Light Traps Fishing in Sungai Sipai Flood Swamp of Indonesia: Recommendations for Future Study

Ahmadi[1*] and Ahmad Rizani[2]

ABSTRACT

Trapping experiments in Sungai Sipai flood swamp, South Kalimantan during rainy season are described in this paper. A set of traditional fishing gears (e.g. *lukah, tempirai bamboo, kruing*) associated with LED and incandescent light was used as sampling tools. Trials consisted of 161-trap hauls/light type using 1-night submersion time of 14 h. Light trap samples were standardized to a catch per unit effort (CPUE) of total catch (g) per 7-nighttrip. Light traps sampling accounted for 403 specimens assigned to 13 species of 11 families. All the shrimp catch was of the species *Macrobrachium sintangense*, while the fish catch was dominated by *Trichogaster trichopterus*, and *Pila scutata* from the mollusc group. This sampling technique clearly displayed gear selectivity. Colour incandescent *Lukah* has significantly higher the amount of catches than colour LED *Lukah* for the most part. *Tempirai-bamboo* trap fishing with colour LED had a significantly different result from control trap. Comparative fishing trials showed that LED *Tempirai-bamboo* trap collected specimens were four times higher than that of LED *Lukah* trap. The performance of light traps had an effect on the number of catches. The use of blinking LED traps was more effective than that of blinking incandescent traps. The collection of detailed species composition from swampy areas is still hindered by technical obstacles that have yet to be completely resolved to support future research. For future applications, the use of LED traps is strongly recommended.

Key words: Flood swamp, LED, Incandescent light, *Lukah, Tempirai-bamboo*, trap, Sungai Sipai, South Kalimantan.

INTRODUCTION

The natives in South Kalimantan still maintain the inherited local wisdom in catching fish. They have created various unique types of environmentally friendly fishing gears. The habitat characteristics, aquatic species, and fishing activities in South Kalimantan have been widely studied, of which have induced focus on Barito River (Utomo *et al*., 2003; Prasetyo *et al*., 2005; Asyari, 2006; Rina and Irma, 2009), on

[1]Training Centre for Marine and Fisheries, Ministry of Marine Affairs and Fisheries, Jalan Medan Merdeka Timur No. 16, Mina Bahari Building III, 8th Floor. Jakarta, 10110 Indonesia
[2]Junior High School 2 Banjarbaru, Jalan Panglima Batur, South Kalimantan 70713, Indonesia
*Corresponding author: ahmadizarigani@gmail.com

Sembujur River (Prasetyo, 2005a; Rupawan, 2009), on Danau Panggang fishery sanctuary (Prasetyo, 2005b; Rahardjo *et al*., 2006, Rupawan, 2007), on Danau Bangkau hinterland swamp, on Aluh Aluh tidal swamp, or on Sungai Sipai flood swamp (Azizi and Novenny, 2001; Ansyari *et al*., 2008; Yunita, 2010). However, these studies did not report any information on the possibility of using light traps for sampling fish and shrimp in swampy areas.

Sungai Sipai village is not only suitable for fishing but also for aquaculture (e.g. patin, catfish, carp), which has been developing rapidly after the Riam Kanan irrigation, which passes this area, became operational. The people who live here are not only working for fisheries but also for agriculture. Some fresh fish from the swamp like snake head, climbing perch, and king catfish are locally consumed or marketed in Martapura and Banjarbaru City, while some are processed into salted fish (e.g. three-spot gourami and snakeskin gourami).

Fishing activities in Sungai Sipai flood swamp are conducted not only by the local people but also by outsiders, and are on-going throughout the year regardless of seasonal periods. The result of these activities is that some types of fish are becoming harder to find and the size of fish is becoming smaller resulting in a decline in the number of catch. These situations are further exacerbated by the use of electro-fishing or *Anco* (lift-nets) which is considered as a potentially destructive gear to both the fish and their habitats because of the very small mesh size (1.5 cm) of the nets, and are frequently operated in the area close to the spawning and nursery grounds. Thus, promotion of sustainable and responsible fishing activities should be encouraged. The trapping with underwater light seems to be a promising option for better fisheries management and socio-economic approaches (Ahmadi, 2012).

