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EFFECTIVENESS OF UNDERWATER DIP LAMPS (LACUDA) AND CONVENTIONAL LED LAMPS IN CENTRAL BANGKA WATERS

EFEKTIVITAS LAMPU CELUP BAWAH AIR (LACUDA) DAN LAMPU LED KONVENSIONAL DI PERAIRAN BANGKA TENGAH

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ABSTRACT

The development of auxiliary fishing device technology for lift nets has progressed rapidly, particularly in the use of underwater dip lamps (LACUDA) and conventional LED lights. Variations in light type, color, and lamp operating methods influence catch quantity, composition, and productivity. This study aims to compare the fishing performance of fixed lift nets using 750-watt green underwater dip lamps (LACUDA) and 600-watt white conventional LED lights. Field research was conducted in October–November 2024 across six fishing trips with 18 hauls. Data collected consisting of catch productivity and composition were analyzed using descriptive statistics and the Mann–Whitney U-test. Results showed that the productivity of fixed lift nets using underwater dip lamps (LACUDA) reached 10.07, higher than 8.34 from conventional LED lights. The total catch weight of LACUDA was 181.3 kg, compared to 150.1 kg for conventional LEDs. Moreover, catch composition under LACUDA lighting was more diverse, comprising five species—smoothbelly sardinella (*Amblygaster leiogaster*), Bangka squid (*Uroteuthis chinensis*), doublespotted queenfish (*Scomberoides lysan*), yellowstripe scad (*Selaroides leptolepis*), and anchovy (*Stolephorus indicus*). In contrast, conventional LED catches included only four species, lacking anchovy. These findings demonstrate that underwater dip lamps (LACUDA) enhance both catch productivity and species diversity compared to conventional LED lights in fixed lift net operations.

Keywords: catch composition, catch productivity, comparison of the total catch, conventional LED lights, underwater dipping lamp (LACUDA)

ABSTRAK

Perkembangan teknologi alat bantu penangkapan ikan pada bagan telah berlangsung cukup pesat, khususnya penggunaan lampu celup bawah air (LACUDA) dan lampu LED konvensional. Variasi jenis, warna, dan metode pengoperasian lampu berpengaruh terhadap jumlah, komposisi, serta produktivitas hasil tangkapan. Penelitian ini bertujuan membandingkan kinerja penangkapan bagan tancap yang menggunakan lampu celup bawah air (LACUDA) berdaya 750 watt berwarna hijau dengan lampu LED konvensional berdaya 600 watt berwarna putih. Penelitian lapangan dilaksanakan pada Oktober–November 2024 melalui enam trip penangkapan dengan total 18 kali pengangkatan. Data yang dikumpulkan meliputi produktivitas dan komposisi hasil tangkapan yang dianalisis secara deskriptif serta menggunakan uji Mann–Whitney U. Hasil penelitian menunjukkan bahwa produktivitas hasil tangkapan dengan lampu LACUDA sebesar 10,07, lebih tinggi dibandingkan lampu LED konvensional sebesar 8,34. Total hasil tangkapan menggunakan LACUDA mencapai 181,3 kg, sedangkan LED konvensional 150,1 kg. Komposisi hasil tangkapan LACUDA juga lebih beragam, terdiri atas lima spesies, yaitu ikan tamban (*Amblygaster leiogaster*), cumi bangka (*Uroteuthis chinensis*), lempis (*Scomberoides lysan*), ciu (*Selaroides leptolepis*), dan teri (*Stolephorus indicus*), sedangkan LED konvensional hanya terdiri atas empat spesies, tanpa teri. Temuan ini menunjukkan bahwa lampu celup bawah air (LACUDA) meningkatkan produktivitas tangkapan dan keragaman spesies dibandingkan dengan lampu LED konvensional dalam operasi bagan tancap.

