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Impact of Brush Shelter- A Fish Aggregating Device (FAD) on the Production Potentiality of Kaptai Lake in Bangladesh

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Abstract: An experiment was conducted from November 2012 to June 2014 at different areas of Kaptai Lake to understand the impact of brush shelter (a fish aggregating device, FAD) on the production potentiality of the lake in context of Bangladesh. During the study period, four important areas in Rangamati district named as Rangamati sadar, Kaptai, Langadu and Barkal upazilla were selected. In the two consecutive years and in the same locations, each of the brush shelters were established in the month of December in 2012 and 2013; and harvested in the month of May of the following years in 2013 and 2014, respectively, to study the water quality parameters, species composition, fish production, abundance of fishes and their juveniles in the brush shelters. The average size of the brush shelters were 15 decimal consisted of floating aquatic weeds and branches and roots of trees. Water quality parameters such as air temperature, water temperature, dissolved oxygen, CO_2, pH, total alkalinity, transparency and water depth were found within the suitable range for fishes. A total of 20 species of fish including one exotic species (*Oreochromis niloticus*) and two species of prawn were recorded in 2012-13 and 17 species of fish and two species of prawn were recorded from harvested brush shelter in 2013-14. Siluriformes was the most dominant order during the study period, constituting near about 37% in 2012-2013 and about 44% in 2013-2014 of the total catch. In this study, average production from the brush shelters in Kaptai Lake was estimated 3520 kg/ha in 2012-2013 and 3008 kg/ha in 2013-2014. From our research findings, brush shelter with selective fishing could be a good alternative tool to increase the production performance of lake fisheries.

Key words: Brush Shelter · Impact · FAD · Fish Production · Kaptai Lake

INTRODUCTION

Thigmotropism in fish (the attraction to a solid object) has been used in many fisheries for successful fish harvesting [1]. As for example, fish aggregating devices (FADs) as man-made floating objects have been increasingly used around the world since the early 1990s for tuna fishing [2]. The term 'floating object' is used as the generic term representing all types of floating objects in a water body [3]. Floating objects are may be logs, parts of trees or drift algae commonly drift on the surface of water which naturally attracts various species of fishes [4]. It has been reported that shelter and food (encrusted algae on FADs) are the stimuli for aggregating behavior of fish under floating objects [1, 5]. Association with floating objects is displayed by fish of almost all ontogenetic stages [6] from small post-flexion juveniles [7, 8] to large adults [9, 10]. FADs are used widely in tropical and semi-tropical waters by recreational, artisanal and commercial fishers, to concentrate pelagic fish for capture [11]. The main advantages of FADs for fishers are that they increase the catchability of fish compared to free swimming fish species [2] increase habitat, recruitment and sustainability of fishes in an area [12]. On the other hand, FADs may also make a fish stock vulnerable to overexploitation, alter fish migration route and increase predation on small fish species by bigger one [12].

Brush shelter or brush-park is a kind of FAD which facilitate the attraction and aggregation of fish. These types of FADs are practiced in West Africa, Madagascar,

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Sri Lanka, Mexico, Bangladesh, Cambodia, China and Ecuador [13]. It is a method of fishing which employed to trap fish using branches of bushy trees. In Bangladesh, this method is locally called juk fishing which also varies regionally with a number of synonyms such as *jhag*, *katta* and *jhata* [14]. In some other countries, it is known as *samrah* in Cambodia [15] and *athkotu* in Sri Lanka [16].

Kaptai Lake is one of the largest man-made reservoirs in Southeast Asia, covering an area of 68,800 ha which was created in 1961 with the primary objective of hydroelectric power generation [17]. Fish production from the reservoir has increased steadily from the beginning and now the total fish production is 9,017 metric tons [18]. Brush shelter as FAD has become popular with the fishers of Kaptai Lake since the early 1990s [19]. Before 10-12 years ago brush shelter fishers comprise only a minority of the total fishing community but now it is major fishing method in Kaptai Lake. Importantly, women are extensively involved in preparations and feeding the fish in the brush shelters [19]. However, brush shelter is detrimental to the overall fishery in the lake as it involved complete harvesting of all the brood fish with their progeny [19].

There is little or no work done in the past to know the impact of brush shelter on the production potentiality of Kaptai Lake. So the aim of the present study was to investigate the fish species contribution and impact of brush shelter in Kaptai Lake in context of Bangladesh.