There is little information on utilizing lights as a method for fishing in a swampy area. Some researchers from Lambung Mangkurat University, South Kalimantan explored collecting fish and shrimp from shallow swamps using *Anco* (lift-nets) or *Tempirai* (bamboo stage traps) associated with electric lights and had some success in catching fish, but caught negligible number of shrimp (Aswadirani, 2003; Mukhlasin, 2004; unpubl. data). In its operation, the electric lights were placed above the gears while the gear body was totally or partially submerged into the swamp. Thus, photo taxis responses in the animals were unclear as it was under shadow. For all these reasons, we recently carried out the preliminary feasibility study to assess the effectiveness of LED and incandescent traps with continuous and blinking patterns as an alternative sampling tool for harvesting aquatic animals from flood swamp area.

MATERIALS AND METHODS

Study Site

The sampling area was focused at Sungai Sipai Village about 4 km from Martapura City or 40 km from Banjarmasin City, South Kalimantan Province of Indonesia (Fig. 1), 03°19'12" S 114°36'29" E (under

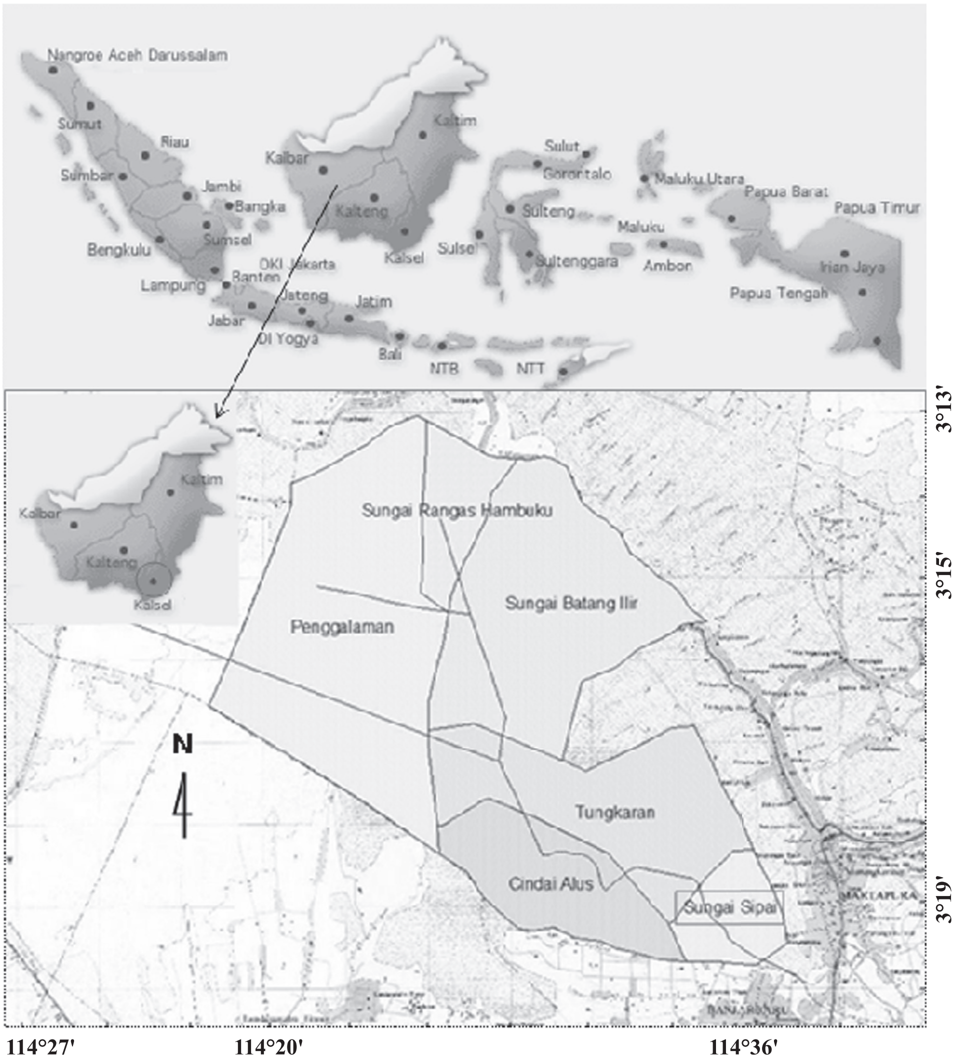

Figure 1. Map showing the study site for trapping experiments in Sungai Sipai flood swamp, South Kalimantan

the equatorial line) determined by the Nokia E72 GPS. Aquatic plants such as *Eichornia crassipes, Ipomoea aquatica, Polygonum* sp, *Pistia stratiotes, Salvinia natans, Salvinia molesta*, and *Hydrilla verticillata* were abundantly found in this swamp. The aquatic organisms were sampled with lighted traps from 29 December 2011 to 4 January 2012, which coincided with the rainy season. The depth of water ranged from 1 to 3 m with transparency varying from 45 to 75 cm as observed from the surface using a Secchi disk at noon. The surface water temperature ranged from 26 to 28°C throughout the trials. The trapping experiments were set up as follows:

Experimental Design

Experiment 1: *Lukah* or fish trap fishing with colour of LED and incandescent. The objective of this experiment was to compare the catch efficiency between colour LED traps and colour incandescent traps.

