Journal of Fisheries
Volume 5 Issue 2 Pages: 489–496 August 2017
Peer Reviewed | Open Access | Online First

eISSN 2311-3111
pISSN 2311-729X

DOI: https://doi.org/10.17017/j.fish.40

Original Article

Fish and fishing gears of the Bangkau Swamp, Indonesia

Irhamsyah • Ahmadi • Rusmilyansari

Faculty of Marine and Fisheries, Lambung Mangkurat University, Banjarbaru 70714, South Kalimantan, Indonesia.

Correspondence
Dr Ahmadi; Faculty of Marine and Fisheries, Lambung Mangkurat University Banjarbaru 70714, South Kalimantan, Indonesia.
Email: ahmadi@unlam.ac.id

Manuscript history
Received: 23 Jan 2017; Received in revised form: 12 May 2017; Accepted: 29 Jun 2017; Published online: 01 Jul 2017

Citation
Irhamsyah, Ahmadi and Rusmilyansari (2017) Fish and fishing gears of the Bangkau Swamp, Indonesia. Journal of Fisheries 5(2): 489–496. DOI: 10.17017/j.fish.40

Abstract
This study contributes to the knowledge of traditional fishing gears and the weight-length relationship of fish species from the Bangkau Swamp, Indonesia. Although the use of fishing gears in Bangkau swamp complies with the local regulation but still, some weaknesses have been identified and the options for improvements are being proposed. The length-weight relationship of three dominant fish species, *Channa striata, Trichogaster trichopterus*, and *T. pectoralis* were analyzed. The *b* values ranged from 1.531 to 2.646, with R^2 values ranged from 0.814 to 0.917 indicating negative allometric growth pattern; the species becomes leaner as the length increases. The food availability and temperature may have an effect on the growth pattern since the fishes were sampled in dry season. To the best our knowledge, this study is the first reference on WLR for swamp fish in the Bangkau village.

Keywords: Freshwater fish; fishing gear; weight-length relationship; Bangkau Swamp; South Kalimantan.

1 | INTRODUCTION

The Bangkau Swamp is one of the prominent fishing areas in South Kalimantan, Indonesia. It is estimated having ichthyomass more than 1.5 tons ha^{-1} $year^{-1}$ (Rahman 2005) and more than 34 fish species are found in this area (Mashuri *et al*. 1998). Like many other similar water bodies in other countries (e.g. Galib *et al.* 2010; Samad *et al.* 2010) this water body plays an important role in meeting fish protein requirements adjacent areas- not only for Hulu Sungai Selatan (HSS) district but also for South Kalimantan province (Herliwati and Rahman 2011). The villagers use different types of fishing gears such as gillnet, stage-trap, hand-lines and portable lift net to harvest fishes from the swamp. All the fishing gears are being developed by villagers to catch fishes selectively and thereby to maintain sustainability of fish production from this valuable wetland. However, this wetland is vulnerable to open access since fishing activity is also done by fishermen from neighboring villages. This makes sense freshwater fishes of this swamp have long been the major source of income for local people. Thus, the Bangkau Swamp fishery is of great concern to the local government, local organization, university, and fisheries experts globally (Pomeroy 1995; Yunita 2010; Slamat *et al*. 2012; Rukmini *et al*. 2013).

Few studies have already been conducted on different aspects of the Bangkau Swamp fisheries including agro-poultry and fisheries (Mashuri *et al*. 1998), eco-biological reproduction of snakehead (*Channa striata*; Bijaksana 2006), food habits and bio-limnology habitat of climbing perch (*Anabas testudineus*; Ansyari *et al*. 2008), characteristic of hinterland swamp and fish diversity (Yunita 2010), eco-biology of *Beje* fisheries (Herliwati and Rahman 2011), genetic conservation of climbing perch (Slamat *et al*. 2012), natural food of climbing perch larvae (Rukmini *et al*. 2013), and restocking of snakehead (Bijaksana *et al*. 2015). Meanwhile the various aspects (e.g. fishing gears and catch composition) of capture fishery are still unevaluated which is very important in managing sustainable fisheries (Galib *et al.* 2009a, 2009b).

Fishing in the Bangkau Swamp is open throughout the year and the catch trend has been declined in the last few years due to over fishing (Herliwati and Rahman 2011). Fishing is carried out by both fishers from Bangkau village and beyond. Consequently, some species of fish became rare and the size of fish is becoming smaller than as usual. This situation is further being exacerbated with the use of electric and potassium by few people to collect fish quickly. This will actually threaten fish and other aquatic species especially because of their applications near the spawning and nursery grounds. This eventually threatens fishers' livelihoods. Facing this situation, the local government through Fisheries Department of HSS district has been promoting and socializing responsible fishing programmes through fisheries extension and other relevant events as well as introducing fish farming business (e.g. climbing perch and snakehead) to the villagers. At the same time, the Faculty of Marine and Fisheries of the Lambung Mangkurat University, South Kalimantan also pays attention to make traditional fishing methods more eco-friendly through gear modification, skills of gear placement, or swamp fish behavioral assessment as well as re-stocking models for several important fish species of high commercial importance. However, it is also necessary to analyze existing fishing gears and catch details to ensure better fisheries management for the swamp through providing recommendations.

