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Fish species difference around the light of metal halide lamps and LED lamps with mini purse seine operation

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Abstract. Purse seine (PS) at Lamongan District Indonesia uses lights as a fish attractor. The types of lamp used are a metal halide (MH). This lamp is very bright but has a large electric power so that fuel consumption is also high. Therefore, it is necessary to do research about the use of an LED lamp that is more energy efficient. This study aims to determine the fish species that are in the vicinity of MH lamps compared to LED lamps based on its swimming layer. The study used the experimental method to obtain catch data from both lamp types, and descriptive method to identify fish species composition. The present study found 16 species coming to both types of lamps. It indicates that the LED lamp as a new lamp can attract the same fish species as a MH lamp. The fish species attracted to both light types of lights were dominated by pelagic fish (88.77% and 81.71%) consisting of small pelagic (7 species) and large pelagic fish (4 species), 4 species of demersal fish (7.81% and 13.26%) and 1 species squid of non-fish (3.42% and 5.03%). Small pelagic fish species are plankton feeder and positive phototaxis fish, while big pelagic fish are carnivorous fish that come for much small fish. Demersal fish also caught in the purse seine are those rising to the upper water column at night.

1. Introduction

Purse seine (PS) is one of the fishing gears that uses light as a fish attractor. The lamp used by Lamongan fishermen is metal halide (MH) lamp. This type of lamp is very bright but uses a very large electrical power that makes energy waste ([1]; [2]). This study used also type of more energy-efficient LED lamp. Fishermen have not used LED lamps, and thus, it is not known whether these types of lamps can attract fish coming around or not and what type of fish species are around the LED lamps.

The purpose of this study was to determine whether the LED lamps can attract the fish to come around or not and to compare the species number around the LED lamps and around the MH lamps. Species composition was recorded based on their swimming layer.

2. Materials and methods

2.1. Place and time

Data were taken at the fishing ground (FG), the north of Lamongan (figure 1). The fishing base of fishermen is Paloh Village, Paciran Sub-District, Lamongan Regency, East Java Indonesia. The study was conducted in September - October 2016.



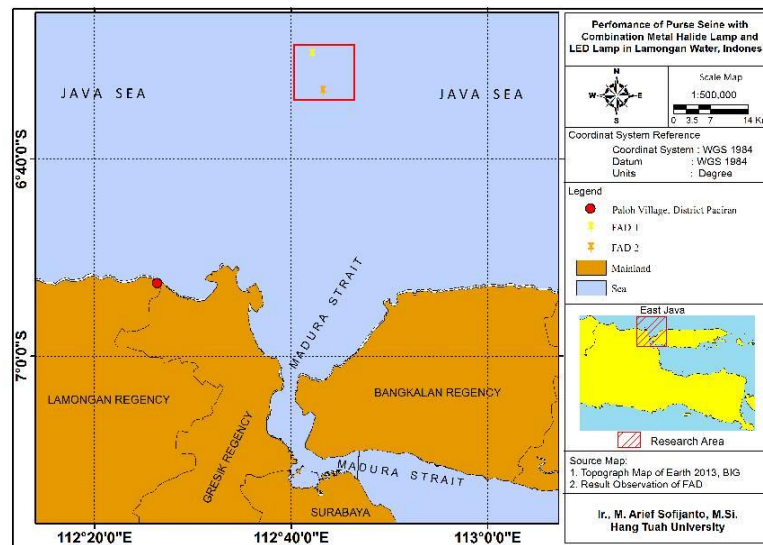


Figure 1. Map of fishing ground

2.2. Instruments and materials

The study used MH lamps and LED lamps as a fish aggregating device or fish attractor. The MH lamps (figure 2a) were placed on the right and left the top of the fishing vessel as many as 16 pieces of 1,500 watts or a total of 24,000 watts. The lamps were supported by a 40,000 watt-generator. The LED lamps (figure 2b) consisted of 6 pieces of 100 watts or a total of 600 watts mounted on the lamp-holding float called *bangkrak*. It was equipped with a 3,000 watt-power generator.