Respective LED traps using five different colours, colour incandescent traps and the controls (without light) were tested simultaneously. Each of the five traps was assigned with 0.9 W Torpedo LED (24x5 cm, Pantai Fishing Net Industry Co. Ltd. China) or with 0.9 W incandescent light YS-2A (22x5 cm, made in China) containing blue, green, yellow, red and extra white powered by 9 V and 3 V dry-cell batteries respectively. *Lukah* is an elongated, tube-shaped bamboo (128x18 cm) containing one entry funnel mounted on the inside in a conical-shape and tapering inside to about 2.5 cm, and containing one exclusion funnel at the opposite side. Thus, fish can enter easily but it is difficult for them to escape. The traps were deployed in the swamp under highly vegetated habitats with slow or no current. They were either submerged partly at an oblique angle of approximately 30º or were sunk to the bottom weighted by a sandbag according to the depth of water.

Experiment 2: *Tempirai* or bamboo-stage trap fishing with colour LEDs. The objective of this experiment was to examine the effect of different colour LEDs on the number of catches.

Five colour LED traps including the control were examined. Each of the five traps was assigned with 0.9 W Torpedo LED (24x5 cm, Pantai Fishing Net Industry Co. Ltd. China) comprised of blue, green, yellow, red and extra white powered by 9-V dry-cell batteries. The *tempirai* was made from bamboo formed into a heart-shape: 52 cm high and 37 cm wide with a horizontal gap 1 cm and 3.5 cm wide opening of the entrance slit. A small trap door on the top allowed for removal of the catches side.

Experiment 3: Trap fishing with white blinking LED and blinking incandescent. The objective of this trial was to examine whether size and shape of light traps have an effect on the number of catches.

Five traps with different sizes and shapes containing white blinking LED or blinking incandescent were investigated. The traps consisted of (a) *Lukah*: bamboo in an elongated tube-shape (128x18 cm) with one entry funnel mounted on the inside of conical-shaped and tapering down to approximately 2.5 cm wide opening, and having an exclusion funnel at the opposite side; (b) *Tempirai-bamboo*: bamboo with heart-shape 52 cm high and 37 cm wide with horizontal gap 1 cm and 3.5 cm wide opening of entrance slit; (c) *Tempirai-wire*: wire with heart-shape 43 cm high and 35 cm wide, covered with 1.2 cm square mesh wire and a 3.5 cm wide opening as an entrance slit; (d) *PVC box-shaped trap*: PVC rod frame (67x53x20 cm) covered with black 150 mm hexagonal mesh wire (16 gauge PVC-coated wires). The trap had ten entry funnels located on each side of the trap with a 5 cm inside ring entrance; and (e) *kruing*: bamboo with funnel-shape 67 cm long and 55 cm high with a door frame of 22x20 cm and conical to the inside. Slackness nylon monofilaments 45 mm stretched mesh was attached inside trap body. Each of the five traps was assigned with either a 0.3 W white blinking Torpedo LED (26x5.5 cm, Pantai Fishing Net Industry Co. Ltd. China) or with a 0.9 W blinking incandescent (20.5x5.5 cm, OYS-1119 C.E, China) powered by 3 V dry-cell batteries. The traps used in this experiment are shown in Fig. 2.

