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FISHES OF KAPTAI LAKE: MANAGEMENT AND CONSERVATION PERSPECTIVES

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Abstract: Native fish species in Bangladesh is decreasing at an alarming rate due to anthropogenic and natural causes and therefore, for the sustainable management of a water body, it is important to know its species diversity, their abundance, existing management and problems. In this study, we recorded fish species of Kaptai Lake, the largest lake in Bangladesh, and also examined the current lake management activities and problems. Fifty three native species belonging to seven orders and 23 families were identified of which 20 species were of conservation importance including eight endangered, six vulnerable and six near threatened species. Seven non-native species were also recorded. Three native species (*Gudusia chapra, Gonialosa manmina* and *Corica soborna*) contributed nearly 90% of the fish production. Lake authority regularly employed fishing ban and released fish seeds of native carps to enhance the stock but, unfortunately, harmful and illegal fishing using destructive fishing gears were common in the lake. The findings of this study may contribute to the sustainable management of the Kaptai Lake fishery.

Key words: Kaptai Lake, freshwater, sustainable management, conservation, non-native fish

সারাংশ: বাংলাদেশে মানবসৃষ্ট এবং প্রাকৃতিক কারণে দেশীয় মাছ কমে যাচ্ছে এবং এ কারণে কোন একটি জলাশয়ের টেকসই ব্যবস্থাপনার জন্য সেটির প্রজাতি বৈচিত্র্যতা, তাদের প্রাচুর্য্য, বর্তমান ব্যবস্থাপনা এবং সমস্যাসমূহ জানা গুরুত্বপূর্ণ। এই গবেষণায় আমরা বাংলাদেশের সবচেয়ে বড় হ্রদ কাপ্তাই হ্রদের মাছের বৈচিত্র্যতা, হ্রদের বর্তমান ব্যবস্থাপনা এবং সমস্যাসমূহও লিপিবদ্ধ করেছি। সাতটি গণের অধীনে ২৩টি গোত্রের তিপান্ন প্রজাতির দেশী মাছ সনাক্ত করা হয়েছে যেখানে ২০টি প্রজাতি সংরক্ষণ গুরুত্বসম্পন্ন যার মধ্যে আটটি বিপন্ন, ছয়টি সংকটাপন্ন এবং ছয়টি প্রায়-বিপদগ্রস্ত প্রজাতি। সাতটি বিদেশী প্রজাতির মাছও নথিভুক্ত করা হয়েছে। মোট মাছের উৎপাদনে তিনটি দেশীয় প্রজাতির (*Gudusia chapra, Gonialosa manmina* ও *Corica soborna*) অবদান প্রায় ৯০ শতাংশ। মাছের মজুত উন্নয়নের জন্য হ্রদ কর্তৃপক্ষ নিয়মিতভাবে মাছধরা নিষিদ্ধকরণ এবং দেশীয় মাছের পোনা অবমুক্ত করে থাকে। ধ্বংসাত্মক মাছ ধরার সরঞ্জাম ব্যবহারের মাধ্যমে ক্ষতিকর এবং অবৈধভাবে মাছ ধরা হ্রদে একটি নিয়মিত ঘটনা। এই গবেষণার ফলাফল কাপ্তাই হ্রদে টেকসই মৎস্য ব্যবস্থাপনায় গুরুত্বপূর্ণ ভূমিকা পালন করতে পারে।

মূল কথা: কাপ্তাই হ্রদ, স্বাদুপানি, টেকসই ব্যবস্থাপনা, সংরক্ষণ, বিদেশী মাছ।

Introduction

Fisheries is playing a key role in the development of people's livelihood in Bangladesh, a south Asian country with diversified fish fauna including over 265 species of native fish species (Rahman 2005). Fisheries sector contributes 3.5% to GDP, 25.71% to the agricultural sector and 60% of the total animal protein consumption in the country (DoF, 2019). Bangladesh is also a major contributor to the world fisheries, ranked 5th in aquaculture and 3rd in inland capture production (FAO 2018). Despite remarkable growth in aquaculture production in the last couple of decades indigenous fish species in the wild are facing an increasing number of threats, both from anthropogenic (Mohsin et al. 2012; Galib et al. 2018a, 2018b) and natural sources (Hossain et al. 2009). As a result number of threatened fish species has increased in recent times (n = 64; IUCN Bangladesh 2015) than the year 2000 (n = 54; IUCN Bangladesh 2000).