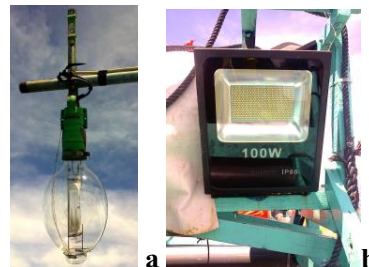


Figure 2. The MH lamp at the fishing vessel (a) and LED lamp at the *bangkrak* (b)

2.3. Research methods

To obtain catch data of the purse seiner with lamps, the experimental fishing method was conducted. Data collection was performed through fishing operations using two different types of attractor lamps. Meanwhile, identifying the fish species coming around the LED lamps and the MH lamps used the descriptive method.

2.4. Data collection

Data were collected from 15 fishing trips with 2 settings per trip. The ignition of the type of LED lamps on the *bangkrak* is shown in the fishing ground (FG) 1. The ignition of the second type of lamp that is the MH lamp on board the net in FG 2. After completion of the first hauling, the fishing vessel returned to the *bangkrak* location for the second setting. Fish species data and the number of fish caught were separately recorded from both types of lamps.

2.5. Data analysis

Fish catches were sorted on board and separated by species and lamp types. These fish were identified following the guide to important economic fish species in Indonesia [3]. The fish identification was done to bring up the species composition data. Data of fish species and number were then presented in the form of pie diagram to describe the species composition based on their swimming layer, pelagic fish (small and large), demersal fish and non-fish.

3. Results and discussion

The study found that LED lamps can gather fish and make the purse seine obtain catches. This finding could become an input for fishermen to operate the type of LED lamps as a fish attractor. The LED lamp can work the same as the MH lamp in attracting the fish in light fishing operations. A number of fish species attracted to the LED lamp are the same as those attracted to the MH lamp. according to [4], a large number of fish species gathering around the lamp could result from a high number of species in the tropical area. Small pelagic fish were planktivores that are positive phototaxis, while large pelagic fish were carnivorous fish that came for feeding the small fishes.

Table 1. The composition of fish catch species base on the swimming layer.

No	Common Name	Scientific Name	Predator/ Plankton feeder	Pelagic/ Demersal
1	Scad mackerel	<i>Decapterus Russell</i>	Plankton feeder	Small Pelagic
2	Fringescale sardine	<i>Sardinella fimbriata</i>	Plankton feeder	Small Pelagic
3	Hairtail scad	<i>Megalaspis cordyla</i>	Plankton feeder	Small Pelagic
4	Striped mackerel	<i>Rastrelliger kanagurta</i>	Plankton feeder	Small Pelagic
5	Short bodied mackerel	<i>Rastrilliger brachysoma</i>	Plankton feeder	Small Pelagic
6	Round hering	<i>Dussumieria acuta</i>	Plankton feeder	Small Pelagic
7	Yellow strip trevally	<i>Selaroides leptolepis</i>	Plankton feeder	Small Pelagic
8	Eastern little tuna	<i>Euthynnus affinis</i>	Predator	Large Pelagic
9	Barred Spanish mackerel	<i>Scomberomorus</i> sp.	Predator	Large Pelagic
10	Barracuda	<i>Sphyrna genie</i>	Predator	Large Pelagic
11	Frigate mackerel	<i>Auxis thazard</i>	Predator	Large Pelagic
12	Silver pomfret	<i>Pampus argenteus</i>	Plankton feeder	Demersal
13	Ribbon fishes	<i>Trichiurus lepturus</i>	Predator	Demersal
14	Black tipped penfish	<i>Leiognathus splendens</i>	Carnivore	Demersal
15	Purple spotted bigeye	<i>Priacanthus tayenus</i>	Predator	Demersal
16	Squid	<i>Loligo</i> sp.	Predator	Nonfish

Also, demersal fishes caught in the purse seine were those that vertically migrated for feeding by entering the water column where the net was set. The species composition caught with MH lamps and LED lamps were presented in table 1. a number of catches (kg) in LED lamps were lower than that in MH lamps because the total power of the MH lamp was greater than the LED lamp. Total catches were 29.845 kg, 23.247 kg from the use of MH lamps and 6.598 kg from that of LED lamps.