2 | METHODOLOGY

2.1 | Study site

The study was conducted at Bangkau village which is about 17 km from Hulu Sungai Selatan district of South Kalimantan province (Figure 1), located at 02°43'S and 115°13'E. The village consists mostly of wetland area with extremely high fluctuation of water level, varies from 0.5 – 6.5 m. About 615.5 ha of the area of this village are being used for fisheries followed by agricultural crop production (360 ha) and residential area (10 ha). There are about 1,600 people live in the 20 km^2 wetland area. The area of the wetland varies with the level of rainfall. During rainy season (October-March), the wetland is entirely flooded and the fishes become difficult to catch. Inversely, during the dry season (April-September) the wetland is covered by very dense vegetation and the fish are being concentrated on the sludge holes or backwater and allow fishers to catch them. This regular changing from water area to high plant biomass is an important factor in regulating high production of freshwater fishes in the wetland. Fishing activities usually start from February and continues up to October. Rukmini *et al*. (2013) reported that the water productivity of Bangkau Swamp is classified as moderate and reported plankton abundance from 0.1 - 40×10^6 cell m^{-3}. There are six species of plankton *i.e. Mougeotia* sp., *Coconeis* sp., *Keratella* sp., *Chlorococcum* sp., *Brachionus* sp., and *Navicula* sp. are abundantly found in the swamp which are also natural food sources for fish. This research was carried out for a period of six months from July to November 2014.

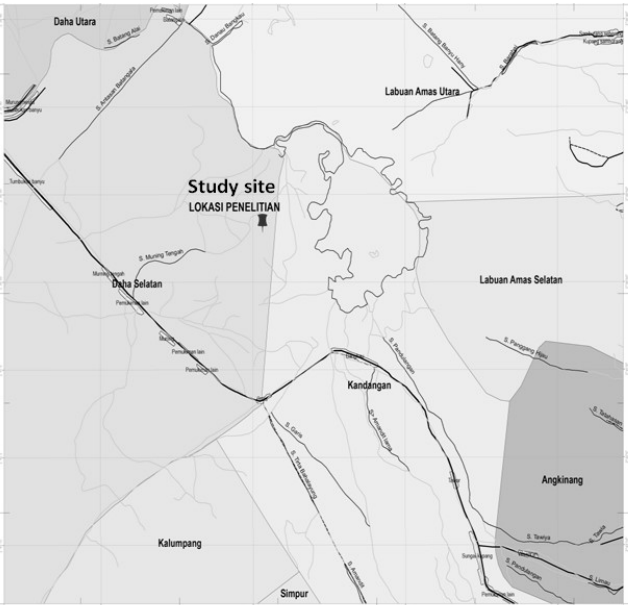

FIGURE 1 Map showing the location of Bangkau Swamp in HSS District, South Kalimantan Province, Indonesia.

2.2 | Statistical analysis

During the research, the catches were counted, identified up to species using taxonomy and key identify fish (Saanin 1986). Total length and weight of each individual fish have been measured by using standard measuring scale (up to the nearest mm) and digital balance (up to the nearest 0.01 g) respectively. The weight-length relationship (WLR) was calculated using the equation $W = {}_aL^b$ (Ali *et al*. 2013); where *W* is the total weight in g, *L* is the total length in cm, *a* is constant and *b* is exponent. The parameters *a* and *b* were estimated by linear regression of the transformed equation: log W = log a + b × log L. Additionally, the coefficient correlation of *r* was estimated, and the *b*-value for each species was compared to the hypothetical value of 3 (Oscoz *et al*. 2005); where $b > 3$ represents positive allometric growth (*i.e.* weight increases more than length), $b < 3$ represents negative allometric growth (*i.e.* length increases more than weight) and $b = 3$ represents isometric growth (i.e. both length and weight are increasing at the same rate). Frota *et al*. (2004) reported that the parameter '*b*' of the WLR equation, also known as allometry coefficient has an important biological meaning, indicating the rate of weight gain relative to growth in length.

3 | RESULTS

3.1 | Fishing gears

A total of eight commonly used fishing gears in the Bangkau village were investigated. These fishing gears were locally known as *Banjur*, *Lalangit*, *Pengilar*, *Tempirai*, *Hancau*, *Lunta*, *Lukah*, and *Rengge* (Figure 2).