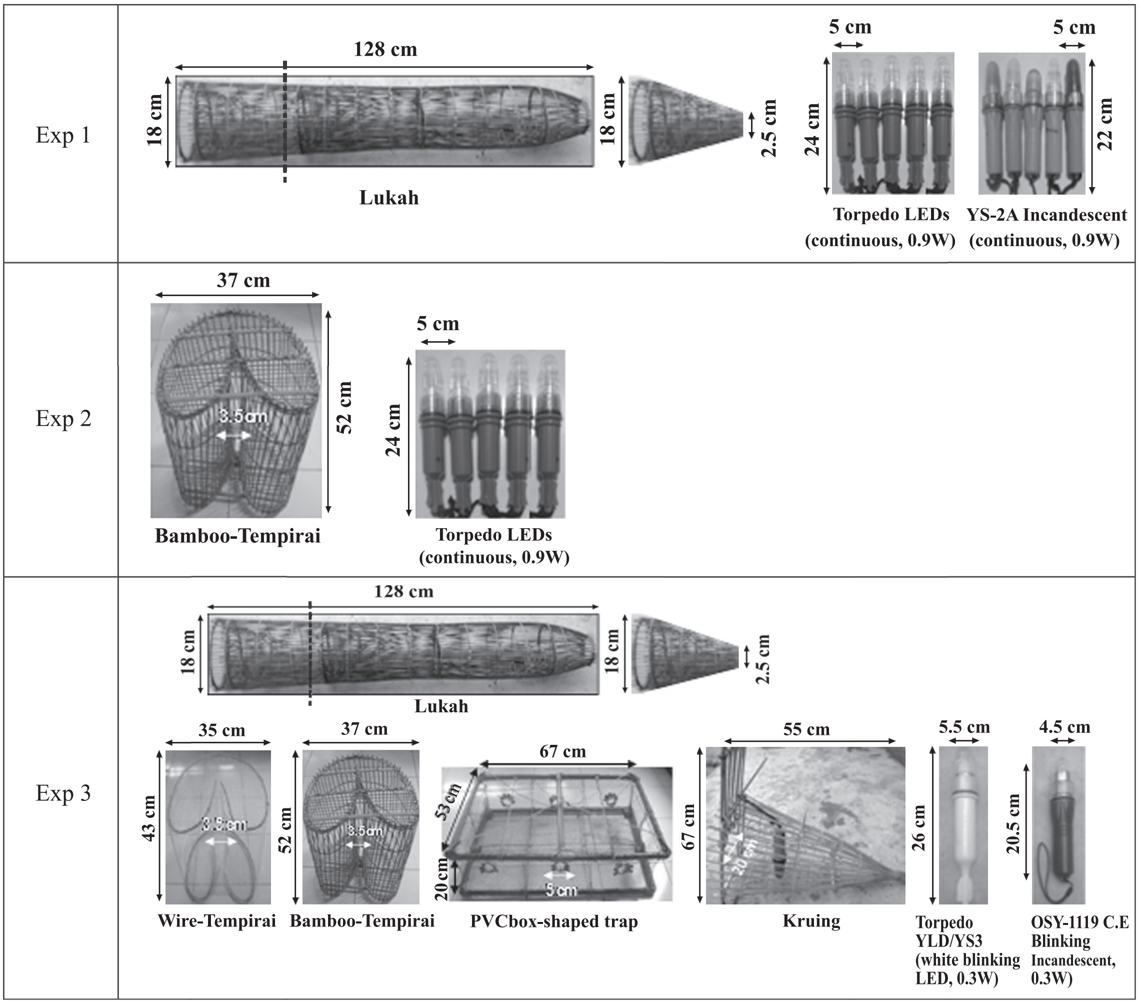

Figure 2. The traps and lights used during the trapping experiments in Sungai Sipai flood swamp.

The light traps were tested randomly in a flooded swamp area and under highly vegetated habitat. Illumination began 1 h before sunset, and traps were retrieved the next morning. On each sampling date, each trap was separated from the others by approximately 3 m, which was considered sufficient to the swampy circumstances to avoid the effective range of each source of light between the traps. Each trap in the groups was used repeatedly over seven night operations. The trials consisted of 161-trap hauls/light type using 1-night submersion time of 14 h. This includes wrapped up the whole body of the traps with a black plastic except at the front of the slit entrances to increase catch efficiency. Light trap samples were standardized to a catch per unit effort (CPUE) of total catch (g) per 7-nighttrip. After retrieval, the catches were counted, identified for species, and measured for total length and weight. For additional information, the light trap cost per unit was about US$ 10.

Statistical Analysis

The Mann-Whitney test was used to establish whether or not significant differences existed between the catches of two light traps or that of the tested light trap with the control. The Kruskal-Wallis test was applied to determine if there were significant differences in the total catches of the five different trapping treatments. A post-hoc analysis test was performed using The Multiple Comparison to see which catch differed significantly among the traps (Conover, 1980). All statistical analyses were considered significant at 5% ($p<0.05$).

RESULTS

Overall Findings

A total of 403 specimens assigned to 13 species of 11 families were collected throughout the study period (Table 1).

Table 1. The catch species composition sampled from Sungai Sipai flood swamp using various lighted traps over 7-night sampling periods.