The Kaptai Lake is the largest lake in Bangladesh located in the southeast part of the country. This lake was originally created for hydroelectric power generation by damming the river Karnaphuli near Kaptai of Rangamati district in 1961 (ARG 1986). The total area of this lake is 68800 ha which contributes 0.24% to the total fish production of Bangladesh (DoF 2019).

Existing researches on this lake are primarily focusing on the determination of primary productivity (e.g. Chowdhury and Mazumder 1981; Ahmed et al. 1999), lake management (e.g. Ahmed et al. 2006) and population biology of few species (e.g. *Labeo rohita*, Ahmed et al. 2005; *Amblypharyngodon mola*, Azadi and Mamun 2004). This lake is also one of the major sources of fishes for the people in southeast Bangladesh. However, the lake is receiving multiple treats resulting in an adverse impact on lake fisheries especially those are of high-value fish species (Ahmed et al. 2006). Despite an important aquatic habitat study on fish fauna of this lake, based on a reliable sampling method, is not available which is considered a prerequisite for the sustainable fisheries management (Galib 2015). The findings of this study may provide important information for the sustainable management of Kaptai Lake or similar water bodies.

Materials and methods

Study area and duration

This study was conducted in Kaptai Lake, located in Rangamati and Khagrachari districts of southeast Bangladesh, for a period of one year from January to December 2020.

Fish sampling and identification

Fish species caught by the professional fishermen were monitored daily to determine the fish species diversity

of Kaptai Lake. A wide range of fishing gears including kechki jal (seine), fas jal (gill net), dharma jak (lift net), thela jal (push net), hook and chai (trap) were used and this combination is effective in sampling fishes from different water levels (Galib et al. 2018a). Fish species were identified based on their morphometric and meristic characteristics after Rahman (2005). Recorded fish species were classified following the Fishbase database (Froese and Pauly 2019).

Conservation status and availability of fishes

National conservation status of fish species are based on IUCN Redlist of threatened fishes of Bangladesh (IUCN Bangladesh 2015). Availability of fish species was determined by analysing the harvested fish by the fishermen and these are very common (VC; present in the catch in large quantities, usually >1000 kg month^{-1}), common (C; present in catch in moderate quantity, usually > 100 – 1000 kg month^{-1}), low (L; present in catch in smaller quantity, usually > 1 – 100 kg month^{-1}) and rare (R; irregular in catch, represented by few individuals).

Data on lake management and problems

Ten focus group discussions (FGDs) with professional fishermen and interviews of BFDC personnel were conducted to collect information on Kaptai Lake management and its problems. In addition, direct visits to different parts of the lake were also conducted.

Results

Fish diversity

Fifty three native fish species have been recorded in this study, belonging to eight orders and 24 families (Table 1). Cyprinidae was the dominant fish order with 18 species followed by Siluriformes (14 species) and Perciformes (11 species). Whereas, Cyprinidae (15 species) was the most dominant family followed by Bagridae (4 species), Ambassidae (3 species), Siluridae (3 species), Mastacembelidae (3 species) and Channidae (3 species). In addition to native fish species, seven non-native fish species were also recorded in Kaptai Lake (Table 1).

Table 1 Native and non-native fish species of Kaptai Lake along with their national conservation status (for native only) and availability in the lake.

Order and family	Species	Conservation	Availability
A. Native fish species			
Beloniformes			
Belonidae	*Xenentodon cancila* (Hamilton, 1822)	LC	C
Clupeiformes			
Clupeidae	*Gudusia chapra* (Hamilton, 1822)	VU	VC
	Gonialosa manmina (Hamilton, 1822)	LC	C
	Corica soborna Hamilton, 1822	LC	VC
Cypriniformes			
Cyprinidae	*Labeo gonius* (Hamilton, 1822)	NT	R
	Labeo rohita (Hamilton, 1822)	LC	VC
	Labeo calbasu (Hamilton, 1822)	LC	C
	Labeo bata (Hamilton, 1822)	LC	C
	Gibelion catla (Hamilton, 1822)	LC	VC
	Cirrhinus cirrhosus (Hamilton, 1822)	NT	C
	Pethia ticto (Hamilton, 1822)	VU	R
	Puntius chola (Hamilton, 1822)	LC	C
	Puntius sophore (Hamilton, 1822)	LC	C
	Amblypharyngodon mola (Hamilton, 1822)	LC	C
	Osteobrama cotio (Hamilton, 1822)	NT	R
	Salmostoma bacaila (Hamilton, 1822)	LC	R
	Salmostoma phulo (Hamilton, 1822)	NT	L
	Esomus danrica (Hamilton, 1822)	LC	R
	Devario devario (Hamilton, 1822)	LC	R
Nemacheilidae	*Paracanthocobitis zonalternans* (Blyth, 1860)	LC	R
Cobitidae	*Lepidocephalichthys guntea* (Hamilton, 1822)	LC	R
Botiidae	*Botia dario* (Hamilton, 1822)	EN	R
Osteoglossiformes			
Notopteridae	*Chitala chitala* (Hamilton, 1822)	EN	C
	Notopterus notopterus (Pallas, 1769)	VU	C