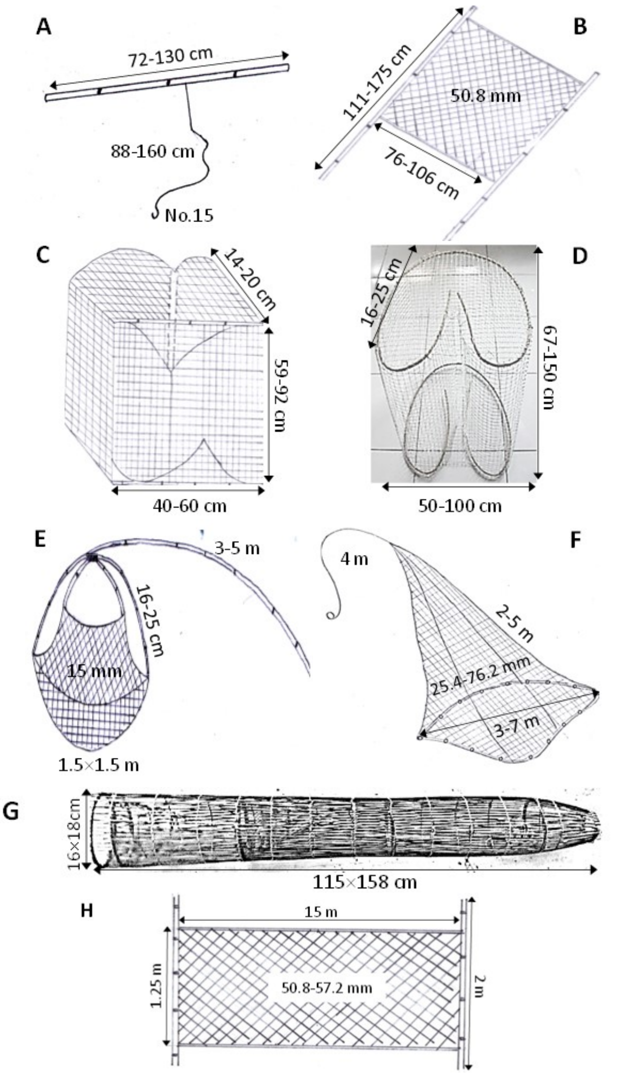

FIGURE 2 The fishing gears used in Bangkau swamp. Banjur (stage lines, A); Lalangit (horizontal gillnet, B); Tempirai (stage trap, C); Pengilar (basket trap, D), Hancau (portable lift net, E), Lunta (cast net, F), Lukah (fish trap, G), and Rengge (gillnet, H).

Banjur (stage lines) is consists of 72 – 130 cm long bamboo with 15 hooks and 88 – 160 cm long nylon rope. The distance between rope and hook is about 25 cm. The frog (*Rana cancrivora*) is used as bait in this fishing gear. Target species are *Channa striata* and *Mystus nemurus*. The average size of *Banjur* in the study area seemed larger than *Banjur* operated in other geographical areas, e.g. Martapura sub-district.

Lalangit (horizontal gillnet) is made of monofilament nylon with 50.8 mm mesh size that is attached between two 111 – 175 cm long bamboo laths with opening distance of 76 – 106 cm. In practice the fisher supply rice bran over the net to attract the fish. This net deployed in the morning and retrieved every 1 – 2 hours. *C. striata*, *Anabas testudineus*, *Trichogaster pectoralis* are often caught by *Lalangit*. The average size of *Lalangit* seems to be typically larger than that of *lalangit* operated in Sungai Batang-Martapura sub district.

Pengilar (basket trap) is made of wire of 40 – 60 cm long, 14 – 20 cm wide and 59 – 92 cm high. It has the entrance and exclusion openings at the opposite side. *Pengilar* is placed vertically and moored at the pole that is planted at the bottom. Target fish species include *Helostoma temminckii*, *T. pectoralis* and *Monopterus albus*.

Tempirai (stage trap) is similar to *Pengilar* but bigger in the size. It is made of heart-shaped wire, generally 50 – 100 cm long, 16 – 25 cm wide, 67 – 150 cm high and 5 cm wide opening. A small trap door either on the left or right side allows removal of catches. The snail (*Achanit*a sp.) is used as bait and placed inside the trap. The trap is set in the riverbank, swampy area or paddy field before sunset and retrieved the next morning or mounted on a high tide and removed after low tide. Major species caught are *T. trichopterus* and *M. albus* are often getting caught in the fisher's trap. The average size of *Tempirai* is typically larger than that of *Tempirai* used in Sungai Batang-Martapura sub district (Ahmadi *et al*. 2014)

Hancau (portable lift net) is consisted of *tampuatar* (3 – 5 m long bamboo)*, rangau* (bamboo lath of 155 – 182 cm and diameter of 2 cm for connecting between nets) and *tabulilingan* (buffer). The size of the net is about 1.5 m^2 with 15 mm mesh size. In principle, *Hancau* is operated by the way of waiting for the fish to gather in the area nets for 25 – 30 minutes and lifted afterward. Mostly *T. trichopterus* are trapped in this net.