Kata kunci: komposisi hasil tangkapan, lampu celup bawah air (LACUDA), lampu LED konvensional, perbandingan total hasil tangkapan, produktivitas hasil tangkapan

INTRODUCTION

Kulur Ilir Village is a village in Central Bangka Regency with great potential for its rich fishery resources. Geographically, Kulur Ilir Village directly borders the Karimata Strait, which is included in the Republic of Indonesia's Fisheries Management Area 711. Kulur Ilir waters directly border the Karimata Strait, which is known for its rich fish resources and high economic value (Permana *et al.* 2019). The capture fisheries sector is one of the leading sectors for the people of Kulur Ilir Village in obtaining economic income. Most people working on the coast of Kulur Ilir Village are fishermen. Fishermen in Kulur Ilir Village mostly use fishing gear in the form of squid fishing rods, fixed lift nets, and gillnets. The types of fishing gear used by Central Bangka fishermen include fixed lift nets, gillnets, trap nets, set nets, fishing lines, and drag nets (Rema *et al.* 2022).

A fixed lift net is a fishing gear widely used by fishermen in Central Bangka, especially those in Kulur Ilir Village. The fixed lift net is a fixed fishing gear that cannot be moved around in a body of water. Based on the Regulation of the Minister of Marine Affairs and Fisheries Number 36 of 2023 concerning the Placement of Fishing Gear and Auxiliary Fishing Devices in the Measured Fishing Zone and Fisheries Management Area of the Republic of Indonesia in Inland Waters, a fixed lift net is a static and fixed fishing gear that is classified as a lift net. The fixed lift net fishing gear operates at night until early morning using auxiliary fishing devices in the form of lights. The use of light serves to attract fish to the fixed lift net area. Fish caught by fixed lift net fishing gear are generally species with positive phototaxis properties. Positive phototaxis is the characteristic of fish that prefer bright and dim water conditions in groups to obtain food (Maskur *et al.* 2019).

Fishermen using fixed lift nets operating in the waters of Kulur Ilir Village are experiencing a decline in fish catches. Furthermore, fixed-net fishing gear has a short lifespan due to natural factors such as wood decay and the impact of waves at sea. This condition makes it difficult for fishermen to manage capital turnover due to suboptimal catch production. Lighting technology plays a crucial role in attracting fish and increasing catches. One aspect of fish biology that influences their attraction to food is their sense of sight. Optical factors such as light intensity, light refraction, light absorption, and the color spectrum of light play a significant role in influencing fish's vision during fishing operations using fixed-net fishing gear (Rosyidah *et al.* 2009).

The problem of declining catches from lift fixed net fishing gear is likely caused by two factors: the degraded condition of fishery resources, whether caused by environmental pollution or overfishing, and the use of less effective auxiliary fishing device technology. The development of auxiliary fishing device technology is an important factor in increasing the effectiveness and efficiency of fishermen's catches. Auxiliary fishing device technology commonly used in lift net fishing gear includes underwater dip lamps (LACUDA) and conventional LED lights. LACUDA and conventional LED lights have different specifications and operating methods. LACUDA has a green base lamp specification, and conventional LED lights have a white base lamp. Meanwhile, for the operating method, LACUDA is operated in the water column, and conventional LED lights are operated in the air on the upper component of the lift net. Based on the results of research conducted by Susanto *et al.* (2018), green-base lamps have a more optimal penetration performance compared to white-base lamps, which can affect the sharpness of fish vision. The method of operating the lights in the water column can minimize light absorption and avoid changing light reflections from the movement of the waves.

Based on this, research is needed to compare the effectiveness of underwater dip lamps (LACUDA) and conventional LED lamps in increasing productivity and catch composition. This study aims to analyze the differences in species composition, catch volume, and catch productivity between the two types of lamps. The results are expected to provide recommendations and evaluations in selecting lamps as a more effective auxiliary fishing device for lift net fishermen.

METHODS

Time and location

The research was conducted from October to November 2024. The research location was in the waters of Kulur Ilir Village, Lubuk Besar District, Central Bangka Regency, Bangka Belitung Islands

Province. This research was divided into three stages: the first stage was observation of the research location, the second stage was data collection, and the third stage was data processing and analysis. A map of the research location can be seen in Figure 1.

Equipment

The tools used in this study included a fixed lift net, a boat, scales, writing instruments, a mobile phone camera, computer, and an echosounder. The fixed lift net served as the research object. The boat served as a means of transportation to the research location, and the scales measured the weight of the fish caught per species. Writing instruments served as a data recorder. The mobile phone camera served to document the research in the field. Minitab software served as a non-parametric test tool in comparing results between treatments, and the echosounder served to detect the presence of fish and measure water depth.