Order and family	Species	Conservation	Availability
Perciformes			
Anabantidae	*Anabas testudineus* (Bloch, 1792)	LC	L
Ambassidae	*Chanda nama* Hamilton, 1822	LC	L
	Parambassis ranga (Hamilton, 1822)	LC	VC
	Parambassis lala (Hamilton, 1822)	LC	L
Channidae	*Channa striata* (Bloch, 1793)	LC	C
	Channa marulius (Hamilton, 1822)	EN	VC
	Channa punctata (Bloch, 1793)	LC	C
Osphronemidae	*Trichogaster lalius* (Hamilton, 1822)	LC	L
	Trichogaster fasciata Bloch & Schneider, 1801	LC	L
Gobiidae	*Glossogobius giuris* (Hamilton, 1822)	LC	C
Sciaenidae	*Otolithoides pama* (Hamilton, 1822)	LC	C
Siluriformes			
Ailiidae	*Ailia coila* (Hamilton, 1822)	LC	C
	Clupisoma garua (Hamilton, 1822)	EN	C
Clariidae	*Clarias magur* (Hamilton, 1822)	LC	VC
Heteropneustidae	*Heteropneustes fossilis* (Bloch, 1794)	LC	VC
Bagridae	*Mystus cavasius* (Hamilton, 1822)	NT	C
	Mystus vittatus (Bloch, 1794)	LC	C
	Mystus tengara (Hamilton, 1822)	LC	C
	Sperata aor (Hamilton, 1822)	VU	VC
Pangasiidae	*Pangasius pangasius* (Hamilton, 1822)	EN	R
Schilbeidae	*Eutropiichthys vacha* (Hamilton, 1822)	LC	C
	Pachypterus atherinoides (Bloch, 1794)	LC	C
Siluridae	*Wallago attu* (Bloch & Schneider, 1801)	VU	VC
	Ompok pabda (Hamilton, 1822)	EN	C
	Ompok bimaculatus (Bloch, 1794)	EN	L
Synbranchiformes			
Mastacembelidae	*Macrognathus aculeatus* (Bloch, 1786)	NT	C
	Macrognathus pancalus Hamilton, 1822	LC	L
	Mastacembelus armatus (Lacepède, 1800)	EN	VC
Synbranchidae	*Monopterus cuchia* (Hamilton, 1822)	VU	L
B. Non-native fish species			
Cypriniformes			
Cyprinidae	*Hypophthalmichthys molitrix* (Valenciennes, 1844)	–	C
	Cyprinus carpio Linnaeus, 1758	–	L
	Barbonymus gonionotus (Bleeker, 1849)	–	L
	Ctenopharyngodon idella (Valenciennes, 1844)	–	C
Perciformes			
Cichlidae	*Oreochromis niloticus* (Linnaeus, 1758)	–	VC
	Oreochromis mossambicus (Peters, 1852)	–	C
Siluriformes			
Loricariidae	*Pterygoplichthys pardalis* (Castelnau, 1855)	–	R

Conservation status: EN, endangered; LC, least concern; NT, near threatened; VU, vulnerable. Availability: C, common; L, low availability; R, rare; VC, very common.

National conservation status and availability in the lake

A total of 20 fish species recorded in this study were of national conservation importance which includes eight endangered, six vulnerable and six near threatened fish species (Table 1). However, the national conservation status of the remaining species was the least concern. In 2020, the fish catch is dominated by three native species, *G. chapra*, *G. manmina* and *C. soborna* (Fig. 1 and 2). They constituted 87.8% of the total landed amount (Fig. 2). Non-native fish contributed below one per cent of the total harvest from the lake.

