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## Development of utilization of electrical lamp for fixed lift net (*bagan*) in Makassar Strait

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**Abstract.** The use of light in some types of fisheries has been one of the most advanced and successful methods to control fish for capture purposes. The use of electrical lamps has been developed as a method of attracting small pelagic fish in Indonesia. Fixed lift nets (*bagan tancap*) are a fishing gear type categorized as lift nets with fine meshed (0.5 cm mesh size) box-shaped netting, operated using lamps to attract pelagic fish. Several studies on fixed lift nets (*bagan*) were conducted in Makassar Strait, South Sulawesi, Indonesia from 2012 -2017. These studies used various types of electric lamps, such as halogen lamps, mercury lamps, incandescent lamps and light emitting diodes (LEDs). The fishing process was analysed through on-board observation during fishing operations and interviews with fixed lift net fishermen. The results showed that small pelagic fish species tended to prefer the halogen (neon) lamps compare to mercury and incandescent lamps, as they were more effective in attracting small pelagic species to fixed lift nets in the coastal area. A new type of lamp considered more environmentally friendly, the light emitting diode (LED), was also introduced on fixed lift nets. The result of the research on introducing light emitting diodes (LEDs) in fixed lift nets is discussed.

### 1. Introduction

The use of light in some types of fisheries has been one of the most advanced and successful methods to control fish for capture purposes [1]. Nowadays, the use of lamps for fishing has developed rapidly and become widespread all over the world, including in Indonesia as an archipelagic country. In fishing technology terminology, the utilization of electrical lamp to facilitate the capture process is called light fishing. In Indonesia, light fishing is distributed over the archipelago, and is especially common in western Indonesian waters.

The use of electrical lamps for attracting of small pelagic fish has been developed in Indonesia [2, 3]. Fixed lift nets (locally called *bagan tancap*) are a fishing gear type categorized as lift nets with fine meshed (0.5 cm mesh size) box-shaped netting, operated using lamps to attract pelagic fish. Several studies in fixed lift net *bagan* were conducted in Makassar Strait South Sulawesi from 2012 -2017. These studies used various types of electric lamp, namely halogen lamps, mercury lamps, incandescent lamps, and light emitting diodes (LED).

In Japan the application of electricity began in 1930 and electric lamps have been used for fishing since 1952 [4]. In Indonesia, it is still unclear when the lamps were first used and who introduced them [5 and 6]. Light fishing has been employed in small-scale artisanal ways since a long time ago but the development of commercial light fishing began in the early 1950's [7]. Light fishing has developed rapidly and spread widely all over Indonesia. In the beginning, kerosene-fuelled pressurized



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lamps were used in shallow coastal fishing using scoop nets and hand line, however nowadays most light fishing employs electric lamps. The use of these lamps is not limited to coastal fisheries only, but has also been extended to offshore fisheries using boat seines, mobile lift nets, purse seines, and other gear [8]. With continuous perfection and advancements in light and lighting technology, light fishing operations have become one of the highly effective fishing categories [9].

This research aimed to display information on the operational methods, catch size and composition, and catch patterns of this gear. The relationship between the type of lighting power used and total catch and discarded catch was also investigated.

## 2. Materials and Methods

Data collection comprised two steps. The first step was on-board observation from a single *bagan* unit which was carried out monthly from April to November 2012 in the Makassar Strait, Indonesia (Fig.1) using a commercial fishing unit. Data were obtained at every fishing operation by examining the catch species, total catch, by-catch and discard species every hauling time.

In this step, several studies on fixed lift net *bagan* were conducted in the Makassar Strait, South Sulawesi, Indonesia. The types of electric lamp used, namely Halogen, Mercury and Incandescent lamps, all had a lighting power of 500 W. The total catch was evaluated. These studies were conducted from April to November 2012 in Makassar Strait. The fishing process was analysed through on-board observation during fishing operation and interviews with the *bagan* fishermen. Species were identified by using references such as [10,11,12,13,14].

