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Option for formulating community based fish sanctuary and its management in *beel* ecosystem in Brahmanbaria

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Abstract. With the objective of formulating community based fish sanctuaries in *beel* ecosystem based on the experiences of traditional fish aggregating devices (FAD), like *katha* and *kua*, this study was undertaken in three *beels viz*., Shakla, Hurul and Shapla located in Brahmanbaria. Results show that surface area coverage for *katha* ranged between 25 and 60 dec. Two harvests were found to be common, may exceed to three harvests depending on the hydrological condition of *beel*. Fish production was recorded higher to be the first harvest that decreased chronologically in the second and third harvests. The area of *kua* ranged from 5 to 100 dec. Fish production of first harvest was almost double than that of the second harvest. None of the owners of *kua* were the member of *beel* management committee (BMC) but they owned land. *Kua* fisheries are not favorable for sustaining yields because all fish including brood stocks and juveniles are harvested completely at a time by dewatering. Moreover, the owners of the *kua* along the canals have a tendency to encroach *khas* land while excavating *kua*. Conflicts also prevailed between the *kua* owners and the BMC. For the sustainability of CBFM concept in the *beel* fishery rigorous motivation works needed for the *kua* owners to bring them under the umbrella of BMC. Based on the results of the FAD an outline of the fish sanctuary and improved management guidelines are put forwarded for *beel* ecosystem.

Introduction

The inland freshwater fisheries of Bangladesh have been ranked third most productive fisheries in the world, just after China and India. The major fisheries take place in rivers and estuaries, *beels* (natural depression), *baors* (dead rivers), flood lands (seasonal floodplains) and a man-made lake (Kaptai lake). The flood dependent fishery has been notable for the diversity of its fish and prawn species and the primary source of fish for all Bangladeshis (Rahman, 1989). Inland open water capture fishery as a whole is in decline over the decades due to multiple causes *viz.*, loss of biodiversity, loss of dry-season fish habitat, loss of breeding and nursery grounds, and loss of river-*beel* connections. Fishing pressure, myopic government agriculture and water leasing policies and overall ecology due to global environmental change are also the major factors responsible for open water fishery destruction (DoF, 2002). The inland open water capture fishery is made up of three interrelated general areas- riverine, *beel-baor* and floodplains.

Beel is a saucer-shaped depression, which may hold water permanently or dry up during the dry season. The total area of *beels* in Bangladesh was estimated to be 114,161 ha, occupying 27.0% of the inland freshwater. The number of *beels* in the northeast region has been reported to be between 3,440 (covering 58,500 ha with a mean size of 7 ha) and 6,149 (covering 63,500 ha with a mean size of 10 ha) (Bernacsek *et al*., 1992). About 58% of the *beels* in the northeast region are permanent and the rest are seasonal. Existing *beel* fisheries can be enhanced through exercising specific management options *viz.,* improving stock, changing the exploitation norm, changing crafts and gears technology, introducing new forms of access, participatory approach and so on. Improvement can be directed in the form of new interventions such as improving their monetary and aesthetic value.

Katha and *kua* fisheries play a vital role in Bangladesh fisheries and they may be regarded as the principal means of fishing during the dry season. From time immemorial *katha* fishing is used for both commercial and conservation point of view. In the past, the most important methods of biological fisheries management and fishing effort regulation practiced in the region have been reserve and pile fisheries. These types of shelter is attracted fish and they accumulated in the *katha* and *kua* in large numbers.

A fish sanctuary is a critical habitat within which fishing is perpetually and completely prohibited. It is an important recognized tool of fisheries management for conservation, protection and restoration of fish species. Fishes congregate in the sanctuaries for shelter, lead peaceful life without any disturbance and can move independently towards the feeding and breeding grounds. Most commonly found sanctuaries in Bangladesh are established in specific areas to protect overwintering broodstock in river *duars*, deep *beels* or to protect spawning grounds of big fishes. Considering an urgent need to formulate sound management options for sustainable development and optimal utilization of the existing *beels* in view of conservation of productive and dynamic ecosystem the study was undertaken.

Materials and methods

Among 116 beels, three *beels viz*., Shakla, Hurul and Shapla located in Brahmanbaria were selected to carry out the study during July 2003 to June 2006 (Fig. 1).

These *beels* belonging to CBFM 2 Project of the WorldFish Center of Bangladesh were leased out to *Beel* Management Committee (BMC- a community based local forum headed by a Chairman) for consecutive five years. The *beel* was managed by the BMC with the cooperation of WorldFish Center, DoF and an NGO - PROSHIKA.