Group/ Local name	English name	Scientific name	Family	No. catch	TL (mm)	Weight (g)
Crustacean:				**6**		
1. Udang Ragang	Swamp shrimp	*Macrobrachium sintangense*	Palaemonidae	6	3.2-5.4	0.8-2
Mollusc:				**338**		
1. Siput gondang	Gondang snail	*Pila scutata*	Ampullariidae	238	-	1545
2. Haliling	Rice snail	*Bellamnya javanica*	Viviparidae	100	-	139
Fish:				**56**		
1. Sepat rawa	Three-spot gourami	*Trichogaster trichopterus*	Osphronemidae	33	6.5-11.0	3-23
2. Kelatau	Giant betta	*Betta anabatoides*	Osphronemidae	5	3.6-4.7	1-3
3. Papuyu/Betok	Climbing perch	*Anabas testudineus*	Anabantidae	1	3.5	1
4. Sanggiringan	Two-spot catfish	*Mystus nigriceps*	Bagridae	6	11.0-17.5	10-28
5. Nila	Nile tilapia	*Orheochromis niloticus*	Cyprinidae	2	14.5-21.8	54-154
6. Puyau	Bulu barb	*Puntioplites bulu*	Cyprinidae	2	10.2-11.2	16-23
7. Dara manginang	Tiger barb	*Puntius anchisporus*	Cyprinidae	1	5.5	2
8. Lele dumbo	King catfish	*Clarias gariepinus*	Clariidae	5	20.3-23.9	57-103
9. Belut	Swamp eels	*Monopterus nemurus*	Synbranchidae	1	45	112
Other aquatic animals:				**3**		
1. Kumbang air	Water beetle	*Dysticus verticalis*	Dytiscidae	1	2.5	4
2. Ular rawa	Rainbow swamp snake	*Enhydris enhydris*	Homalopsidae	2	46-61	115-141

There was a large variability in the number of catch between mollusc and other aquatic species collected. The shrimp catch was represented by the species *Macrobrachium sintangense* (De Man, 1898) only, with sizes ranging from 3.2 to 5.4 mm total length and 0.8 to 2.0 g weight. The mollusc catch was dominated by *Pila scutata* (Moussan, 1848) at 70.4%, and the rest consisted of *Bellamnya javanica* (von den Bush, 1844) at 29.6%. The fish catch composed of 58.9% *Trichogaster trichopterus* (Pallas, 1770), 10.7% *Mystus nigriceps* (Valenciennes, 1840), 8.9% *Betta anabatoides* (Bleeker, 1851), 8.9% *Clarias gariepinus* (Burchell, 1822), 3.6% *Oreochromis niloticus* (Linnaeus, 1758), 3.6% *Puntioplites bulu* (Bleeker, 1851), 1.8% *Puntius anchisporus* (Vaillant, 1902), 1.8% *Anabas testudineus* (Bloch, 1792), and 1.8% *Monopterus nemurus* (Bleeker, 1846). Fish sizes ranged from 3.5 to 45 mm TL and 1 to 154 g weight. In addition, two other aquatic animals, namely *Dysticus verticalis* (Say, 1823) and *Enhydris enhydris* (Schneider, 1799) were also collected; their sizes ranged from 2.5 to 61.0 mm TL and 4 to 141 g weight.

Effect of Using Different Colours of LED and Incandescent Light in Trap Fishing

Two groups of colour LED and colour incandescent *Lukah* traps with continuous patterns were examined in Experiment 1. There was no statistically significant difference in the total number of catch among those traps (Table 2) (Kruskal-Wallis test, $H_{LED} = 3.248$; $H_{INC} = 1.593$, $p>0.05$).

Table 2. The number and weight of catch composition between colour LED traps and colour incandescent traps (*Lukah*).

Light trap types/Species	Number of catch						Weight (g)					
LED *Lukah*	B	G	Y	R	W	C	B	G	Y	R	W	C
Bellamnya javanica	5	3	2		3	1	6	7	3		4	1
Pila scutata	10	4	3	3	11	1	64	56	54	14	159	7
Mystus nigriceps	1		1		1		12		13		22	
Trichogaster trichopterus		2		2				21		13		
Total	16	9	6	5	15	2	82	84	70	27	185	8
CPUE							11.7	12.0	10.0	3.9	26.4	1.1
Incandescent *Lukah*	B	G	Y	R	W	C	B	G	Y	R	W	C
Bellamnya javanica		1			1			1			2	
Pila scutata	9	6	5	13	8	2	31	41	56	40	43	9
Mystus nigriceps					1						11	
Trichogaster trichopterus	2	1	1		2		12	6	6		19	
Monopterus nemurus	1						112					
Clarias gariepinus		1		1		1		89		85		103
Enhydris enhydris		1	1					115	141			
Total	12	10	7	14	12	3	155	252	203	125	75	112
CPUE							22.1	36.0	29.0	17.9	10.7	16.0