Data collecting

Data collection in this study used experimental fishing. According to Hardani *et al.* (2020), experimental methods are quite effective for determining and identifying differences in treatment in a research activity, measurably and systematically. Data collection in the field used one unit of fixed lift net with two treatments using different auxiliary fishing devices in the form of conventional LED lights and LACUDA lights. Data collection in the field was carried out on six fishing trips, with each trip consisting of 3–4 hauls, or lifting of the fixed lift net, resulting in a total of 18 hauls. The implementation of each haul did not use a long interval of net immersion for each treatment but rather adjusted to the number of fish collected under the net.

The treatment of using conventional lights and LACUDA lights was carried out alternately on each trip. The use of conventional lights and LACUDA lights with an alternating pattern aims to ensure an optimal and controlled comparison of catch results. The first trip, or odd-numbered trip, began with the use of conventional lights followed by LACUDA light treatment, then on the second trip, or even-numbered trip, the treatment was reversed, starting with the use of LACUDA lights followed by conventional light treatment. This pattern continued alternately until the sixth trip.

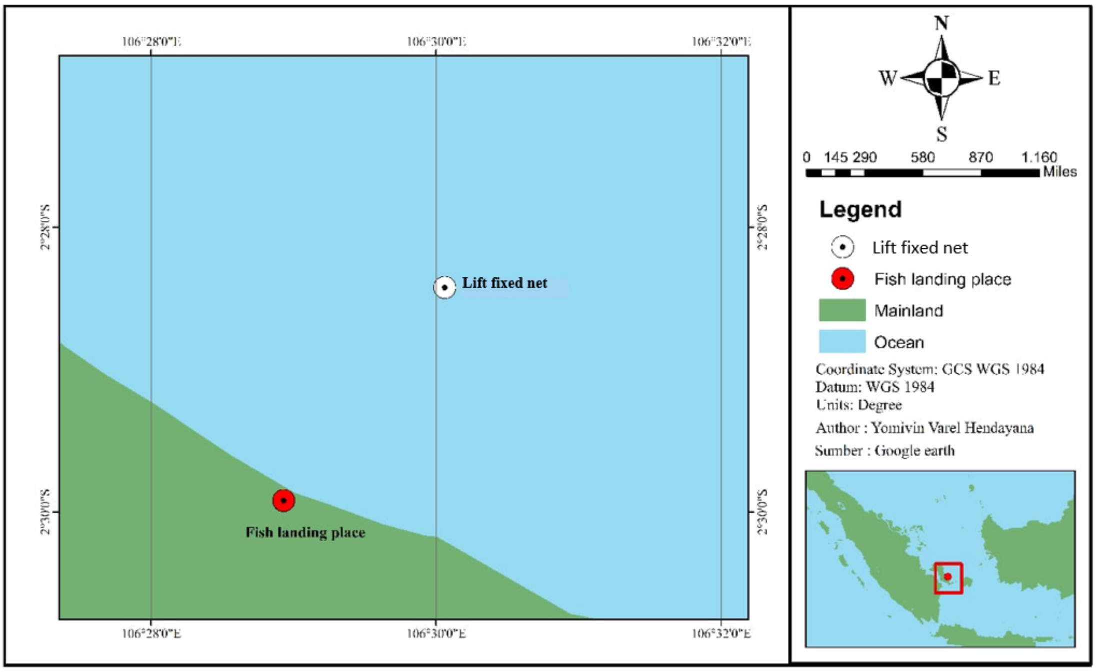

Figure 1. Map of research locations in the waters of Kulur Ilir Village, Central Bangka Regency.