MATERIALS AND METHODS

Study Sites: This research investigation was conducted from November 2012 to June 2014 at different areas of Kaptai Lake (Fig. 1). During the study period four important areas in Rangamati sadar, Kaptai, Langadu and Barkal upazilla were selected to know the impact of brush shelter on the production potentiality of Kaptai Lake. In every area each brush shelter was established in November to December and harvested in April to May to study the catch composition, fish abundance and production. Species composition was recorded according to the group and order of fish and prawn during the period of harvesting. In the catch, fish and prawn species were identified using the taxonomic keys followed by Shafi and Quddus [20], Rahman [21] and Kibria [22].

Establishment of Brush Shelters: The size of the brush shelter ranged from 10 to 30 decimal with an average size of 15 decimal. Brush shelters were prepared by using two types of materials; materials for shed and materials for shelter of fishes. Floating aquatic weeds, water hyacinth (*Eichhornia crassipes*), *Enhydra fluctuans* and *Ipomoea aquatica* were mostly used for shed of fishes and branches and roots of different trees like Hijal (*Barringtonia acuitangula*), Mango (*Mangifera indica*), Black-berry (*Syzygium cumini*), Jack fruit (*Artocarpus integra*), Jarul, Hawra, Nonta were used for shelter of fishes. Long bamboos and nylon rope were used to

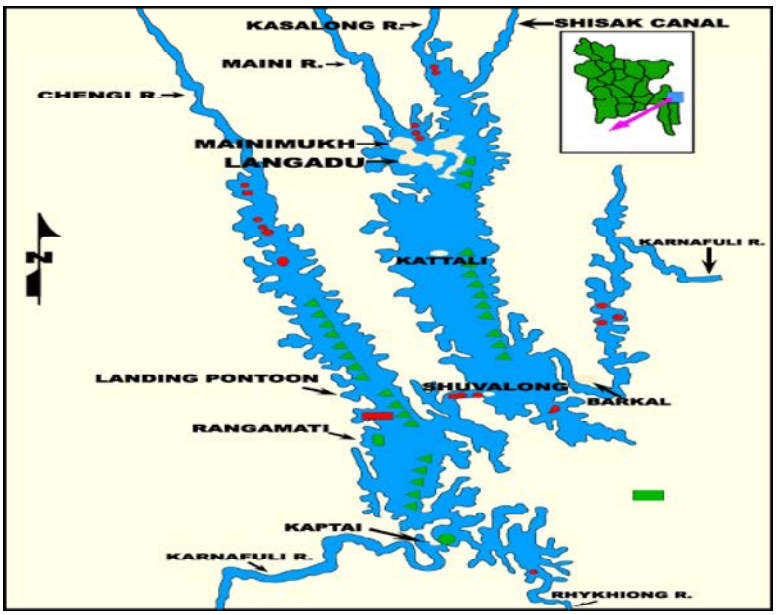

Fig. 1: Map of Kaptai Lake showing the study area of Kaptai Lake, Bangladesh.

encircle and fix aquatic weeds, branches and roots of different trees. Feed like wheat bran, rice bran, mustard oil cake and fermented rice were administered periodically. Attractants like *methi*, *akangi*, *spices* were used to attract fish before harvesting.

Water Quality Analyses: A number of water quality parameters such as air temperature (°C), water temperature (°C), dissolved oxygen (mg/L), free CO_2 (mg/L), pH, total alkalinity (mg/L), transparency (m) and water depth (m) were recorded monthly. Temperature (air and water) was recorded with a glass Celsius thermometer, water transparency was recorded with a Secchi disc, pH and DO were measured using a digital pocket pH meter (model-HI 98107 pHep® HANNA Instruments, Carrollton, TX, USA) and DO meter (DO-5509; Lutron Electronic Enterprise Co. Ltd., Taipei, Taiwan), respectively. Other chemical parameters were measured using a HACH kit box (model FF-2, No. 243001; Loveland, CO, USA). All water quality parameters were studied following the procedure of APHA [23].

Fishing Operation: Fishing operation in a brush shelter is complicated and three to five days were needed to complete harvesting. Expert fishing team was hired for fishing in brush shelter. Large seine net (*Juk jal*) and oxygen musk were used for harvesting. Before harvesting total area of brush shelter were encircled with a large seine net up to bottom. Then they clear the brushes from the encircled area, during this time they use oxygen musk to keep themselves under water for long time. Harvesting starts by a cast net to catch large size fishes. For total harvesting slowly reduced the net and catch all of the fishes.