B = Blue; G = Green; Y = Yellow; R = Red; W = White; and C = Control

The Mann-Whitney test showed that the blue and white LED traps collected more catch than the control as well as the blue, red, and white incandescent traps ($p<0.05$). Both types of traps had some success in catching *Pila scutata*, followed by *Bellamnya javanica, Mystus nigriceps, Trichogaster trichopterus*, *Monopterus nemurus* and *Clarias gariepinus,* but was not effective in catching shrimp. The Mann-Whitney test showed that there were no significant differences between the weight of colour LED and incandescent traps ($T = 1.215$, $p>0.05$). Catch per unit effort (CPUE) of the LED and incandescent traps ranged from 1.1 to 26.4, and 10.7 to 36.0, respectively.

In Experiment 2, the five colour *Tempirai-bamboo* LED traps with continuous patterns and the control were investigated. The results showed that there was no statistically significant difference in the total number of catch among the six traps as appears in Table 3 (Kruskal-Wallis test, $H = 3.513$, $p<0.05$). The most dominant species found in the experiment included *Pila scutata* (Ampullariidae), followed by *Bellamnya javanica* (Viviparidae), which were caught mainly by blue and green colour traps. These traps were also effective for catching *Puntioplites bulu, Betta anabatoides*, *Trichogaster trichopterus, Macrobrachium sintangense* and *Dysticus verticalis*. From field observation, *Pila scutata* was commonly found in each trap, but *Anabas testudineus, Clarias gariepinus* and *Orheochromis niloticus* are rarely caught in this time. The least number of catches was found in the control trap (total 4 specimens). In regard to weight of catches, all LED traps tested were significantly higher than the control trap indicating that the colours affected the number of catches. CPUE was ranged from 2.3 to 61.6.

Table 3. The number and weight of catch composition obtained from colour LED traps (*Tempirai-bamboo*)

Light trap types/Species	Number of catch						Weight (g)					
LED *Tempirai-bamboo*	B	G	Y	R	W	C	B	G	Y	R	W	C
Bellamnya javanica	11	25	6	8	1		18	29	8	17	1	
Pila scutata	56	26	23	17	11	1	381	217	107	81	43	1
Puntioplites bulu	1	1	3				23	16	25			
Betta anabatoides	1	1				2	1	1				5
Macrobrachium sintangense	3				1		4				2	
Dysticus verticalis	1						4					
Trichogaster trichopterus		3		4	4	1		23		37	47	10
Anabas testudineus			1						1			
Clarias gariepinus				1						57		
Orheochromis niloticus					1						154	
Total	73	56	33	30	17	4	431	286	141	192	93	16
CPUE							61.6	40.9	20.1	27.4	13.3	2.3

B = Blue; G = Green; Y = Yellow; R = Red; W = White; and C = Control

The comparative fishing trials showed that *Tempirai bamboo* LED trap (experiment 2) collected specimen were four times higher than *Lukah* LED trap (experiment 1) (The Mann-Whitney test, T = 6.658, p<0.01). The weight of catch, except in *Tempirai* white LED trap, was also generally accepted as unfavourable. In addition, *Pila scutata, Bellamnya javanica* and *Trichogaster trichopterus* were frequently found in each individual trap throughout the sampling periods.

Relationship Between Size and Shape of Trap with its Catch Efficiency

The performance of *Lukah, Tempirai-bamboo, Tempirai-wire, PVC box-shaped trap,* and *Kruing* associated with white blinking LED or with blinking incandescent were evaluated in Experiment 3. There were no significant differences in the total number of catch among these traps as shown in Table 4 Kruskal-Wallis test, $H_{LED} = 4.486$; $H_{INC} = 3.342$, p>0.05). Overall, *Tempirai-wire* collected more specimens than *Tempirai-bamboo*, *PVC box-shaped trap* or *kruing*. In terms of species composition, *Tempirai-wire* was effective for catching *Pila scutata, Bellamnya javanica, Mystus nigriceps, Trichogaster trichopterus, Orheochromis niloticus, Puntius anchisporus*, *Clarias gariepinus* and *Macrobrachium sintangense*. Thus performance of light traps had an effect on number of catches. In regard to weight of catches, white blinking LED traps were