The number of species caught in the purse seine with LED lamps equaled to that in, MH lamps, 16 species. The fish species were then grouped with their position in the water column as pelagic fish, demersal fish and non-fish (table 2 and table 3). They consisted of 7 species of small pelagic fish (scad mackerel, fringescale sardine, hairtail scads, striped mackerel, short-bodied mackerel, round herring, and yellow strip trevally); 4 species of large pelagic fish (skipjack, mackerel, barracuda and bonito); 4 species of demersal fish (silver pomfret, ribbon fishes, black tipped penfish and purple spotted bigeye) and 1 species of squid.

Table 2. Fish species caught using MH lamps based on the swimming layer

Non Fish	Weight (kg)	Small Pelagic	Weight (kg)	Large Pelagic	Weight (kg)	Demersal	Weight (kg)
Squid	795	Scad mackerel	11,325	Eastern little tuna	4,440	Silver pomfret	675
		Fringescale sardine	1,017	Barred spanish mackerel	1,025	Ribbon fishes	460
		Hairtail scad	975	Baracuda	520	Black tipped penfish	435
		Striped mackerel	375	Frigate mackerel	190	Purple spotted bigeye	245
		Short bodied mackerel	295				
		Round hering	265				
		Yellow strip trevally	210				
1	795	7	14,462	4	6,175	4	1,815
%	3.42		62.21		21.87		13.26

Table 3. Fish species caught using LED lamps based on the swimming layer.

Non Fish	Weight (kg)	Small Pelagic	Weight (kg)	Large Pelagic	Weight (kg)	Demersal	Weight (kg)
Squid	328	Scad mackerel	2,290	Eastern little tuna	475	Silver pomfret	320
		Fringescale sardine	465	Barred spanish mackerel	540	Ribbon fishes	250
		Hairtail scad	400	Baracuda	370	Black tipped penfish	194
		Striped mackerel	255	Frigate mackerel	40	Purple spotted bigeye	100
		Short bodied mackerel	190				
		Round hering	180				
		Yellow strip trevally	120				
1	328	7	3,900	4	1,425	4	864
%	5.03		59.84		21.87		13.26

The fish composition by MH lamps and LED lamps are shown in Figure 3.

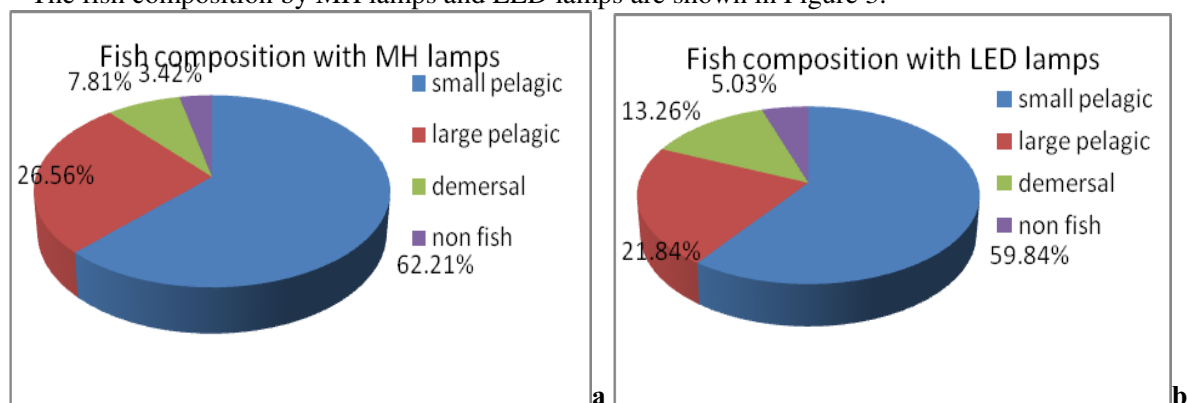
**Figure 3.** Fish composition with MH lamps (a) and LED lamps (b)