Statistical Analysis: After the termination of the study, collected data on different parameters were analyzed and average fish species contributions in brush shelters of different locations were presented in pie-chart forms using Microsoft Excel 2007 software program.

RESULTS AND DISCUSSION

Water Quality Parameters: The growth of fish and other aquatic organisms strongly depends on the water quality. Mean values and ranges of water quality parameters over the study period are presented in Table 1. The result of the water quality analysis indicated the suitable ranges for fishes in different study areas of Kaptai Lake. The water quality parameters remained more or less similar. In the present study we investigated some physical and chemical factors of water from different study areas of Kaptai Lake. The air and water temperature of experimental areas of Kaptai Lake were found to vary from 20 to 33°C and 19.5 to 31.5°C, respectively. This result supposed to be suitable for growth of fishes. The concentration of dissolved oxygen and free CO_2 in the experimental sites was ranged from 4.8 to 7.8 mg/L and 1.61 to 4.3 mg/L, respectively. In this present study, dissolved oxygen concentrations were suitable for fishes throughout the study period. The range of pH and total alkalinity of the different areas were varied from 6.5 to 8.6 and 51.3 to 70.5 mg/L, respectively. The transparency and water depth of the experimental sites were varied from 0.79 to 2.8 m and 5.7 to 20.2 m, respectively. All of these results were in agreement with Rahman *et al.* [24] and Uddin *et al.* [25].

Table 1: Water quality parameters as obtained under four different areas during the study period, mean±standard error and ranges in parentheses

	Experimental sites of Kaptai Lake			
Parameters	Rangamati Sadar	Kaptai	Langadu	Barkol
Air temperature (°C)	27.95±3.03 (20-32)	27.32±2.70 (23-31)	26.56±3.41 (20.5-32.2)	27.86±2.62 (23.5-33)
Water temperature (°C)	26.74±2.60 (21-30)	26.80±2.23 (22-30.4)	25.60±3.46 (19.5-31.5)	26.28±3.37 (19.5-31.5)
DO (mg/L)	6.20±0.87 (4.80-7.80)	6.06±0.36 (5.29-6.92)	6.19±0.49 (5.52-7.52)	6.32±0.54 (5.28-7.34)
CO_2 (mg/L)	3.18±0.65 (1.87-4.18)	2.78±0.64 (1.63-4.03)	3.01±0.64 (1.95-4.03)	3.23±0.69 (1.61-4.32)
pH	7.63±0.52 (6.50-8.62)	7.53±0.23 (6.85-7.85)	7.60±0.15 (7.25-7.80)	7.42±0.32 (6.69-7.85)
Total alkalinity (mg/L)	59.77±5.52 (51.30-68.75)	60.53±5.86 (52.56-70.50)	61.78±6.03 (52.56-70.50)	60.09±4.93(53.56-69.30)
Transparency (m)	1.84±0.37 (0.79-2.22)	1.75±0.38 (0.91-2.19)	1.98±0.27 (1-2.19)	1.91±0.51 (0.95-2.85)
Water depth (m)	10.40±3.37 (5.7-15.4)	10.98±3.77 (5.9-17.5)	13.15±3.63 (7.2-19.4)	12.89±4.07 (7.1-20.2)

Table 2: Species composition (% of total catch) of fishes from the brush shelter in different areas of Kaptai Lake

Order	Local Name	Scientific Name	Contribution in total production (%) 2012-13	2013-14
Siluriformes	Kajuli	*Ailia coila*	8.82	4.82
	Gulsa	*Mystus cavasius*	7.06	8.54
	Tengra	*Mystus vittatus*	1.62	6.35
	Pabda	*Ompok pabda*	2.50	5.09
	Boal	*Wallago attu*	14.41	12.48
	Air	*Sperata aor*	2.35	6.68
Cypriniformes	Calibaush	*Labeo calbasu*	20.73	16.86
	Bata	*Labeo bata*	2.06	4.87
	Rui	*Labeo rohita*	1	-
	Catla	*Catla catla*	2.03	-
Perciformes	Tilapia	*Oreochromis niloticus*	8.97	9.64
	Shol	*Channa striatus*	8.12	5.80
	Gajar	*Channa marulius*	4.23	4.82
Osteoglossiformes	Foli	*Notopterus notopterus*	4.56	4.97
	Chitol	*Notopterus chitala*	2.65	-
Synbranchiformes	Baim	*Mastacembelus armatus*	5.15	2.68
Others (fish and prawn)			3.76	6.39