Lake management

Kaptai Lake is managed by the Bangladesh Fisheries Development Corporation in collaboration with government law enforcing agencies, primarily Bangladesh Navy. Every year, seasonal fishery closure or temporary fishing ban is being employed from May to July to enhance the natural stock. During the

seasonal fishery closure, BFDC personnel regularly monitor fishing activities in the lake and distribute government subsidies to the fishermen to cope with the situation. In 2020, 438.86 MT of rice was distributed among 21943 fishermen.

In addition, seeds of native carps (primarily *Labeo rohita*, *Gibelion catla* and *Cirrhinus cirrhosus*) were also being stocked by BFDC. In 2019–2020, 43078 kg (= 1319887 individuals) of seeds of native carp species have been released into the lake to enhance the stock.

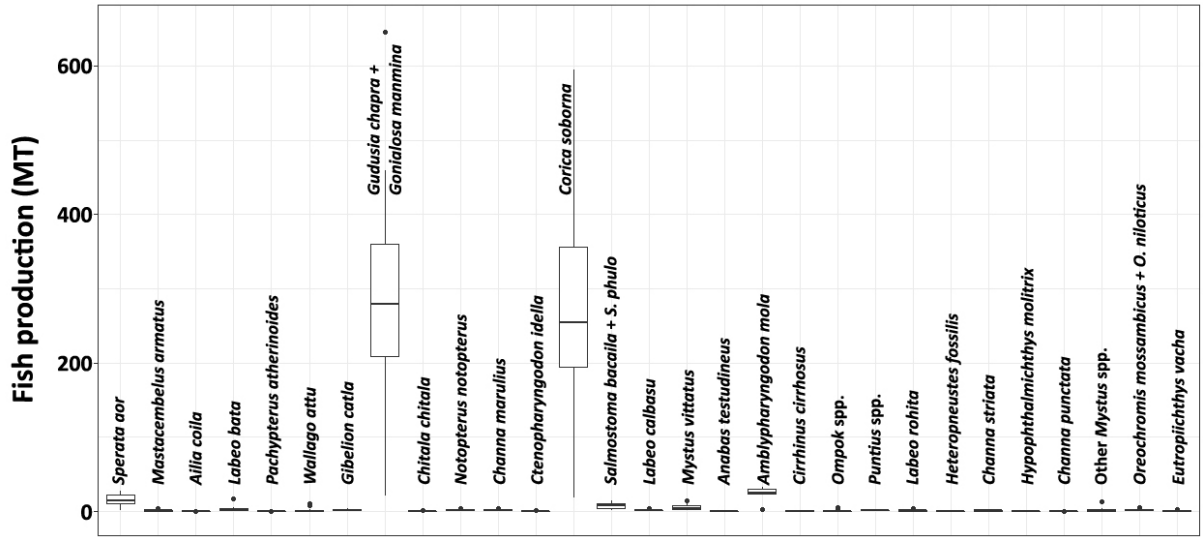

Fig. 1 Landing of different fish species in 2020 at different fish landing centres of Kaptai Lake. Midline within the box is the median; upper and lower limits of the box represent the third and first quartile (75th and 25th percentile) respectively.

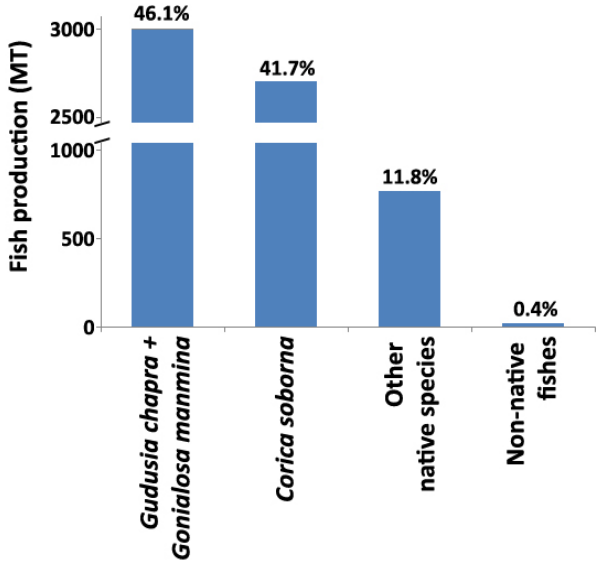

Fig. 2 Fish production, by groups, in Kaptai Lake in 2020.