With the on-going development of science and technology, scientists have found that light-emitting diodes (LEDs) could be considered as eco-friendly lamps. The use of these LED electric lamps could lead to more environmentally friendly fishing technology for attracting pelagic species. Thus, the second step was conducted from July to October 2017. Experimental fishing used light emitting diodes (LEDs) on fixed lift nets in Makassar Strait and compared them with neon (halogen) lamps of the same power. Data collection was conducted by following 50 hauling operations. There were a total of 26 hauls using LED lamps and 24 hauls using neon lamps.

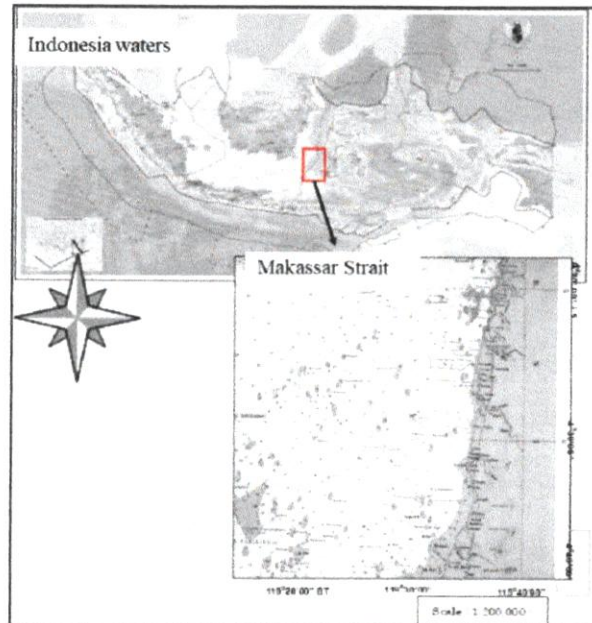


Figure 1. Map of Makassar Strait, showing the experimental and data collection area

### 3. Results and discussion

A *bagan* is a lift net with fine meshed (0.5 cm mesh size) of box-shaped netting, operated with electric or kerosene lamps to attract pelagic species. Historically lift nets in South Sulawesi can be divided into two types, the fixed lift net (*bagan tancap*) and boat lift net (*bagan perahu*). This gear originated from South Sulawesi, Indonesia and in recent years has rapidly developed in terms of the number of units. In the beginning, boat lift nets started to operate in Luwu Regency in Bone Bay in 1987 and then spread to the Makassar Strait (Baru Regency) in 1989. Nowadays, this gear is widely distributed across the major fishing grounds of South Sulawesi. Fixed *bagan* (Figure 2) have become distributed across Eastern Indonesia.

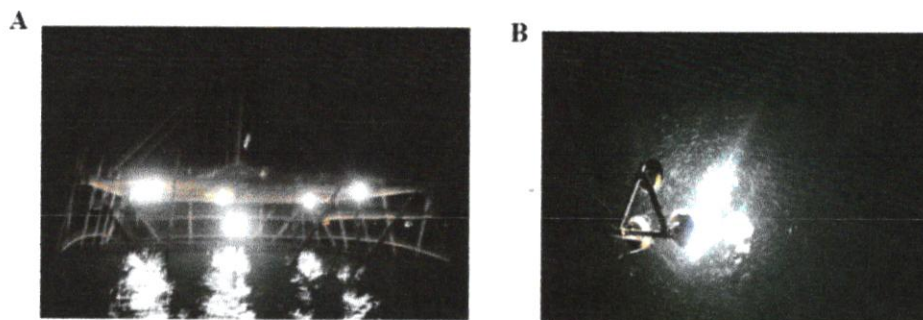


Figure 2. The use of electric lamps on a fixed lift net in Makassar Strait (A); Fish schooling under the electric lamp (B) [4]

The fishermen turn on the electric lights to attract the small pelagic species. These pelagic species will come to the light sources as they have a phototaxis positive response, and feeding motivation. The light intensity is gradually reduced after the schooling fish stay long in the vicinity of the illuminated area. The fish are concentrated by two mercury lamps placed in the centre of the net, inducing the fish to enter the catchable area.