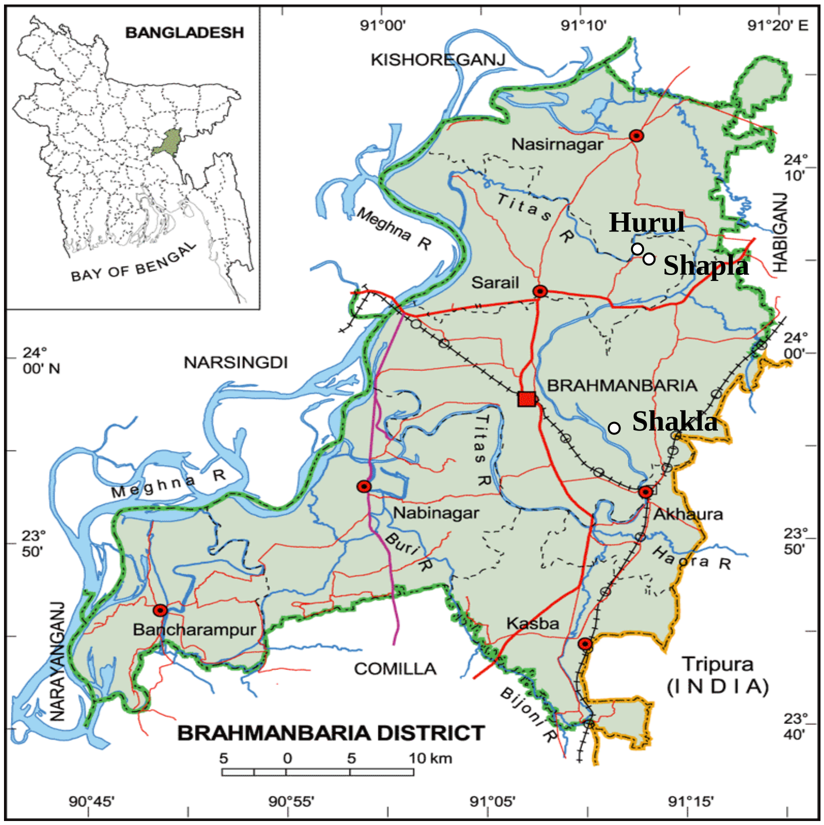

Fig. 1. Map of Brahmanbaria district showing location of the *beel* Shakla, Hurul and Shaapla (Courtesy of www.banglapedia.org).

The research was based on both primary and secondary data, comprehensive literature review and extracts of local knowledge and information. Data were collected using different sets of questionnaire, interviewing the fishers and people residing in and around the *beels.* Collection of primary data was made by the survey on fish aggregating devices (FAD) like *katha* and *kua* fishing methods, rainfall, water level and overall fishers' perception on *beel* ecosystem. Secondary data were collected from fishing community, former lease holders, *beel* management committee (BMC), local administration, Bangladesh Water Development Board (BWDB), Department of

Fisheries (DoF), Bangladesh Fisheries Research Institute (BFRI) and Meteorological Department. Comprehensive study was done on FAD considering their installation, area covered, feeding protocol, fish luring/attracting ingredients used, overall management and fishing activities.

In addition, standing crop at each harvest, fish size, species composition and frequency of harvesting were also recorded. Descriptive statistics and correlation analysis on the collected data were done using SPSS software.

Results

In the studied *beels*, *kathas* were installed when water started to recede at reasonable depth. BMC installed a few number of *kathas* (<10 in number) in the deepest pool areas (natural depression) of each *beel* during September-November using branches of trees like *hijole* (*Barringtonia acutangula*), mango (*Magnifera indica*), *shewra* (*Sterbulus* sp.), black berry (*Syzygium cumini*), *jarul* (*Lagerstroemia speciosa*), tamarind (*Tamarindus indica*) and *gab* (*Diospyros peregrina*) with a cover of water hyacinth (*Eichhornia crassipes*) at surface. Number of brush branches used for each *katha* varied between 100 and 250 with an average of 171. Area for *katha* ranged between 25 and 60 dec with a mean of 39.7 dec (Table 1). A high percentage of fish is being captured each year from the total *beel's* standing stock adopting the said method. Generally two harvests were common from each *katha*, sometimes it exceeded to three harvests over the fishing period depending on the hydrological condition of the *beel*.