Problems

Major problems, both anthropogenic and natural, are listed in table 2. Illegal fishing in the lake during ban period is a major problem in the study area. In addition, use of harmful fishing gear, especially during dry seasons is causing a grave damage to the lake fishery.

Table 2 Problems of fisheries in Kaptai Lake.

Type	Problems
Man-made	Illegal fishing during ban period.
	Use of harmful fishing gears (e.g. Jak net and Gara net).
	Release of non-native species threatens the native biota.
	Indiscriminate exploitation of fishes during dry season.
	Deposition of slowly-degradable materials (e.g. plastic and polythene) ino the lake, primarily from tourism activities.
	Siltation problem, primarily due to 'jhum' cultivation of crops (or burn agriculture) in hilly surrounding areas which involves clearing the trees and other vegetation resulting in increased silt deposition into the lake
Natural	Reduced water level in breeding grounds during summer (e.g. Maini channel breeding ground)
	Natural siltation through rivers feeding the lake.
	Impacts of climate change, especially increased temperature and decreased rainfall.

Discussion

This study provides important information on fish diversity in Kaptai Lake along with their conservation status in Bangladesh and availability in the lake. The management system of the lake and existing problems were also identified which are important for better management of the lake.

The fish diversity in Kaptai Lake is quite high, supporting a good number of species of national conservation importance. Historically, water bodies of Bangladesh support diversified fish fauna (e.g. Imteazzaman and Galib 2013; Mohsin et al. 2013; Chaki et al. 2014) but a decreasing trend of native fish species richness and abundance has been reported at present in most of the studies (Mohsin et al. 2014; Galib et al. 2016). The presence of fish species of conservation importance in the catches indicates that this habitat could be an excellent place for the natural conservation of the species concerned.

From economic point of view, Kaptai Lake is losing high-value fish species such as native carps (e.g. *L. rohita*, *L. calbasu*, *G. catla* and *C. cirrhosus*). In 1966, these carps contributed >80% of the total fish production (Ahmed et al. 2006) whereas this shifted to three small indigenous fish species (*G. chapra, G. manmina* and *C. soborna*) at present time, contributing nearly 90% of the total fish production. However, the share of these three species was 63.4% in 2001 (Ahmed et al. 2006) which indicates a rapid increase of their abundance in Kaptai Lake. This also indicates that they are an effective competitor for resources (e.g. food and space) in the habitat and may be they are capable enough to outcompete other species occupying similar ecological and functional niches.

Presence of non-native species in the lake in good amount, except for *P. pardalis*, has both positive and negative prospects. Non-native cyprinids were introduced intentionally to increase the fish production in the lake whereas tilapias (*O. niloticus* and *O. mossambicus*) were introduced accidentally during the 80s (Haldar et al. 2002; Ahmed et al. 2006). These are common pathways of non-native fish introduction worldwide (García-Berthou et al. 2005; Gozlan 2008). However, intentional introduction of potentially non-native invasive species is a common practice in most of the Asian countries and their potential adverse effects on the native biota and ecosystem are of little concern (Jones et al. 2021). Recently, suckermouth catfish (*P. pardalis*) was caught irregularly in the lake. This is a common and popular ornamental fish species in Bangladesh (Galib and Mohsin 2010) many people released them in the wild when they attain large sizes in aquarium. All the non-native species recorded in the lake are among the most frequently introduced aquatic species in the world (García-Berthou *et al.*, 2005). Moreover, all the non-native species recorded in this study are capable of being invasive in the lake and in many countries of the world they are causing considerable damages to the ecosystem and biota.

The problems recorded in this study are common in Bangladesh, already reported in many studies (e.g. Galib et al. 2009, 2013; Shamsuzzaman et al. 2017). Despite supports to the fishermen during ban period illegal fishing in the lake indicates that either the current level of support is not adequate or there are outstanding fishermen from this support. The specific cause should be identified and resolved as soon as possible. Creating alternative livelihood options may be effective in this case. It is a good initiative to stock seeds of native carps into the lake but studies are needed to determine the success of this initiative because, in past, this (= stocking of carp fingerlings) was not successful (Ahmed et al. 2006).

In conclusion, a holistic management approach is required for Kaptai Lake to deal effectively with problems associated with existing management, tourism and local agriculture. As nature-induced problems are difficult to solve, priority should be given on anthropogenic effects.

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