Research conducted in 2017 showed that small pelagic fish species tend to prefer the halogen lamp with total catch 746.1 Kg. (average 33.9 kg/trip) compare with the mercury lamps with total catch 676.1 kg (average 30.7 kg /trip) and incandescent lamps with total catch 490.1 kg (average 22.2 kg/trip). Statistically analysis indicated a significance difference between halogen and incandescent lamps (Fig.3-5). This study indicated that neon (florescent) lamps were more effective in attracting small pelagic species to fixed lift nets in the coastal area.

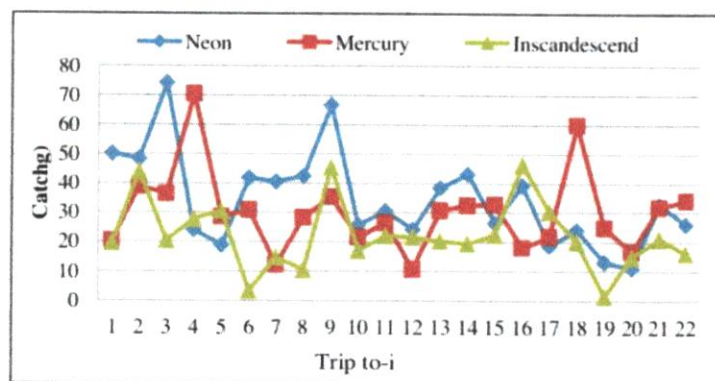


Figure 3. Total catch of *bagan* lift net using 3 types of electric lamp

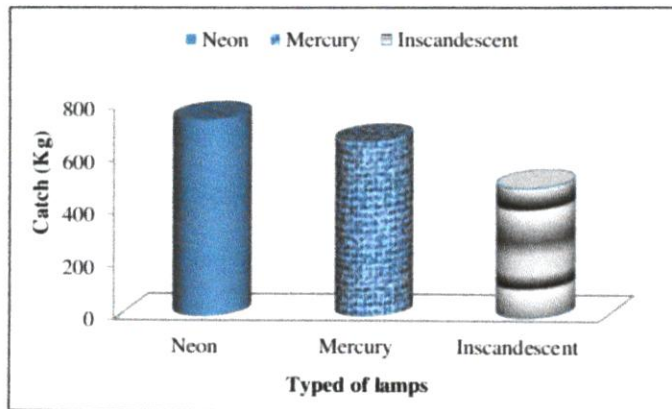


Figure 4. Total lift net catch during the experiment by electric lamp type

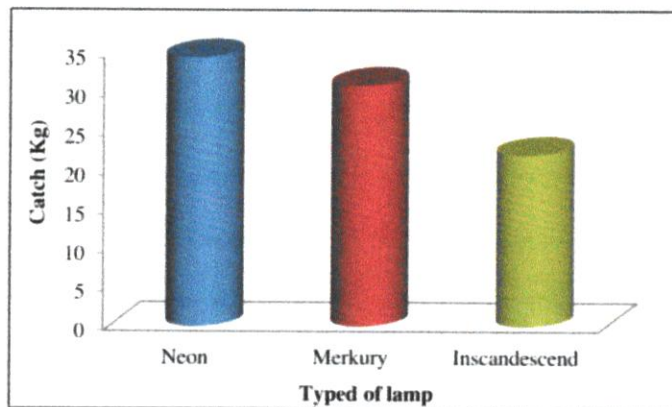


Figure 5. Average catch of set lift net per fishing trip

The results show that the total catch of fixed lift nets during the study was 235.2 kg using LED lamps, and 635.4 kg with neon lamps. There were differences in catch volume between LED lamps and neon lamps with the same power. The next experiment used different power levels, where LED power was higher than for the neon lamp. Research was conducted in 2017 [15] on the utilization of LEDs on fixed *agan*, comparing neon lamps with low intensity LEDs (Figure 6).