Lunta (cast net) is a circular net with small weights distributed around its edges. The net is cast or thrown by hand in such a manner that it spreads out on the water and sinks. This technique is called net casting or net throwing. Fish are caught as the net is hauled back in. It is made of monofilament nylon net of 25.4 – 76.2 mm mesh size. Total length of the net is about 2 – 5 m long and has a radius which ranges from 3 – 7 m. Weights (approximately 4.5 kg) are in form of iron rings (diameter: 3.2 cm) distributed around the edges. When the net is full, a retrieval clamp, which works like a wringer on a mop, closes the net around the fish. The net can be cast from a boat or from the riverbank. Commonly caught fishes with *Lunta* include *C. striata*, *A. testudineus*, *T. pectoralis* and *T. trichopterus*.

Lukah (fish trap) is an elongated tube-shaped fishing gear made of bamboo (115 – 158 cm long) of 16 – 18 cm diameter. There is one entry funnel mounted on the inside of conical-shape for fish to enter and tapering inside to about 2.5 cm in diameter, called *hinjap* (one-way valve, made of elastic rattan; there are 2-3 *hinjap* installed about 35 – 40 cm one to other), and the other side is covered with cork-stopper so that the fish that have entered cannot escape. The traps are deployed in the swamp in densely vegetated areas of slow or no current in the morning and retrieved in the afternoon. They are either submerged partly at an oblique angle of approximately 15º or lowered to the bottom weighted by a sandbag depending on the depth of water. Mostly *C. striata*, *A. testudineus*, *Helostoma temminckii*, *T. pectoralis*, and *M. albus* are trapped in *Lukah*. The average size of *Lukah* is slightly smaller than that of *Lukah* used in Sungai Batang-Martapura sub district.

Rengge (gillnet) is typically made of monofilament nylon with 50.8 – 57.2 mm mesh size. It is about 15 m long and 1.25 m high, equipped with weights at the bottom and floats at the top, and is moored at the two poles that are planted at the bottom of each end. However, installation of *Rengge* can vary depending on the fish caught and its habitat. Mostly *A. testudineus* and *T. pectoralis* are trapped in this gear.

3.2 | Fish fauna

A total of 188 specimens belonged to 7 species of 6 families were collected throughout the research period (Table 1). The fish catch composed of *Trichogaster trichopterus* (31.38 %), *T. pectoralis* (20.74 %), *Anabas testudineus* (17.02 %), *Helostoma temminckii* (12.23 %), *Channa striata* (11.17 %), *Monopterus albus* (5.85 %) and *Mystus nemurus* (1.60 %) with total length and body weight varied from 50 to 570 mm and 1 to 1500 g respectively.

The WLR for three species i.e. *C. striata, T. trichopterus* and *T. pectoralis* showed that the *b* values were significantly lower than critical isometric value ($b < 3$), indicating negative allometric growth pattern in all species. All estimated *b*-values in the WLR equation were within the range 1.531 and 2.646, with R^2 values ranged from 0.814 to 0.917. A strong relationship between length and weight of fish were observed (Figure 3). No significant difference was observed between the slopes of the species ($P > 0.05$).

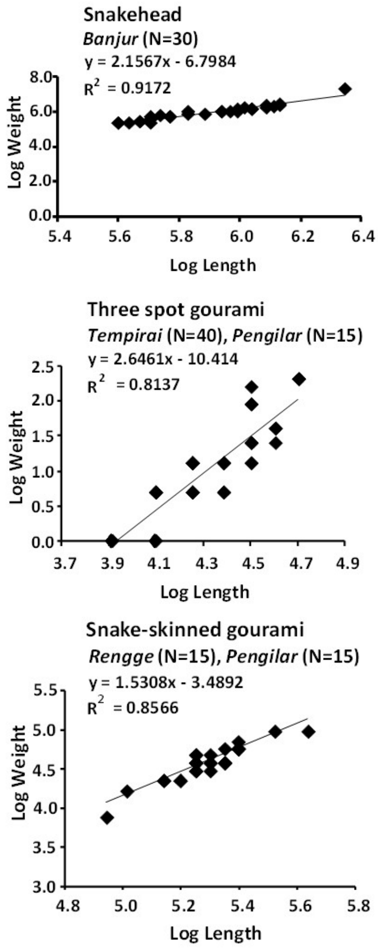

FIGURE 3 The relative growth curves (negative allometric; length-weight relationship) for three fish species sampled from Bangkau Swamp using the selected fishing gears.