Data Analysis

Productivity of catch

Catch productivity is the ability of a type of fishing gear to produce a catch over a specific period. The catch productivity value can measure the effectiveness of fishing activities in a given body of water. According to Nelwan *et al.* (2016), catch productivity (kg/haul) can be determined using the following formula:

$$Productivity = \frac{C}{F}$$

Description:
C = Total catch of fish of the fixed lift net
F = Total number of fishing attempts (1 trip per 3–4 hauls)

Composition of the catch

The composition of the lift net catch was analyzed by counting the number of lift net catches by species and calculating the total number of lift net catches. According to Saragih *et al.* (2021), the composition of the lift net catch can be determined using the following formula:

$$Pi = \frac{ni}{N} \times 100\%$$

Description:
Pi = Composition of catch types (%)
ni = Number of types of fish species i (kg)
N = Total catch of fixed lift net (kg)

Comparison of the productivity of catches from fixed lift nets

The comparison of the productivity of the catch of the lift fixed net with the treatment of conventional lights and underwater dip lamp (LACUDA) was carried out by a non-parametric statistical test, the Mann-Whitney U-Test. The selection of this analysis test was based on the characteristics of data that were not normally distributed, and this study involved two different treatments (Sugiyono 2007). The Mann–Whitney U-Test is appropriate for use in this condition because it does not require the assumption of normal distribution. The formula used in the non-parametric statistical test, the Mann–Whitney U-Test, is as follows:

$$U_1 = n_1 n_2 + \frac{n_1(n_1+1)}{2} - R_1$$

$$U_2 = n_1 n_2 + \frac{n_2(n_{12}+1)}{2} - R_1$$

Description:
n_1 = Number of samples 1.
n_2 = Number of samples 2.
U_1 = Number of ranks 1.
U_2 = Number of ranks 2.
R_1 = Number of ranks in sample n 1.
R_2 = Number of ranks in sample n 2.

Testing hypothesis Mann–Whitney U-Test:
H0 = There is no significant difference between conventional and LACUDA lamps.
H1 = There is a significant difference between conventional and LACUDA lamps.
Hypothesis decision making in the Mann–Whitney U-Test, where Sig. (2-tailed) < real level (α), then Ho is not accepted Sig. (2-tailed) > real level (α), then Ho is accepted where α = 0.05 (5%) with a confidence level of 95%.

RESULTS AND DISCUSSION

Specifications of underwater dip lamps (LACUDA) and conventional lamps

The underwater dip lamp (LACUDA) tested in this study is an auxiliary fishing device provided by the Fisheries Service of Central Bangka as an aid for fishermen who are members of a fishing cooperative. LACUDA has specifications consisting of four main components: LED chip on board (COB) lamps, LACUDA tube frames, electrical cables, and electrical plugs as electrical power connectors. The LED chip on board (COB) lamps consist of six units with an electrical power capacity of 125 watts each, so the total electrical power required is 750 watts. The LACUDA tube frame is made of a combination of aluminum, carbon, and acrylic glass, which serves to protect the LED chip on board when operating LACUDA in the water column. The cable used is 15 m long, thus providing flexibility in operating LACUDA in various water column depth conditions. The electrical plug serves as a connector to flow electrical current to

LACUDA. LACUDA has a green base color and is operated by being immersed or dipped into the water column.

The specifications of conventional LED lamps consist of the main lamp, lamp frame, lamp plate, and electrical cable. Conventional LED lamps consist of six LED lamps with a capacity of 100 watts each, so that the total electrical power produced is 600 watts. The conventional LED lamp frame is made of wood, which functions as a support for the LED lamp on the fixed lift net. The metal lamp plate has a function to focus the light on the water. A 5 m long electrical cable functions to channel the electric current source to the lamp. Conventional LED lamps used by fishermen generally use a type of white base lamp that is widely available in the market, such as in electronic stores, stalls, and online stores. The use of conventional LED lamps is by hanging them in the air on the fixed lift net construction. The design and shape of the underwater dip lamp (LACUDA) and conventional LED lamps can be seen in Figure 2.

Distribution of fish in LACUDA and conventional LED lights

The composition of fish distribution on fixed lift nets using conventional LED lights and LACUDA produces different fish distribution patterns. Fish distribution patterns on fixed lift nets can be identified using an echosounder. An echosounder is an acoustic device that functions to detect the presence of fish and depth. Echosounders work by emitting sound waves into the water column through a transducer and then receiving the reflected sound waves so that the data can be converted into visual form. Visual data obtained from an echosounder includes fish distribution, topography, and the bottom substrate of the water (Becker and Sandwell 2008; Lubis *et al.* 2017).