Figure 3a shows that small pelagic fishes were dominated of the species composition of the fish caught in MH lamps that are 62.21%, followed by large pelagic fishes of 26.56%, then demersal fish of 7.81% and squid of 3.42%. While figure 3b shows that the species composition of fish caught in LED lamps consists of 59.84% of small pelagic fish, followed by 21.84% of large pelagic fish, 13.26% of demersal fish, and 5.03% of squids. Pelagic fish were dominating total catches that are 88.77% in MH lamps and 81.71% in LED lamps, respectively. Pelagic fish species are known to be positive phototaxis. According to [5], fish come to the light source, because they are attracted by light (direct factor) and there is much small fish around the light source (indirect factor) reflecting food availability, such as plankton, that is positively phototactic. Such small pelagic fish are plankton feeder [6]. Similarly, large pelagic fish come as a predator on small fish because they are carnivorous. The arrival of these fish to the light is feeding activity [5]. Multi-species fish and squids caught in purse seine light fishing are primarily small pelagic fish species attracted to light. Thus, the species caught are fishing targets in purse seine light fishing [7].

3.1. Small pelagic fish

The number of small pelagic fish caught in the purse seine was 7 species using either MH or LED lamps. The former consisted of scad mackerels (*Decapterus russell*), fringescale sardines (*Sardinella fimbriata*), hairtail scads (*Megalaspis cordyla*), striped mackerels (*Rastelliger kanagurta*), short bodied mackerels (*R. brachysoma*), round herring (*Dussumieria acuta*) and yellow strip trevally (*Selaroides leptolepis*). The latter comprised fringescale sardine (*S. fimbriata*), hairtail scad (*M. cordyla*), striped mackerel (*R. kanagurta*), short bodied mackerel (*R. brachysoma*), round hering (*D. acuta*), and yellow strip trevally (*S. leptolepis*). These fish come to around the area exposed to light not merely because they are positive phototaxis but because they look for plankton gathering around light source. This is supported by [6] that small pelagic fish caught around the light source are planktivores.

3.2. Large pelagic fish

Four species of large pelagic fish are eastern little tuna (*Euthynnus affinis*), barred spanish mackerel (*Scomberomorus* sp), barracuda (*Sphyraena genie*) and bonito (*Auxis thazard*). All of the species are predatory fish which come around the light source to hunt for small fish.

3.3. Demersal fish

The present study found the same 4 species caught with MH lamps and LED lamps, silver pomfret (*Pampus argenteus*), ribbon fishes (*Trichurus lepturus*), black tipped penyfish (*Leiognathus splendens*), and purple spotted bigeye (*Priacanthus tayenus*). The catches in MH lamps consisted of 675 kg of *P. argenteus*, 460 kg of *T. lepturus*, 435 kg of *L. splendens*, 245 kg of *P. tayenus*, in the LED lamps, the catches consisted of 320 kg of *P. argenteus*, 250 kg of *T. lepturus* (250 kg), 194 kg of *L. splendens*, and 100 kg of *P. tayenu*. These species inhabit around the sea bottom but could also be caught in the purse seine fishing operations since they enter the upper water column for feeding. Demersal fishes are known to have active activity at night (nocturnal) and they migrate vertically to swim from the bottom to the upper water column because there is plenty of food and plankton.

3.4. Nonfish

The non-fish catch was squid, least of 5.03% for MH and 3.42% for LED lamps, respectively. According to [8], squids play an important role in the ecosystem and serve as the primary link in the food chain both as a predator (carnivore) and prey. Squids feed on planktonic organisms, such as crustaceans, small shrimp, copepods, cephalopods, gastropods, polychaeta, and small fish species ([8]; [9]). In general, squid capture uses lights with high-power attractor that squid rises to the water surface and caught in the purse seine as bycatch. Nevertheless, according to [10], squids were captured with a fix lift net using lights as a fishing attractor.

4. Conclusion

LED lamps could attract fish. The fish species coming around the MH lamps and the LED lamps were the same as many as 16 species. They were dominated by pelagic fish (88.77% and 81.71%). The species composition consisted of small pelagic fish (62.21% and 59.84%), large pelagic (26.56% and 21.87%), demersal (7.81% and 13.26%) and non-fish (3.42% and 5.03%). During the study obtained total catch of 29,845 kg, 23,247 kg caught in the purse seine with MH lamps and 6,598 kg in the purse seine with LED lamps. The number of catches in both lamp types were different due to the use of different total electrical power.

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