4 | DISCUSSION

Diversity and intensity of fishing gears used in a water body play a key role in maintaining status of fish biodiversity and can be a significant threat to fish fauna (Chaki *et al.* 2014; Galib 2015; Joadder *et al.* 2015; Galib *et al.* 2016). All the gears described in this study demonstrate the simplicity of its design and fabrication and represent their ease of operation. The fishers are always humble to share their traditional indigenous knowledges as well as receptive to new ideas. In our investigation, *Banjur* is considered the most effective gear for snakeheads. *Tempirai* and *Hancau* are the least preferred fishing gears and primarily used to capture small fishes (< 100 mm). The escape gaps and trap density of *Tempirai* and *Lukah* are still not clear at present. *Hancau* fishers understand that the mesh size they are using at present is detrimental to sustainability of catches. Net fishers acknowledged that net length and mesh sizes were an issue and in all villages the idea of defining standards length and mesh sizes. Meanwhile, the operation of *Lunta* were more often limited within marsh vegetated habitat and targeted fish species. Basically, the fishing gears used in the study area comply with the local regulation. By-catch is insignificant as all the harvested fishes were being sold which means that the benefits are widely spread. Thus, this represents that the improvements of the selected fishing gears were necessarily done.

TABLE 1 Catch composition of different fishing gears used in the Bangkau Swamp.

Gear type/Local name	English name	Scientific name	Family name	Total catch	Total length (mm)	Weight (g)
***Banjur* (stage line)**						
1. Haruan	Snakehead	*Channa striata*	Channidae	15	270–570	200–1500
2. Baung	Catfish	*Mystus nemurus*	Bagridae	3	270–410	200–800
***Lukah* (fish trap)**						
3. Haruan	Snakehead	*Channa striata*	Channidae	2	270–300	200–220
4. Papuyu	Climbing perch	*Anabas testudineus*	Anabantidae	5	80–140	15–56
5. Tambakan/ Biawan	Kissing gourami	*Helostoma temminckii*	Helostomatidae	3	130–200	50–150
6. Sepat siam	Snake-skinned gourami	*Trichogaster pectoralis*	Osphronemidae	2	150–190	70–100
7. Belut	Swamp eels	*Monopterus albus*	Synbrancidae	4	260–410	17–77
***Tempirai* (stage trap)**						
8. Sepat	Three-spot gourami	*Trichogaster trichopterus*	Osphronemidae	40	50–110	1–10
9. Belut	Swamp eels	*Monopterus albus*	Synbrancidae	3	350–420	24–71
***Pengilar* (basket trap)**						
10. Tambakan/ biawan	Kissing gourami	*Helostoma temminckii*	Helostomatidae	20	130–250	50–200
11. Sepat siam	Snake-skinned gourami	*Trichogaster pectoralis*	Osphronemidae	15	150–280	70–150
12. Belut	Swamp eels	*Monopterus albus*	Synbrancidae	4	360–410	45–77
***Hancau* (portable lift net)**						
13. Sepat	Three-spot gourami	*Trichogaster trichopterus*	Osphronemidae	15	50–100	1–5
***Lalangit* (horizontal gillnet)**						
14. Haruan	Snakehead	*Channa striata*	Channidae	2	270–290	200–220
15. Papuyu	Climbing perch	*Anabas testudineus*	Anabantidae	4	60–120	2–4
16. Sepat siam	Snake-skinned gourami	*Trichogaster pectoralis*	Osphronemidae	4	140–190	50–90
***Rengge* (gillnet)**						
17. Papuyu	Climbing perch	*Anabas testudineus*	Anabantidae	20	140–210	60–170
18. Sepat siam	Snake-skinned gourami	*Ttrichogaster pectoralis*	Osphronemidae	15	140–220	50–120
***Lunta* (cast nets)**						
19. Haruan	Snakehead	*Channa striata*	Channidae	2	280–310	220–310
20. Papuyu	Climbing perch	*Anabas testudineus*	Anabantidae	3	90–130	23–39
21. Sepat	Three-spot gourami	*Trichogaster trichopterus*	Osphronemidae	4	50–70	1–3
22. Sepat siam	Snake-skinned gourami	*trichogaster pectoralis*	Osphronemidae	3	170–200	80–100

In addition, there is an interesting indigenous knowledge called *Pulau Berjalan* (walking island) composed of floating aquatic plants (e.g. *Eichornia crassipes*, *Ipomoea aquatic* and *Hydrilla verticillata*) to form an island (or bridge) when they were freely moving on the water surface during high water level season. The size of floating islands with could reach about 200 m^2. Due to their very large surface area, during their movement, they occasionally covered a group of swimming fishes. Such fishes will react instantaneously and become panic because of the sudden darkness of the water due to the shading by the island. These fishes will then look for a bright place or hole because they also need a place to breath to the surface. Based on this theory, fishers in the Bangkau village make square holes just at the middle of this floating island and then over the surface of this square hole, they set up *Lalangit* to catch the fishes. The use of *Banjur* is also a promising option for collecting specimens.