The distribution pattern of fish in a fixed lift net using underwater dip lamps (LACUDA) can be seen in Figure 3. The distribution pattern of fish is predominantly in water areas with dim conditions. According to Yadudin *et al.* (2018), the dim conditions preferred by fish have a light intensity of 0.5–4 lux. Based on the results of recordings from the echosounder sensor, the distribution pattern of fish using LACUDA lamps is relatively spread across the water column and the water surface.

The distribution pattern of fish under conventional LED lights can be seen in Figure 4. This distribution pattern focuses only on the surface layer of the water and does not show any distribution pattern in the water column. Echosounder recordings show that fish distribution under conventional LED lamps is dominated by the surface area of the water, while the LACUDA lamps are spread across the surface area and the water column. This indicates that conventional LED lights are less than optimal in penetrating the water column.

Conventional LED lamps have a white base color and are operated in the air by being suspended from a fixed network structure at a height of 3.5 m above sea level. LACUDA lamps are green and are operated by being placed in the water column at a depth of 4–5 m. This research was conducted on a fixed lift net unit with a total water depth of 7.9 m.

(a) (b)

Figure 2. Design and construction of lamps: (a) underwater dip lamp (LACUDA), (b) conventional LED lamp.

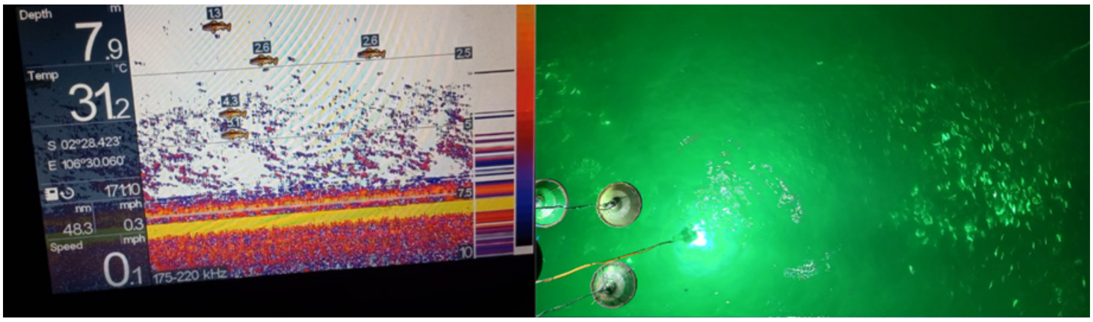

Figure 3. Distribution of fish in underwater dipping lights (LACUDA).

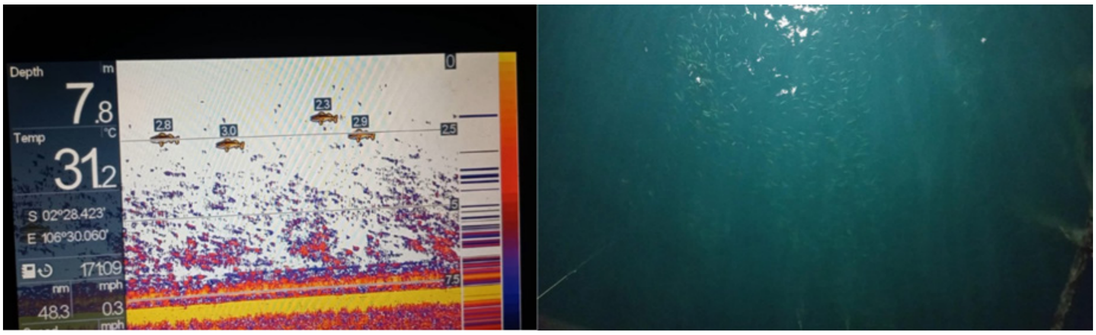

Figure 4. Distribution of fish on conventional LED lights.

The construction of the LACUDA lamp is different from conventional LED lamps. The construction design of the LACUDA lamp used in this study focuses light distribution only on the edge or horizontal angles, while the vertical angles are not optimally distributed. This is due to the presence of the LACUDA lamp tube cover component, which limits light distribution to vertical angles that are not available. Based on the research results of Yulianto *et al.* (2014), the construction of underwater dip lamps on the bottom lamp tube cover needs to be designed by providing a light space so that light distribution can be optimally distributed both horizontally and vertically. Illustrations of the light distribution of LACUDA and conventional LED lamps can be seen in Figure 5.