Table 1 Particulars of *katha* and fish production in the *beels* Shakla, Hurul and Shapla during 2003-06

Beels	Area of *katha* (dec)	Average depth (m)	Number of branches in *katha*	Fish production in *katha* (kg)			
				First harvest	Second harvest	Mean harvest (1st & 2nd)	Total harvest (1st+2nd)
Shakla	40* (25-60)**	3.4 (3-4)	168 (120-250)	560 (390-720)	414 (270-630)	487 ±131	974
Hurul	40 (28-60)	3.9 (2.5-5)	185 (150-250)	549 (245-921)	408 (280-492)	478 ±172	957
Shapla	39 (25-55)	4.2 (3-5)	161 (100-220)	642 (375-1,047)	476 (290-624)	559 ±188	1,118
Mean of *beels*	40	3.8	171	584	433	508	1,016

* Average value **Range of values

The *katha* produced standing crop ranged from 245 to 1,047 kg (av.584kg) and 270 to 630 kg (av. 433kg) from a mean area of about 40 decimal for the first and second harvests, respectively. Combining first and second harvests of *katha* the total fish production of Shakla, Hurul and Shapla *beels* were estimated as 974, 957 and 1,118 kg, respectively with an average of 1,016 kg. Fish production at first harvest was found to be always higher and decreased chronologically at the second and third harvests (Table 1). In Shakla *beel*, a significant correlation ($r = 0.495$; $P<0.05$) existed between the *katha* area and its fish production. In Hurul *beel*, that relationship was highly significant ($r = 0.642$; $P<0.01$) and a significant relationship ($r = 0.0471$; $P<0.05$) was also found between fish production and water depth. However, no such relationship was existed for Shapla *beel*. Kibria (1983) recorded the standing crop of *jug* (*katha*) fishery in Dakatia river, Chandpur, which ranged from 83 to 1,608 kg/ha with a mean of 539 kg/ha from 24 *jugs*. Wahab and Kibria (1994) reported standing crop ranging from 100 to 1,000 kg for each *jug* of 12 to 54 m^2 with a mean water depth of 1.25 m. Ahmed and Hambrey (1999) reported a mean standing crop of 242 kg for each *jug* of 0.02-0.12 ha in Kaptai lake.

Katha selectivity attracts carps like rui, *Labeo rohita*, mrigal, *Cirrhinus cirrhosus*, carpio, *Cyprinus carpio*, catla, *Catla. catla* and miscellaneous fishes like air, *Sperata aor*, punti, *Puntius* spp., lamba chanda, *Chanda nama*., lal chand, *Pseudambassis lala,* mola, *Amblypharyngodon mola*, kankila, *Xenentodon cancila*, ek thuita, *Hyporhamphus quoyi*, tengra, *Mystus* spp., potka, *Tetraodon cutcutia*, *Tetraodon fluviatilis*, kholisha, *Colisa* spp., chela, *Salmostoma phulo,* Chela spp., meni, *Nandus nandus*, baila, *Glossogobius giuris*, kucho chingri, *Machrobrachium lamarrei* etc.

Number of *kuas* in the *beels* Shakla, Hurul and Shapla ranged between 250 and 300, 140 and 150, and 40 and 50, respectively. Due to deep natural depression, most of the natural *kuas* of Shapla *beel* do not dry up even in the dry season. The *kua* owners of the studied *beels* are not the members of BMC but are the landowners. Number of brush branches used for each *kua* ranged between 20 and 600 with an average of 87. Area for *kua* ranged from 5 to 100 dec with a mean of 43 dec (Table 2). The fish harvest from *kuas* varied from 47 to 686 kg and from 35 to 410 kg with a mean area of 43 dec for the first and second harvests, respectively. Combining first and second harvests of *kua* the total fish production was 368 and 383 kg, for Shakla and Hurul *beels*, respectively an average of 375 kg. First harvest was estimated to be almost double than that of the second one (Table 2). Fish yield from *kua* can vary considerably but usually ranges from 20 to 500 kg (Wahab and Kibria, 1994). Data of Shapla *beel* were sporadic and incomplete and are not presented here. In Shakla *beel*, a highly significant relationship ($r = 0.873$; $P<0.01$) was found between fish production and water depth. No such correlation was found for the *beel* Hurul. *Kua* was found to attract selectively carps like *L. rohita*, *C. cirrhosus*, *C. carpio*, *C. catla*, and miscellaneous fishes like *Wallago attu*, *S. aor*, *Puntius* spp., *C. nama*, *P. lala*, *A. mola*, *X.*

cancila, *H. quoyi*, *Mystus* spp., *T. cutcutia*, *T. fluviatilis*, *Colisa* spp., *S. phulo*, *Chela spp.*, *N. nandus*, *G. giuris* and *M. lamarrei*.