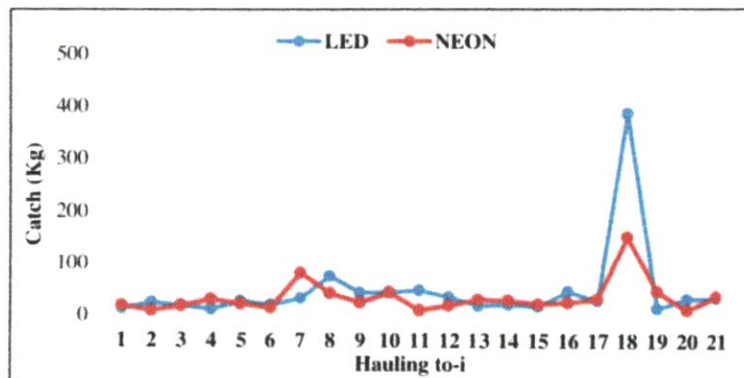


Figure 6. Comparison of total lift net catch using LED and neon lamps by haul

The research showed that neon and LED were both effective when used on fixed lift nets (*bagan tancap*) in Makassar Strait. However, the lift net catch was higher using LEDs than neon lamps. In future developments, we can recommended to the fisherman, especially in coastal areas, to use LEDs as new technology in light fishing, which is both more environmentally friendly and effective. Catch composition using LED and Neon lamps is shown in Figure 7.

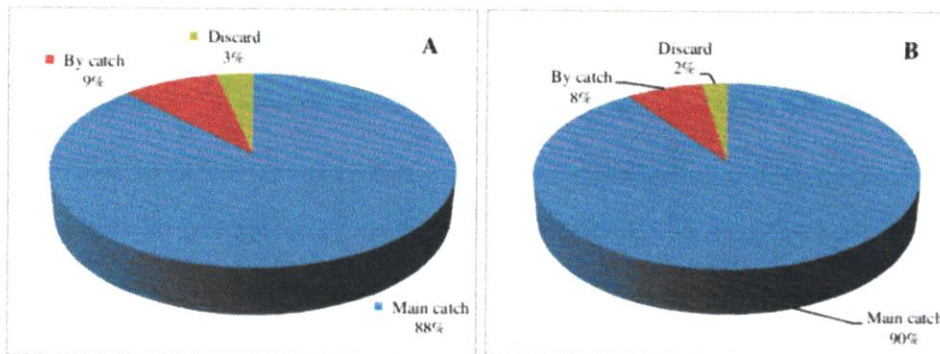


Figure 7. Lift net catch composition by lamp type: LED (A) and Neon Lamp (B)

Figure 7 indicates that the lift net catch composition was almost the same using the different lamps. The main (target) catch of the lift net was 88% with LEDs compared to 90% with neon lamps. By-catch and discards were also almost the same. As compared to boat lift nets, the percentage of discarded catch is much lower for fixed lift nets [6].

Using light emitting diodes, average fixed lift net catch was higher than using neon lamps (Figure 8). This indicates that light emitting diodes as can be introduce for light fishing, especially on fixed lift nets in coastal areas.

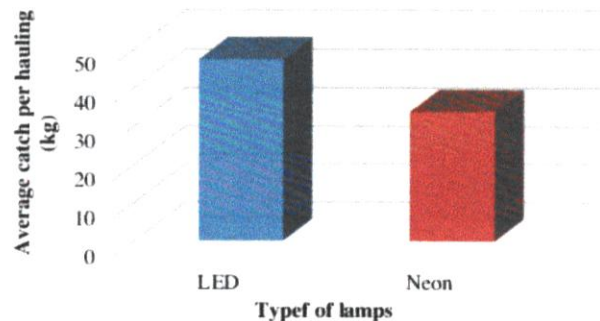


Figure 8. Comparison of average fixed lift net catch using LED and Neon lamps

#### 4. Conclusion

1. Halogen lamps (neon lamps) were more effective than incandescent lamps for attracting small pelagic species to fixed lift nets in the coastal area.
2. Light emitting diodes (LEDs) are more effective as attractors of small pelagic fish to lift nets in coastal area compared with neon lamps.
3. In the operation of fixed lift nets, the use of LEDs as auxiliary fishing gear can be recommended as a more environmentally friendly technology.

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