Based on the construction form, conventional LED lamps should be able to produce a spread of light that spreads completely both vertically and horizontally, because the construction has a lamp disc component that is designed to focus the light distribution in a focused manner to the fishing operation waters. However, the light intensity produced by conventional LED lamp is less than optimal because the lamp is operated at a fairly high height above the sea surface, so that the light intensity produced is less than optimal in penetrating the water column layer.

One of the factors that causes LACUDA lamps to produce more fish distribution results compared to conventional LED lamps is that LACUDA lamps have a power difference of 150 watts higher than conventional LED lamps. According to Julianus and Patty (2010), the higher the light intensity produced by the lamp, the greater the chance of fish with positive phototaxis approaching the light source, as long as the light intensity is at the optimal threshold suitable for the fish. According to Zhang *et al.* (2023), green light has a wider penetration ability so that light can reach fish or marine biota in deeper layers of the water column, and the probability of fish being attracted to the light source is higher.

Quantity and productivity value of catch

The operation of a fixed lift net using conventional LED lamps and underwater dip lamps (LACUDA) results in different catch quantities and productivity. The differences in catch quantities and productivity values produced by fishing gear or auxiliary fishing devices can be used as a reference in developing fishing technology. The catch quantities and productivity values of fixed lift nets using underwater dip lamps (LACUDA) and conventional LED lamps are displayed graphically in Figure 6.

The catch obtained using underwater dip lamps (LACUDA) was a total catch of 181.3 kg in 18 haulings. The productivity value of the catch on the fixed lift net using underwater dip lamps (LACUDA) obtained a value of 10.07 (kg/hauling), while the conventional LED lamp obtained a total catch of 150.1 kg in 18 haulings. The productivity value of the catch on the fixed lift net using conventional LED lamps obtained a value of 8.34 kg (kg/hauling). Based on this, it is known that the productivity value and total catch of the fixed lift net using underwater dip lamps (LACUDA) are 20.74% greater than those using conventional LED lamps. Based on the results of the Mann–Whitney U-Test, the treatment of using conventional LED lamps and LACUDA lamps shows a significance value greater than the value of α = 0.05, which is 0.267. The use of conventional LED lamps and LACUDA lamps does not have a significant effect. However, based on the catch data obtained, the use of LACUDA lamps is more recommended than conventional LED lamps because they produce higher catch results.

Composition of the catch

The composition of fish catches on fixed lift nets using conventional LED lamps and LACUDA lamps differs. A comparison of the composition of fish catches on fixed-lift nets using conventional LED and LACUDA lamps is shown graphically in Figures 7 and 8.

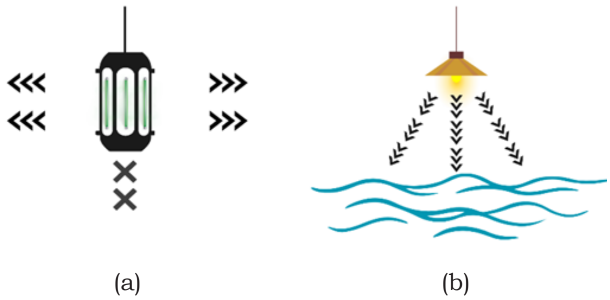

Figure 5. Illustration of light distribution: (a) underwater dip lamp (LACUDA), (b) conventional LED.