Table 2 Fish production of *kua* in the *beels* Shakla and Hurul of Brahmmanbaria, during 2003-06

Beels	Area of *kua* (dec)	Average depth (m)	Number of brushes in *kua*	Fish production in *kua* (kg)			
				First harvest	Second harvest	Mean harvest (1st & 2nd)	Total harvest (1st+2nd)
Shakla	34 (5-100)*	2.5 (2-3)	80 (20-300)	222.0 (47-635)	146 (35-410)	184 ±84	368
Hurul	52 (15-90)	2.4 (1.7-4)	95 (40-600)	267.0 (63-686)	116 (45-131)	191 ± 93	383
Mean of *beels*	43	2.4	87	244.0	131	187	375

* Parenthesis shows the range of values

Discussion

Under the Fish Protection and Conservation Act 1950, *katha* fishing is illegal (Ahmed and Aguero, 1987). This measure was taken to protect broodfish which use rivers as overwintering grounds. However, in the past this regulation was not enforced and largely ignored by most leaseholders and fishermen and till now same practice is going on. Moreover, the reduced flow caused by the *katha* has also been blamed for an increase in siltation (FAP-6, 1994). In spite of these constraints, *katha* fishing is widespread in Bangladesh in the dry season between September and April and is used in a number of ways in the *beels*, *haors*, canals, and secondary rivers. In the past the most important methods of biological fisheries management and fishing effort regulation practiced in the region have been reserve and pile fisheries. Pile fisheries consisted of *katha* which were harvested only once a year for *choto maach* (small indigenous fishes) and every three years for *boromaach* (large fish). Another type of fishery which utilizes *katha* was the reserve fishery which may contain one or more *jalmohals*. *Kathas* were also installed in several areas of the fishery and fish are only harvested once in every 5-7 years. However, more commonly practiced *katha* are set by individuals and fish are harvested once a year (MacGrory and Williams, 1996).

The *Katha* and *Kua* type of shelters attract fish and they accumulate in the *katha* and *kua* in large numbers. The existing *kuas* of *beel* ecosystem are not fish friendly because all fish, including fry, fingerlings, juveniles and brood lived in *kuas* are caught by the owner at a time. Unplanned and unregulated use of this type of fishing methods pose to be a serious threat both to natural stocks and to the effectiveness of stock enhancement. Moreover, the owners of the *kua* along the canals have a tendency to encroach *khasland* while excavating *kua*. There are also conflicts between the *kua* owners and BMC. The BMC are utilizing their utmost effort for *beel* management but the owners of *kuas* are getting the maximum benefit in respect to fish harvest. Legal battles sometimes erupt between farmers who dig *kua* for trapping fish and the leaseholders who claim the fish catches (FAP-6 1994).

The establishment of fish sanctuary in the community-managed *beels* is a new concept, which would help to increase the survival of broodstock during the dry season, a critical period in their life when they are mostly vulnerable to over-fishing in *beels*. Increased survival of these broodstocks should result in a greater recruitment of juveniles into the fishery of following years which in turn should lead to increase fish productivity. This measure can be undertaken on a range of different types and sizes of perennial water bodies depending on the area, shape, depth and proportions of the depression area of the total water body. This would eventually help to protect a large number of different fish species and therefore benefit to the fishery would be dispersed across a broad spectrum of fishing community and *beel* side villagers.

The canals present in *beel* ecosystem are used as linkages between *beels* and rivers which enable adult riverine fishes including the Gangetic major carps to migrate to the rivers for spawning. At present, raised dyke of the *kuas* and siltation blocked off most of the canals of the *beel*. *Kua* owners encroached the canals resulting gradual disruption of linkages between rivers and *beels*. Besides gradual encroachment and complete drying of *kua* fishery and other wetlands, rice cropping is also eliminating the chance of adult fishes to thrive in the *beels*. Therefore, it is essential to excavate the connecting canals of the *beels* for easy access of fish with incoming water. Re-excavation of connecting canals of *beel* and natural depression areas could save fisheries resources for future generations. Besides, the indiscriminate exploitation of fish from inland open waters by complete removal of water from natural depressions, floodplains and canals results in loss of the entire population of wild fish species including brood fish and juveniles. The practice suggests that biodiversity is sacrificed for short-term economic benefits. For the sake of sustainability of *beel* ecosystem, harmful fishing method like complete harvesting of fish from the deeper pools/*kuas* by complete dewatering should be banned. In this context, an awareness/training programme should be extended to fishers to create an awareness of the factors affecting the health of the fisheries and the rationale for the restrictions on a particular fishing gear in a particular season.