Fish Harvesting and Species Composition: The result of species composition and percentage composition during the study period from the harvested brush shelter are presented in Table 2 and Figs. 2.1, 2.2, respectively. Species composition was recorded according to the group and order of fish and prawn during the period of harvesting. A total of 20 species of fish including one exotic species (Tilapia, *Oreochromis niloticus*) and 2 species of prawn were recorded from the harvested brush shelter in 2012-2013. In the next year (2013-2014), 17 species of fish and 2 species of prawn were recorded from harvested brush shelter. Three species (*Labeo rohita, Catla catla, Notopterus chitala*) were not found in the brush shelter of different areasin 2013-2014. Siluriformes (catfish) was the most dominant order constituting near about 37% of the total catch followed by the Cypriniformes (25.82%), Perciformes (21.32%), Osteoglossiformes (7.21%), Synbranchiformes (5.15%) and the rest 3.76% of the catches were small and medium sized fish and prawn in 2012-13. On the other hand, in 2013-14, the highest amount about 44% of total catch was also comprised of Siluriformes followed by Cypriniformes (21.73%), Perciformes (20.26%), Osteoglossiformes (4.97%), Synbranchiformes (2.68%) and the rest 6.39% of the catch were small and medium sized fish and prawn. Among the catfish as a single species *Wallago attu* and *Mystus cavasius* dominated the catch and the percentage of Kajuli, Boal reduced,

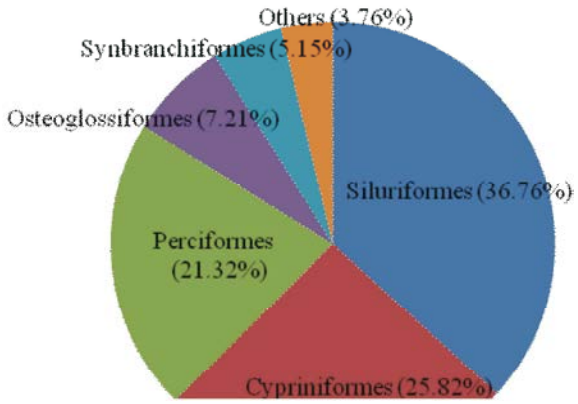

Fig. 2.1: Percentage composition of different order of fish harvested from the brush shelter (2012-2013)

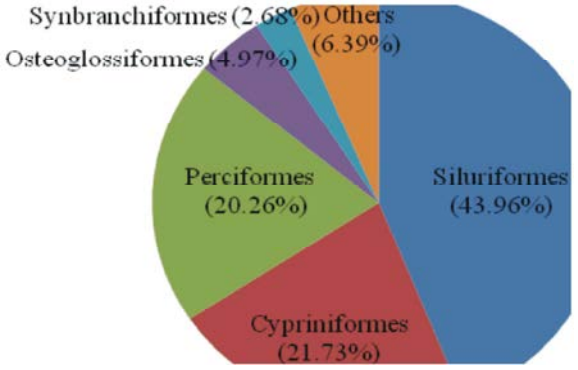

Fig. 2.2: Percentage composition of different order of fish harvested from the brush shelter (2013-2014)

but the percentage of Gulsa, Tengra, Pabda and Air increased in second year of harvesting (Table 2). In 2012-2013, the major carp *Labeo calbasu* dominantly contributed about 20.73% followed by 1% of *Labeo rohita* and 2.03% of *Catla catla*, but in next year the percentage of *Labeo calbasu* reduced to 16.86% and *Labeo rohita* and *Catla catla* were not harvested from brush shelter. Among the perciforms the percentage of exotic species Tilapia *(Oreochromis niloticus)* and Gajar increased in the second year; whereas, the contribution of Shol reduced. According to Ahmed and Hambrey [19] the composition of fishes in brush shelter of Kaptai Lake consisted of Indian major carps (17%), Catfish (24%), Clupeids (13%), Feather back (9%), Tilapia (6%) and others (31%). Ahmed and Akther [26] reported that the species composition of katha (brush shelter) in Titas River was more than 47% of total catch comprised of Siluriformes followed by Perciformes (19.86%) and Cypriniformes (3.21%) and the rest of 29.11% were small and medium size fish and prawn. Ho [27] listed a mixture of 34 cyprinid, catfish, feather backs and snakeheads species in brush parks of the Cambodian Mekong River. The abundance of Catfish and Indian Major Carps in brush shelter were highest probably because of their food availability and shelter for free breeding and hazardless environment.