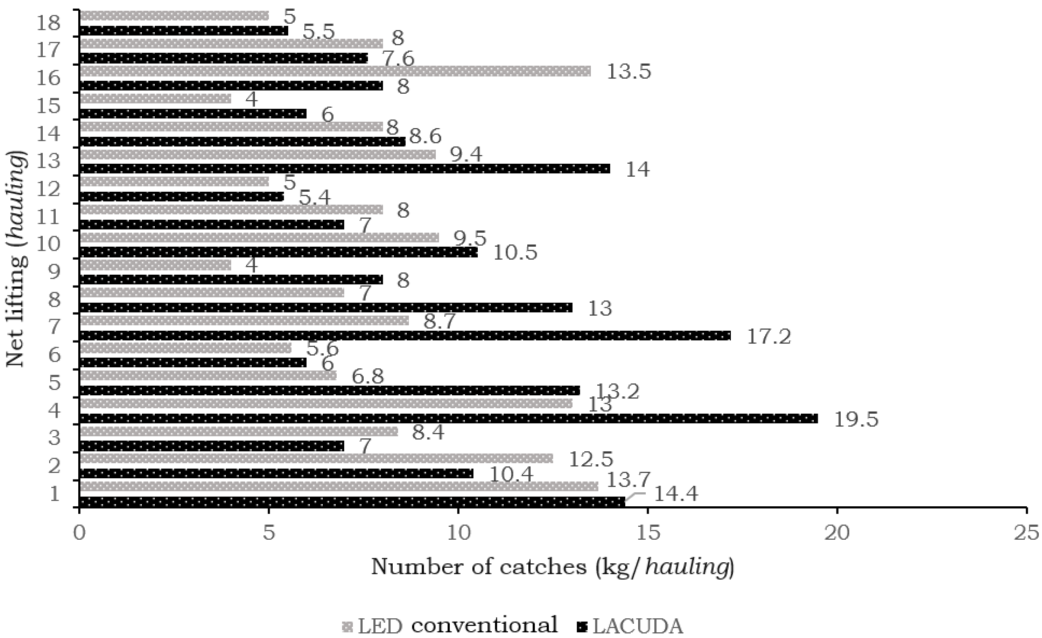

Figure 6. Comparison of the quantity and productivity value of catches from fixed lift nets using underwater dip lamps (LACUDA) and conventional LED lamps.

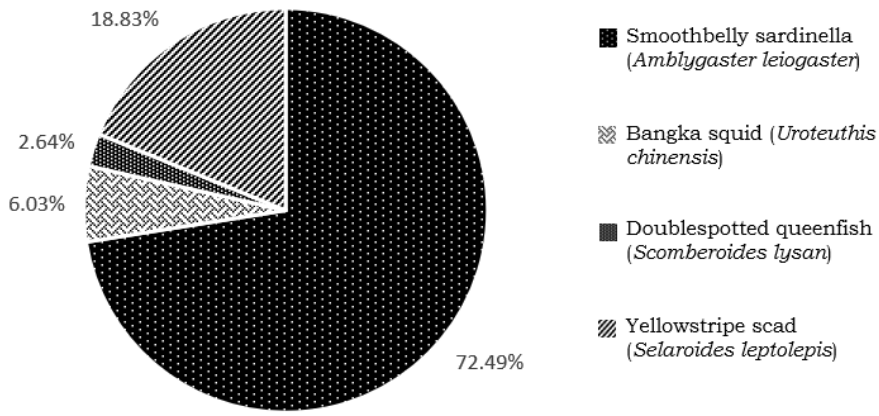

Figure 7. Composition of the catch of a fixed net using conventional LED lights.

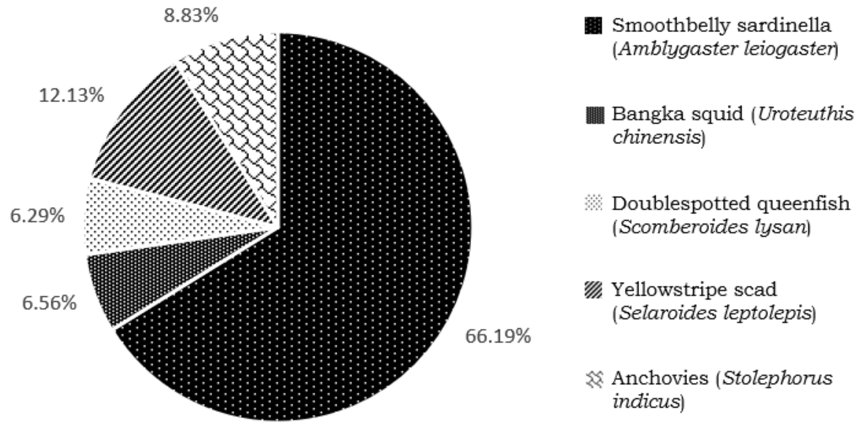

Figure 8. Composition of the catch of the fixed net using underwater dip lamps (LACUDA).

