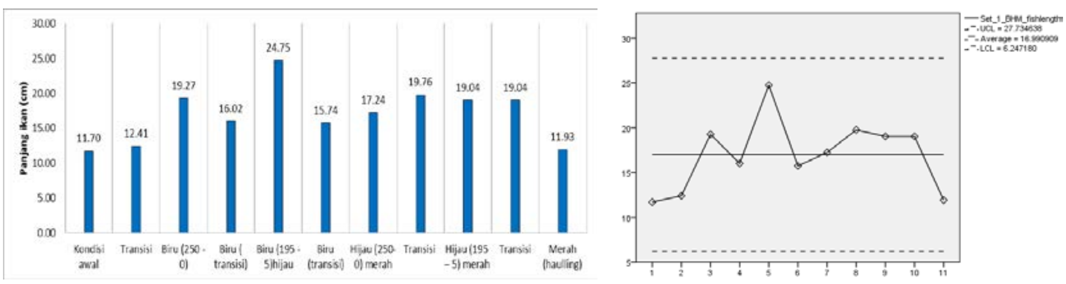
Figure 7. The fish existence and their vertical movement (left), and the uniformity rest Results (right)

Fish are basically the animals which have high mobility for some kinds of the pelagic. Based on their characteristic and behaviour, the pelagic fish form herd in the waters; some herd have spaces between fish which are close enough, and some have space which are tenuous enough. The pelagic fish are the group of fish which are sensitive enough of disturbance or the environmental changes. The pelagic fish commonly have the positive phototaxis ability to the light response. (Thenu, *et al.* 2013; Gustaman and Isnaini, 2012; Rosyidah, *et al.* 2009; Sulaiman, *et al.*, 2015; Susanto and Hermawan, 2013), thus some catching efforts using lamp as the attractor media of fishing.

The lift net (Gustaman and Isnaini, 2012; Sulaiman, *et al*., 2015) is one fish-catching tool which uses lamp/light as the fish attractor. The use of light intensity in the waters influence very much in collecting fish in the lift net, therefore the utilization and operational process become the most important factor. The sudden change of light intensity will cause the fish to get away as their behaviour response. The depth of the fish herd on average result of the acoustic observation of all given treatments show the average depth of the fish herd is in the depth of (x±std) 6.7±1.9 m, with the movement variation vertically or horizontally. It can be seen from the results that the fish are in the relative similar depth position and the insignificant movement, which is proven from the conducted uniformity test results. Based on the uniformity test results, the fish are commonly in the similar depth range, and tend to be in the acoustic area. In other words, it can be concluded that the fish do not respond to any given treatments.

Size and Type of fish

Figure 18 is a result of the setting/treatment that has been done in the order of setting 1 (blue- green-red) and setting 2 (blue-green-red).



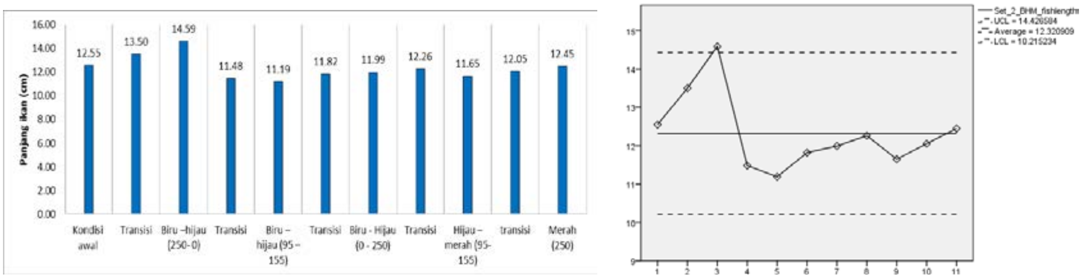


Figure 8. The length of fish from acoustic observation (left) and uniformity test results (right)

The length of the fish as the result of the acoustic analysis of the treatment given shows that the length of the fish in the waters in the area of the chart has an average length (FL ± std) of 13.49 ± 3.09 cm. Based on the range of the length detected, it is predicted that there are many small pelagic fish groups such as selar, kite and bloating. Based on the result of uniformity test on the data obtained, the uniformity of the fish size in each treatment is obtained. These results indicate that most fish detected is the same type and in the same size, so it seems that the fish does not respond to the treatment given. Differences in the size at the end and at the beginning of the operation of the fishing gear are due to the presence of fast swimmer groups such as barracuda and scavengers entering the research area to eat food. This is supported by the catches obtained.