In this study, average fish production from each of the experimental brush shelter in the study areas were estimated to be 3520 kg/ha in 2012-2013 and 3008 kg/ha in 2013-2014; whereas, the average fish production of Kaptai Lake was 131 kg/ha in the same years [18]. The fish production of brush shelter is 23 to 28 times higher than the natural fish production of Kaptai Lake. Ahmed and Hambrey [19] reported a mean harvest of 242 kg/brush shelter at a time in Kaptai Lake. Ahmed and Hambrey [19] also found that a total of 483 ton fish of different species and sizes is being harvested each year, accounting for about 8% of the total catch from Kaptai Lake. Major carps contribute 81 metric tons of the catch from brushes. The average production from katha (brush shelter) in Titas River of Bangladesh has been estimated to be 750 kg/ha/year based upon the surveyed fishing season of 243 days [26]. However, in the present study, we found that the production capacity of the experimental brush shelter in Kaptai Lake was 4 to 5 times higher than the Titas River. Most of the harvested fishes were indigenous fish. It was alarming for Kaptai Lake that among the harvested fishes most of the fishes were sexually matured and female fish contain eggs.

The results indicated that the fish biodiversity are declining due to indiscriminate fishing by brush shelter and combination of over-exploitation, habitat degradation, use of pesticide, destruction of breeding ground, siltation, various ecological changes in its natural habitat and lack of proper management are the key causes for reducing fish biodiversity.

Abundance of Fishes: The abundance of fishes in brush shelter during the study period in different areas of Kaptai Lake is presented in Table 3. Abundance of fishes was recorded according to the number of fish harvested from the brush shelter during harvesting period. The abundance of fishes categorized as high, medium, low and very low. This result shows the abundance of fish species in different study areas of Kaptai Lake is not similar. This difference may be due to food availability and favorable condition for their natural breeding.

Table 3: Abundance of Fishes in brush shelter in different areas of Kaptai Lake

Rangamati Sadar	Kaptai	Barkal	Langadu	Abundance
Calibaush	Calibaush	Kajuli	Tilapia	High
Boal	Gojar	Calibaush	Calibaush	High
Kajuli	Shol	GulsaTengra	Boal	High
GulsaTengra	Gulsa	Boal	GulsaTengra	Medium
Pabda	Tilapia	Pabda	Baim	Medium
Air	Boal	Baim	BujuriTengra	Medium
Shol	Foli	Air	Shol	Low
Foli	Tengra	Foli	Foli	Low
BujuriTengra	Baim	BujuriTengra	Pabda	Low
Gojar	Air	Bata	Air	Very Low
Tilapia	Pabda	Chingri	Kajuli	Very low
		Shol	Bata	Very low

Abundance of Juvenile Fishes: According to the Fish Act of Bangladesh, catching of major carps of less than 23 cm in length is illegal. Among the harvested major carps, almost 28% Calibaush *(Labeo calbasu)* were less than 23 cm in length. Juvenile of different fishes take shelter in the brush shelter and they were harvested before mature. Among the harvested fishes, 16% Air and 12% Bata were juvenile.

CONCLUSION AND RECOMMENDATIONS

The present study revealed that brush shelter fishing is detrimental for the Kaptai Lake fishery because it involved to the complete harvest of all types and sizes of fishes especially brood and juvenile fishes. For indiscriminate fishing in pre-breeding season, brood fishes were reduced and also reduced the natural fish population of Kaptai Lake. But, proper management of brush shelter fishery can be used as a potential tool for sustainability of fisheries resources, where natural fish population can be conserved without harvesting of juvenile and brood fishes during harvesting period. In this sense, establishment of brush shelter could help to improve the status of fish habitat and biodiversity in Kaptai Lake. Fish population can take shelter and food in the brush shelter during the dry season and can gain sexual maturity for spawning in the next breeding season which is obviously very important. If all fish were not harvested from the brush shelters, then brood and juvenile fishes are expected to be dispersed on different part of the Kaptai Lake at the onset of next breeding season and could contribute in the natural recruitments for the following year. Therefore, fishers should be discouraged from harvesting of total catch from the brush shelter. The fishing community adjacent to the lake can play an important role for the proper management of brush shelters in the Kaptai Lake.

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