The catch composition of fixed lift nets using conventional LED lamps consists of the following species: smoothbelly sardinella (*Amblygaster leiogaster*), Bangka squid (*Uroteuthis chinensis*), doublespotted queenfish (*Scomberoides lysan*), and yellowstripe scad (*Selaroides leptolepis*). The dominant catch composition of fixed lift nets using conventional LED lights is dominated by smoothbelly sardinella (*A. leiogaster*), second catch is yellowstripe scad (*S. leptolepis*), third place is Bangka squid (*U. chinensis*), and last place is doublespotted queenfish (*S. lysan*). The catch composition of fixed lift nets using conventional LED lights is dominated by smoothbelly sardinella (*A. leiogaster*) at 72.49% and yellowstripe scad (*S. leptolepis*) at 18.83% of the total catch of fish from fixed lift nets.

The composition of the catch of the fixed lift net using underwater dip lamps (LACUDA) consists of the species of smoothbelly sardinella (*A. leiogaster*), Bangka squid (*U. chinensis*), doublespotted queenfish (*S. lysan*), yellowstripe scad (*S. leptolepis*), and anchovies (*S. indicus*). The dominance of the number of catch compositions of fixed lift net using underwater dip lamps (LACUDA) in the first order is dominated by smoothbelly sardinella (*A. leiogaster*), yellowstripe scad (*S. Leptolepis*), anchovies (*S. indicus*), bangka squid (*U. chinensis*), and doublespotted queenfish (*S. lysan*). The catch of fixed lift nets using LACUDA lamps was dominated by smoothbelly sardinella (*A. leiogaster*) at 66.19%, yellowstripe scad (*S. leptolepis*) at 12.13%, and anchovies (*S. indicus*) at 8.83% of the total catch of fixed lift nets.

The catch of fixed lift nets using LACUDA lamp has a total diversity of 5 species, while conventional LED lamp have a total diversity of only 4 species. Based on this, it can be concluded that the catch of fixed lift nets using LACUDA lamp has a slightly higher level of diversity in catch composition than using conventional LED lamp. The use of basic colors in LACUDA lights can affect catch productivity, because green light has a fairly good penetration ability compared to other colors. Green light not only has good penetration ability but is also more sensitive or sensitive to the visual acuity of pelagic fish and has a lower stress level compared to other light colors (Susanto *et al*. 2018).

Fish attracted to light are not only positively phototactic but also influenced by other factors such as the greater visibility of phytoplankton and zooplankton abundance by fish, which are their natural food (Muhyun *et al*. 2022). The light coverage of LACUDA lamps is wider than conventional LED lamps because the light intensity produced by LACUDA lamps is higher, although conventional LED lamps have a better light distribution angle than LACUDA lamps.

Differences in the operating methods of lights on fixed lift nets will affect the quantity and composition of the catch. Several previous studies have shown that the operating method of underwater lights on fixed lift nets is more effective than conventional LED lights (Shen *et al*. 2013; Guntur *et al*. 2015). Underwater dip lights (LACUDA) are quite effective in collecting fish and increasing catches. Based on this statement, the construction of the lights, the operating method, the intensity of the light, and the use of color are among the factors that influence the quantity and composition of fish caught.

CONCLUSION

The composition of the fish catch using underwater dip lamps (LACUDA) is slightly more diverse than using conventional LED lamps. The catch using underwater dip lamps (LACUDA) consisted of five species, such as smoothbelly sardinella (*Amblygaster leiogaster*), Bangka squid (*Uroteuthis chinensis*), doublespotted queenfish (*Scomberoides lysan*), yellowstripe scad (*Selaroides leptolepis*), and anchovies (*Stolephorus indicus*). Conventional LED lights only included four species, such as tamban fish (*A. leiogaster*), Bangka squid (*U. chinensis*), doublespotted queenfish (*S. lysan*), and yellowstripe scad (*S. leptolepis*). The catch productivity value using underwater dip lamps (LACUDA) was 10.07 (kg/haul) with a total catch of 181.3 kg. The catch productivity value using conventional LED lamps was only 8.34 (kg/haul) with a total catch of 150.1 kg. The use of LACUDA with conventional LED lamps did not significantly affect catch productivity, but based on the productivity and composition of the catch, LACUDA was slightly superior and more effective than conventional LED lights.

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