Small pelagic fish will generally have a positive phototoxic response to light, even some small groups of pelagic fish move in the direction of light. This is suspected because food sources such as plankton whose life cycle requires light to meet their needs, where the food source of pelagic fish is plankton.

Fish density

Respectively, the image shows the result of the setting/treatment that has been carried out in the order of setting 1 (blue-green-red) and setting 2 (blue-green-red).

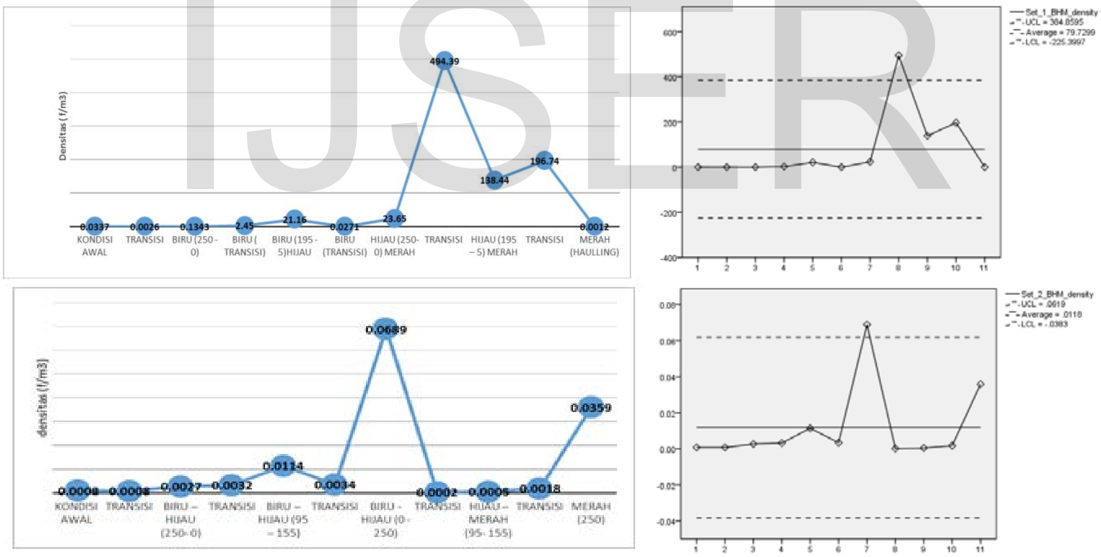


Figure 9. Fish density in the waters as a result of acoustic data analysis

Fish density is the amount of fish in waters. The density produced is proportional to the number of fish forming herd in the waters, the larger the fish herd formed the density of the fish the unity of the volume produced will be even greater. The density in this study is written in units of fish/meter^3 or f/m3. The result shows that there are several densities experiencing considerable fluctuations in some treatments given. The treatment of changing color of the lamp and the intensity given affect the presence of fish, especially in spectrum of blue-green light color, in which it has an attraction of collecting fish in stacks with the highest density of fish reached 495 f/m3, based on the two experiments on the blue-green spectrum that had significant effect to form a fish herd.

The result of experiment by reducing the intensity of light in RGB light spectrum shows that the calculated fish density has the same value based on the results of the uniformity test of density values obtained with an average density (dens ± std) 1.045 ± 0.64 f/m3. From the results of this test describes that the fish herd when the experiment is conducted is the same fish. In other words, fish do not move/run away from the research area.

CONCLUSION

Arduino Uno microcontroller is the main component in implementing RGB lamp spectrum on fish behavior in fisheries. RGB light control produces seven models of light distribution with different color spectra and PWM values. Acoustic parameter indicates that the movement of fish herds at an average depth of 6.7 ± 1.9 m, with variations in vertical movement. The size of fish in the lighting area has a mean length (FL ± std) of 13.49 ± 3.09 m. Fish density in the blue-green light spectrum has an attraction in collecting fish with the highest fish density reaching 495 f/m^{-3}.

In the initial phase, the duration used to collect fish is quite long, while the analysis uses acoustic descriptor method. To implement RGB light control system and its effect on fish behavior to get closer to light source, statistical analysis has been carried out using uniformity test.

Sudirman (2015) has assumed that sudden changes in light will result in a group of fish became shocked and came out of the catchable area. This research proves that subtle color changes in light can keep a group of fish, where the fish are not surprised and remain in the catchable area.

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