The body shape of all species analyzed displays a negative allometric growth, which means that length of fish increases more than weight. From family Channidae, similar observations were found for *Parachanna obscura* (Olurin and Savage 2011), *Channa maurulius* (Rathod *et al*. 2011) and *C.* diplogramma (Ali *et al*. 2013) but contrary with the result from *C. striata* in Thailand (Satrawaha and Pilasamorn 2009) and *C. punctatus* in India (Khan *et al*. 2012). From family Osphronemidae, both species *Trichogaster Sota* in India (Paswan *et al*. 2012) and *Trichopodus trichopterus* in Iran (Jafaryan *et al*. 2014) were more or less similar to our findings. In case of *Anabas testudineus* (family Anabantidae), positive allometric was reported (Rahman *et al*. 2015). However, Kumar *et al*. (2013) recorded a negative allometric growth similar to the present study. In fish, the weight is considered to be a function of length (Weatherley and Gill 1987), and the fish length is the best indicator of production efficiency (Ghorbani *et al*. 2012). The WLR are not constant over the entire year and vary according to factors such as food availability, feeding rate, gonad development and spawning period (Bagenal and Tesch 1978), temperature and salinity (King 1996), inherited body shape (Yousuf and Khurshid 2008) and fecundity (Lawson 2011). In this study, the pattern of negative allometric growth may be attributable to the food availability and temperature since the fishes were sampled in dry season (July-September). LWR may help to develop sustainable management strategies in this region.

For further researches, evaluation of the effectiveness and efficiency of the selected traditional fishing gears from this area is of high importance. More researches are also required on the gear selectivity through modification of the net/trap shapes and sizes or by applying the '*pocketing method*' to evaluate the escape gaps and trap density of *Tempirai, Pengilar* and *Lukah*, among others. The use of '*mince teabag*' baits containing local ingredients is a promising option for *Banjur, Hancau, Lalangit, Tempirai* or *Pengilar*. A '*teabag*' baiting method has been effective in the cod longline fishery (Anon 2005) and crab pot fishery such as the Green crab *Carcinus maenas* (Behrens Yamada *et al*. 2006) and the blue swimming crab *Portunus pelagicus* (Vazquez Archdale *et al*. 2008). Research on the luring of fish schools by underwater sound is also interesting option, especially when the wetland is entirely flooded by water and the fishes are difficult to catch. The use of an audio fishing lure system for attracting fish is being developed. The success of field recording of underwater sound has been reported for the payao fishing in Philippines (Babaran *et al.* 2008). In Taiwan, researchers used aversive underwater sound to drive fish from intake areas (Wu *et al*. 2009). A *donburi* fishing method that uses sound generated underwater to attract fish has been applied in Kagoshima Prefecture of Japan (Yan *et al*. 2010). Fish behavior control methods using underwater sound in marine ranching in Japan are also being developed (Anraku *et al*. 2006). The use of fishing traps with LED (Light Emitting Diode) underwater lamps in swamp waters may provide a great challenge for us (Ahmadi 2012, 2014; Ahmadi and Rizani 2013) since there are no reports on its application in this region, so far. Thus, phototactic responses in the swamp fishes are still in question mark. By doing these suggestions, it meant that more detailed data are needed to analyze the factors leading to this variation, and the results are still open for discussion.

5 | CONCLUSIONS

Although the use of fishing gears in Bangkau Swamp complies with the local regulation but some weaknesses of the traditional fishing gears have been identified. The present study shows that the *b* values of species analyzed were significantly lower than critical isometric value, indicating negative allometric growth; the species becomes leaner as the length increases. To the best knowledge of the authors, this study is the first reference on WLR for three fish species in Bangkau Swamp. More references on WLR for other native species are required to give clear indication of their effects and make management recommendations.

ACKNOWLEDGMENTS

This research was conducted within the framework of BOPTN program, funded by Lambung Mangkurat University Banjarmasin (Grant ID 023-04.2.415150/2014). We are gratefully acknowledged the support by the village chief of Bangkau and local people during research activities. The authors also wish to acknowledge the constructive criticism of anonymous reviewers.

REFERENCES

Ahmadi (2012) Catch efficiency of low-powered incandescent light and LED light traps fishing in Barito River of Indonesia. Kasetsart University Fisheries Research Bulletin 36(3): 1–15.

Ahmadi (2014) LED light trap fishing as alternative method for harvesting American crayfish. Fish for the People SEAFDEC Bulletin 12(1): 32–37.

Ahmadi and Rizani A (2013) Light traps fishing in Sungai Sipai flood swamp of Indonesia: Recommendations for future study. Kasetsart University Fisheries Research Bulletin 37(2): 17–30.

Ahmadi, Rachman MAY, Irhamsyah and Husin S (2014) Comparison of catching efficiency of two Indonesian traditional traps, *Ayunan* and *Tamba*. Journal of Fisheries 2(2): 113–118.

Ali A, Dahanukar N and Raghavan R (2013) Length-weight and length-length relationship of three species of snakehead fish, *Channa diplogramma*, *C. marulius* and *C. striata* from the riverine reaches of Lake Vembanad, Kerala, India. Journal of Threatened Taxa 5(13): 4769–4773.