Table 4. The number and weight of catch composition between white blinking LED and blinking incandescent light of various traps

Light trap types/Species	Number of catch					Weight (g)				
White blinking LED	A	B	C	D	E	A	B	C	D	E
Bellamnya javanica	6	5	3			8	8	6		
Pila scutata	11		11		1	50		47		5
Mystus nigriceps	1				1	10				28
Trichogaster trichopterus	2		4			17		29		
Betta anabatoides		1					2	0		
Orheochromis niloticus			1					54		
Puntius anchisporus			1					2		
Clarias gariepinus			1					79		
Total	20	6	20	0	2	85	10	138	0	33
CPUE						21.3	2.5	34.5	0	8.3
Blinking incandescent light	A	B	C	D	E	A	B	C	D	E
Bellamnya javanica	1	17	1			1	18	1		
Pila scutata			4	1	1			17	21	1
Trichogaster trichopterus	1		1			8		7		
Macrobrachium sintangense			2					2		
Total	2	17	8	1	1	9	18	27	21	1
CPUE						3.0	6.0	9.0	7.0	0.3

A = *Lukah*; B = *Tempirai-Bamboo*; C = *Tempirai-Wire*; D = *PVC box-shaped trap*; E = *Kruing*.

significantly higher than that of blinking incandescent traps (The Mann-Whitney, T = 5.656, $p<0.01$). CPUE of white blinking LED and incandescent blinking traps were ranged from 2.5 to 34.5 and 0.3 to 9.0, respectively.

DISCUSSION

It is acknowledged that this study is the first record of trapping with underwater lights in Sungai Sipai flood swamp. The latest study was made by Mukhlasin (2004, unpubl. data) who provided basic information on the use of *Tempirai-bamboo* in conjunction with 5 and 10 W electric lights and the control (with no light) to sample fish from Melayu Hulu River (the nearest-neighbouring village). He used electric lights that were placed on top of the traps while the gear bodies were partially submerged into the water. The results showed that *Tempirai* with no light was the most effective among the two lighted traps, but no clear explanation of this result was provided. On the other hand, the results showed positive behavioural responses of the animals without direct contact with the lights. Based on this assumption, a series of trap experiments using underwater lights was conducted for providing better results, increased energy efficiency through the use of LED and their applicability to some specific conditions (e.g. under the rain, etc).

There was a large variability in number of catch between mollusc and fish collected. The most obvious trend observed during this study was Gondang snail (*P. scutata*) and rice snails (B. javanica) were excessively found in the light traps. Gondang snail contains high protein and used for duck food, while rice snail (locally known as *haliling* or *tutut*) is served as delicious food. Economic value species, namely *Trichogaster trichopterus, Mystus nigriceps, Orheochromis niloticus, Monopterus nemurus* and *Clarias gariepinus* caught by lighted traps are commonly known in this swamp and meet local market size; however, the use of lift net, cast net or scoop net is considered not effective sampling gears for such species due to their densely vegetative behaviour. We could not sample the adult *Anabas testudineus* (Bloch, 1792), *Channa striata* (Bloch, 1793) or *Trichogaster pectoralis* (Regan, 1910) during this study. This is because they possibly inhabit the deeper waters located beyond the range of the sampling area. Only the juvenile climbing perch was caught in a negligible number (Table 1). This implies that in order to effectively catch more species, performance of light should be improved and the sampling sites should cover habitats where people rarely come to fish. This indicates that more detailed data will be needed to analyze the factors leading to this variation. The fish production in particular climbing perch depends on natural harvest (Azizi and Novenny, 2001; Prasetyo, 2005b; Yunita, 2010) while measures of fish farming are still deficient due to high mortality at fingerling stage and slow growth. At the same time, the need for wild seed for aquaculture is still high. Therefore, understanding the food habits, habitat and reproduction biology of climbing perch at different stages is necessary (Ansyari *et al.*, 2008; Rupawan, 2009). In line with this, the use of lights seems feasible for trapping juvenile (fingerling) and adult climbing perch and other important species to fill the gap.

Utomo and Prasetyo (2005) suggested collecting adult climbing perch over 12 cm TL (40 g weight) for commercial and breeding purposes. Thus, light traps have clear implications in fisheries management planning since the fishing activity is open throughout the year.