Present contributions of commercially important fishes to total fish production in *beel* ecosystem reveals that major carps along with other fish species are dwindling. As a result, fishing pressure has already been shifted to economically less valuable species. Although major carps are highly migratory fish, their nature and movement patterns over the first three years of life indicate that it might be possible to re-establish this fishery in *beel* ecosystem through stocking of available hatchery produced fingerlings (Tsai and Ali 1985).

The imposed lease value of each *beel* was found to be much higher comparing with recent fish production trends. People opined that due to ecological reasons, various environmental factors, and anthropogenic activities fish production trends in the *beels* are declining drastically. Moreover, utilizing utmost effort the BMC members could not earn profit and ultimately failed to deposit the lease money in time. For the success of present management strategy of the *beel* annual lease value should be reduced considerably. All intervention of *beel* ecosystem should be done ensuring profit of the BMC otherwise the members will be deprived and ultimately leave BMC umbrella. Although all the members of BMC utilize their utmost effort to maximize production in the *beels*, but it is found that owners of the *kua* fishery got the maximum benefit with little effort. For the sustainability of the CBFM concept in the *beel* fishery rigorous motivation works needed for the *kua* owners to bring them under the umbrella of BMC. In case of committee formation the authority do not follow to co-opt actual fishers, landowners and the people actually residing along the immediate vicinity of the *beels*. The success of any community-based program depends on an active committee involving true stakeholders with efficient leadership.

Conclusion

Because of the threats posed to floodplain fisheries by over-exploitation and environmental degradation, there has been historically a perception amongst fishers and government alike of the need to protect certain fishery areas in order to conserve fish stocks. In this context, the proposed fish sanctuary can be established in the deeper pool areas of each *beel* following the traditional method of *katha* and *kua*. For establishing sanctuary, excavation of *kua* may be required, but it depends on the depth of the natural depression.

For the sustainability of sanctuary and the socio-economic condition of the poor fishers attached with BMC at least 4 sanctuaries should be established in a <100 ha *beel*. During the start-up year, no fish will be harvested from the sanctuary. Fish will be harvested alternately from only two sanctuaries in the subsequent years keeping two sanctuaries intact in each year.

The sanctuary can be of any size and shape, as the results of traditional FAD indicated that the fish production of *katha* was found to be significantly correlated to the areas of Shakla and Hurul *beels*. However, from the management point of view an area of around one acre (100 dec) would be the appropriate one for the establishment of a sanctuary this context, it can be mentioned that the recently excavated *kua* of 82.64 dec (200′ ×180′) area in Shakla *beel* for establishing fish sanctuary is a unique initiative.

It is suggested to use locally available tree branches as fish shelters except the controversial trees like *koroch* and *mango*. as they are found to be toxic and not preferred by the fish as shelter. The most preferred materials for sanctuary are the branches of *hijole* (*B. acutangula*) and *shewra* (*Sterbulus* sp.) trees. A range of 200-250 branches is enough for installation of brushes into a sanctuary of one-acre area. The tree branches need at least two weeks sun drying until the leaves fall off. Only then they should be used for installation purposes. At least 6-7 weeks required for allowing a film of periphyton to be established on the bark of the tree branches after installing them into the *kua*. The periphyton grown on branches are used usually as a food for many fish species. The surface area of sanctuary should be covered with either water hyacinth (*E. crassipes*) or *helencha* (*E. fluctuans*) depending on the availability for providing shade and shelter for fish and keep the water cool. In dry season, at least 50% surface area of each sanctuary should be made open for augmenting photosynthesis activities. To retain and define the fish sanctuary a number of bamboo poles can be fixed around the sanctuary area during water-inundation period. A frame made of bamboo splits can also be tied horizontally to the bamboo poles surrounding the sanctuary to keep the water hyacinth, *Helencha* etc. intact. A signboard should be placed close to the sanctuary detailing the name of the sanctuary, brief purposes and the name of supervising authority the BMC. Some popular slogans with inspiring and directional messages for creating public awareness should be fixed with bamboo poles of the sanctuary.

In addition to fish sanctuary establishment, it is essential to excavate the connecting canals of each *beel* for easy access of fish with incoming water from the river and vice versa.

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