Anon (2005) Artificial baits take off-in vac-packed 'teabags'. Fisheries News International 44: 24 pp.

Anraku K, Makino T, Okawa F, Watanabe K, Masu S, Ozono H, Takeshita H, Kawamura G and Archdale MV (2006) Fish behavior control methods in marine ranching in Japan - III. Development of fish guidance device. INOC-UMS/BMRI, ICCOSMA, pp. 405–413.

Ansyari P, Yunita R, Asmawi S and Kudsiah H (2008) Study on food habits and bio-limnology habitat of Climbing perch (*Anabas testudineus* Bloch) at swampy area of South Kalimantan. Journal of Science Technology 8(1): 73–80. [Indonesian with abstract in English].

Babaran RP, Anraku K, Ishizaki M, Watanabe K, Matsuoka T and Shirai H (2008) Sound generated by a payao and comparison with auditory sensitivity of jack mackerel *Trachurus japonicus*. Fisheries Science 74: 1207–1214.

Behrens Yamada S, Dawkins M, Quaintance A, Sugg L, Bublitz R and Hardege J (2006) Green Crab Sex Pheromones: new tools for controlling a global invader? Aquatic Nuisance Species. Project Report, Pacific States Marine Fisheries Commission, Portland, Oregon, p. 13

Bijaksana U (2006) The Feasibility Study on eco-reproduction of snakehead in Bangkau swamp of South Kalimantan Province. National Symposium on Biotechnology in Aquaculture 2006. Cooperation between IPB and Research Agency for Freshwater Aquaculture, Bogor 5 July 2006.

Bijaksana U, Hidayaturrahmah and Dewi KS (2015) Re-stocking' model of snakehead farming, *Channa striata* Blkr in Bangkau swamp of South Kalimantan Province. Global Journal of Fisheries and Aquaculture 3(2): 198–204.

Chaki N, Jahan S, Fahad MFH, Galib SM and Mohsin ABM (2014) Environment and fish fauna of the Atrai River: global and local conservation perspective. Journal of Fisheries 2(3): 163–172. doi: 10.17017/jfish.v2i3.2014.46

Frota LO, Costa PAS and Braga AC (2004) Length-weight relationship of marine fishes from the central Brazilian coast. NAGA, the World Fish Center Quarterly 27(1): 20–26.

Galib SM, Rashid MA, Chaki N, Mohsin ABM and Joadder MAR (2016) Seasonal variation and community structure of fishes in the Mahananda River with special reference to conservation issues. Journal of Fisheries 4(1): 325–334. doi: 10.17017/jfish.v4i1.2016.139

Galib SM, Samad MA, Hossain MA, Mohsin ABM and Haque SMM (2010) Small Indigenous Species of Fishes (SISF) in Chalan Beel with reference to their harvesting and marketing. Bangladesh Journal of Progressive Science and Technology 8(2): 251–254.

Galib SM, Samad MA, Kamal MM, Haque MA and Hasan MM (2009b) A study on fishing gears and methods in the Chalan Beel of north-west Bangladesh. Journal of Environmental Science & Natural Resources 2(2): 213–218.

Galib SM, Samad MA, Mohsin ABM, Flowra FA and Alam MT (2009a) Present status of fishes in the Chalan Beel- the largest Beel (wetland) of Bangladesh. International Journal of Animal and Fisheries Science 2(3): 214–218.

Ghorbani A, Salamatdoustnobar R, Ghaem Maghami SS and Motallebi V (2012) The effect of different levels of prebiotic on the length of fingerling rainbow trout. African Journal of Biotechnology 11(36): 8928–8931.

Herliwati and Rahman M (2011) Eco-biological characteristic of *Beje* fisheries in Bangkau swamp area of South Kalimantan. Limnotek 18(1): 26–37. [Indonesian with abstract in English]

Jafaryan H, Sahandi J and Dorbadam JB (2014) Growth and length-weight relationship of *Trichopodus trichopterus* (Pallas 1770) fed a supplemented diet with different concentration of probiotic. Croatian Journal of Fisheries 72: 118–122.

Joadder MAR, Galib SM, Haque SMM and Chaki N (2015) Fishes of the river Padma, Bangladesh: current trend and conservation status. Journal of Fisheries 3(2): 259–266. doi: 10.17017/jfish.v3i2.2015.111

Khan MA, Khan S and Miyan K (2012) Studies on length-weight and length-length relationships of four freshwater fishes collected from River Ganga. Journal of Fisheries and Aquatic Sciences 7(6): 481–484.

King RP (1996) Length-weight relationships of Nigeria freshwater fishes. NAGA ICLARM Quarterly 19(3): 49–52.

Kumar K, Lalrinsanga PL and Sahoo M (2013) Length-weight relationship and condition factor of *Anabas testudineus* and *Channa* species under different culture systems. World Journal of Fish and Marine Sciences 5(1): 74–78.