In this study, *Tempirai-bamboo* LED trap has higher catch rate as compared to *Lukah* LED trap because the area of entrance was bigger in *Tempirai-bamboo* trap. In other case, the green and yellow incandescent *Lukah* traps proved very useful in sampling rainbow swamp snakes (*Enhydris enhydris*) that were not collected by other traps (e.g. *Tempirai* or *Kruing*). This is because *Lukah* had one entry funnel mounted on the inside of conical-shaped and tapering to an approximately 2.5 cm wide opening resulting in the snakes were unable to escape. Therefore, *Lukah* might be useful in eradication programs focusing on eliminating the snakes from the swampland; however, more trials are necessary.

It is commonly known that fishing activity usually increases during the dry season or low tide when fish are easily collected (Utomo and Prasetyo, 2005; Prasetyo *et al*., 2005; Prasetyo, 2005a; Asyari, 2006). On the contrary, in many places (e.g. Lubuk Lampan in South Sumatera and Danau Panggang in South Kalimantan) fishermen tend to stop fishing during rainy season or high tide/flood because it is considered inefficient and ineffective (Utomo, 1995; Prasetyo, 2005b; Rupawan, 2007). The conduct of trapping experiments in flood swamp area during rainy season presented us with many challenges. Understandably, it was not easy to fish under such conditions because the fish were more spread out and were quite difficult to catch even when using conventional fishing gears such as lift net, cast net, scoop net or hand line. This was exacerbated by the unavailability of a small boat for trap deployment, which was subsequently completed all by walking and manual operation. In addition, the depth and turbidity of the swamp restricted space and motion for our sampling activity. Moreover, trapping under densely vegetated habitats may cause short sighting distance for the animals to respond to the lights. Nevertheless, this study supports the concept that the lights were able to entice aquatic animals entering into traps even when using 0.24 W LED powered by 3-volt dry-cell batteries as well as supports our previous works (Ahmadi *et al*., 2008; Ahmadi and Rizani, 2012).

Beside the conventional method, we also made an additional work to increase catch efficiency by covering the whole body of the traps with a black plastic except at the front of the slit entrances in order that aquatic animals focused entering the traps. Unfortunately, the results obtained were unsatisfactory. Except the aforementioned challenges, the one main technical problem was attributable to the operational lights which were under-exposed. LEDs emit a limited intensity of light which has a relatively narrow angle range, while incandescent bulbs illuminate in all directions. Thus, trapping strategies may need to be adjusted to improve the catch efficiency, for example, by putting a reflector on the current lights set-up or by placing a flashlight inside the trap (e.g. *Lukah* and *Tempirai-bamboo*) to provide a focused beam of light, as well as increase the power of battery, although these modifications are still open for discussion.

The catch per unit of effort (CPUE) presented in this study was roughly standardized for all treatments although this approach may not be appropriate because the length of time that the lights were operational was variable and dependent on the type of light devices and variance in battery life. For example, a 0.9 W incandescent light YS-2A in Experiment 1 was dimmed faster than 0.9 W Torpedo LED under the same operation time. For future applications, the use of LED will provide various advantages over incandescent lights, including higher energy efficiency of LEDs, the greater availability of colour of LED, and their longer durability with lower maintenance as compared to the incandescent. This study also enabled us to confirm that the use of blinking LED trap was more effective than that of blinking incandescent trap. In terms of costs, the present light trap is cheaper (~US$ 10 per unit) as compared to the other traps, which use relatively expensive materials either for the lighting system or the main body (mostly plexiglass), for instance Stobutzki trap US$ 300 (Stobutzki and Bellwood, 1997), Bucket trap US$ 120 (Watson *et al*. 2002) and Bottle trap US$ 70 (Mwaluma *et al*., 2009). Installation of underwater instruments (e.g. video-camera and digital light-meter) would also be helpful to visualize interactions between the animals and light traps.

CONCLUSION

The results of trapping experiments in swampy area demonstrated that colour incandescent trap (*Lukah*) has significantly higher the amount of catches than colour LED trap for the most part. *Tempirai-bamboo* trap fishing with colour LEDs differed significantly from control traps. Comparative fishing trials showed that *Tempirai-bamboo* LED trap collected specimens four times more than *Lukah* LED trap. The performance of light traps had an effect on the number of catches. The blinking LED trap was more effective than the blinking incandescent trap. The collection of detailed species composition from swampy areas is still hindered by technical obstacles that have yet to be completely resolved to support future research. For future applications, the use of LED traps is strongly recommended.

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