Lawson EO (2011) Length-weight relationships and fecundity estimates in mudskipper *Periophthalmus papilio* (Bloch and Schneider 1801) caught from the mangrove swamps of Lagos Lagoon, Nigeria. Canadian Journal of Fisheries and Aquatic Sciences 6: 264–271.

Mackinnon K, Hatta G, Halim H and Mangalik A (1996) The Ecology of Kalimantan. Singapore: Periplus Editions Ltd, p. 802.

Mashuri A, Chairuddin Gt, Husin S and Rahman M (1998) Action research of Agropoultry-Fisheries in the priority area of Bangkau lake, South Kalimantan Province.

Olurin KB and Savage OD (2011) Reproductive biology, length-weight relationship and condition factor of the African snake head, *Parachanna obscura*, from River Oshun, South-west Nigeria. International Journal of Fisheries and Aquaculture 3(8): 146–150

Oscoz J, Campos F and Escala MC (2005) Short Communication: Weight-length relationships of some fish species of the Iberian Peninsula. Journal of Applied Ichthyology 21: 73–74.

Paswan G, Abujam SKS, Dey M and Biswas SP (2012) Length-weight relationship of two species of *Trichogaster* (*Calisa*) from Brahmaputra Basin of Assam. Journal of Bio Innovation 1(1): 6–13.

Pomeroy RS (1995) Community-based and co-management institutions for sustainable coastal fisheries management in Southeast Asia. Ocean and Coastal Management 3: 143–162.

Rahman (2005) Estimation of fish resources sustainable yield in Bangkau swamp waters. Faculty of Fisheries Lambung Mangkurat University, Banjarbaru. [Indonesian with abstract in English]

Rahman A, Talukdar K, Rahman W and Deka Parag (2015) Length-Weight relationship and relative condition factor of *Anabas testudineus* (Bloch) of Deepar Beel (wetland) of Assam, India. International Journal of Applied Research 1(11): 956–958.

Rathod SR, Shinde SE and More PR (2011) Length-weight relationship in *Salmostoma navacula* and *Channa maurulius* Godavari River at Kaigaon Toka, Dist. Aurangabad (M.S.) India. Research Science Technology 3(3): 104–106.

Rukmini, Marsoedi, Arfiati D and Mursyid A (2013) Natural feed on fish larvae of climbing perch (*Anabas testudineus* Bloch) in the monotonous marshes waters of Danau Bangkau, South Kalimantan. BAWAL 5(3): 181–188. [Indonesian with abstract in English]

Saanin, H., 1986. Taksonomi dan Kunci Identifikasi Ikan. Penerbit Bina Cipta. Bogor.

Samad MA, Asaduzzaman M, Galib SM, Kamal MM and Haque MR (2010) Availability and consumer preference of small indigenous species (SIS) of the river Padma at Rajshahi, Bangladesh. International Journal of BioResearch 1(5): 27–31.

Satrawaha R and Pilasamorn C (2009) Length-weight and length-length relationships of fish species from the Chi River, northeastern Thailand. Journal of Applied Ichthyology 25(6): 787–788.

Slamat, Marsoedi, Athaillah M and Diana A (2012) Genetic Conservation of the climbing perch (*Anabas testudineus* Bloch) in swamp waters of South Kalimantan. Journal of Indonesian Fisheries Research 18(1): 1–68.

Vazquez Archdale M, Anasco CP and Tahara Y (2008) Catches of swimming crabs using fish mince in “teabags” compared to conventional fish baits in collapsible pots. Fisheries Research 91: 291–298.

Weatherley AH and Gill HS (1987) The Biology of fish growth. London: Academic Press, p. 443.

Wu YH, Yu HY, Shao IT, Lee ZC, Lin ST, Yan HY, Hsu CH, Lee CP and Jiang HH (2009) The method using underwater sound in reducing fish entrainment and impingement at the cooling water inlets of nuclear power plants in Northern Taiwan. TaiPower Engineering Month 733: 108–117.

Yan HY, Anraku K and Babaran RP (2010) Hearing in marine fish and its application in fisheries. In: Behavior of Marine Fishes: Capture Processes and Conservation Challenges (ed.) P. He. Iowa: Wiley-Blackwell, Ames. pp. 45–64.

Yousuf F and Khurshid S (2008) Length-weight relationship and relative conditions factor for the halfbeak Hemiramphus far Forsskal, 1775 from the Karachi Coastal. University Journal of Zoology Rajshahi University 27: 103–104.

Yunita R (2010) The characteristic of hinterland swamp and fish diversity of Danau Bangkau of Hulu Sungai Selatan, South Kalimantan. Ecotropic Journal of Environmental Sciences 5(1): 34–40. [Indonesian with abstract in English].

CONTRIBUTION OF THE AUTHORS

I & R primary data collection; **I, R & A** data analysis; **A** manuscript preparation.