

Bagarius bagarius (Hamilton, 1822)

Subjects: Biodiversity Conservation
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B. bagarius (Hamilton, 1822) is a fish species that has huge potential as food and game fish in Bangladesh, Bhutan, India, and Nepal, but is encountering the threat of extinction in Bangladesh and throughout the world, which can be inferred from its alarming conservation status in Bangladesh as well as throughout the world. It is known as “Baghair” or “Bagh mach” in Bangladesh. In Bangla, the term “Bagh” refers to a tiger.

Keywords: catfish ; biology ; critically endangered ; threats ; conservation

1. Biological Features, Ecology, and Population Trends

1.1. Identification

B. bagarius has an elongated and flat body, and it is flattened up to the pelvics [1]. For convenience, it is divided into three body parts:

- a. Head region: i. It has a large, osseous, and naked head which is greatly depressed, and its snout is sharply conical without pointing [2]. ii. It occupies a ventral, wide, and crescentic mouth [3] with thick lips and sharp, unequal teeth, which are organized into bands on the jaws [2]. They occupy dorso-ventrally flattened buccal cavity and pharynx [4]. iii. Its eyes are small and placed dorsally [2]; a membranous fold separates the closely placed nostrils [5]. iv. It has four pairs of barbells. One pair is maxillary, with stiff and broad bases, one pair is tiny nasal, and the remaining two pairs are mandibular barbell [2][5]. v. Its gill openings are wide [5]; gill membranes are free from each other and attached with the isthmus base [2][5]. It has 4–8 elongated neural spines and 6–9 gill rakers [6].
- b. Middle region: i. They bear no scales but have a myriad of pentagonal epidermal elevations on their skin that give a rough feel on touch [7]. Their skin is also equipped with flask-shaped mucous glands that secrete either acidic or neutral mucopolysaccharides as mucous [7]. ii. Their bodies are attractively light yellowish or greyish in color, with large messy black bands. These bands cover the dorsal and adipose fin bases [5]. iii. Dorsal fin has 1 spine and 6 soft rays [8] where Roberts [6] identified 9–12 pectoral fin rays and Jayaram [2] identified 13 pectoral fin rays with a soft elongation. Pectoral fin also holds a spine with serrated inner edge. iv. Pelvic fins are equipped with six rays [2]. Kottelat [8] noted 13–14 soft rays, though Jayaram [2] included larger range of 12–15 rays for its anal fin. Its pelvic fin originates in front of the base of the last dorsal ray, and the adipose fin originates behind the anal fin origin [8]. v. It has a complete and simple lateral line [2]. v. It poses 38–42 vertebrae in total [6][8], where 17–20 are expanded abdominal vertebrae and 19–22 are caudal vertebrae [6]. vi. Its air-bladder is small and enclosed in two bony capsules [2].
- c. Caudal region: Its air-bladder is small and enclosed in two bony capsules [2].

1.2. Records of Length and Weight

In **Table 1**, data based on length and weight of *B. bagarius* found in different ones are presented. The total length and weight ranges were 0.21–81.5 cm and 1.35–70 gm, respectively. Some lacked weight-related data [9][10].

Table 1. Length-weight records of *B. bagarius*.

Length (cm)	Weight (gm)	References
16.1–21 (TL)	20–45	[11]
28.1–42.2 (TL)	70–257	[12]
6.2–81.5 (TL)	1.35–2364	[13]
10.2–41.5 (TL)	-	[12]
4.08–19.2 (SL)	-	[9]

1.3. Ambiguity with Other Species

B. bagarius has often been confused with *Bagarius yarrelli* (Sykes, 1839). Roberts ^[9] documented some confusing identification of these two species in some earlier ones. In Bangladesh, misidentifications of this species have been noted in some ^{[14][15]} by IUCN Bangladesh ^[16]. These two species have been used as synonymous in Alam ^[14], but Lashari et al. ^[17] and Nagarajan et al. ^[18] confirmed that these two species are genetically distinct from each other. *B. bagarius* and *B. yarrelli* can be differentiated from each other by using some attributes, including the smaller one that lives in streams is *B. bagarius* and the larger one inhabiting large rivers is *B. yarrelli* ^[16]. Moreover, the pelvic fin of *B. bagarius* originates from a region, anterior from an imaginary perpendicular line from the base of last dorsal fin ray, where in *B. yarrelli* it originates from the posterior of that line ^[19]. Again, in *B. bagarius* the anal fin origin is advanced from the adipose fin origin on the contrary, *B. yarrelli* has the anal fin origin just beneath or backward from the adipose fin origin ^[19].

1.4. Food and Feeding Habit

Although a detailed one on the morphology and histology of the digestive tract of *B. bagarius* ^[20] presents that they are omnivorous fish, a trophic one of this species shows that they are carnivorous in nature ^[21]. They forage in the benthopelagic ^[22], surface, and sub-surface zones ^[23] for food. They feed both in daylight and in darkness ^[23]. They are primarily dependent on small and medium sized fishes for food, while insects and crustaceans are their second choice ^[23]. Among insect food items, they show their preferences for Diptera (Simuliidae), Trichoptera (Glossosomatidae), Ephemeroptera (Heptageniidae), Coleoptera, and Odonata ^[21]. Frogs, shrimps, and plant matters are also enlisted in their food menu ^{[15][21]}. The feeding intensity of this fish was reported to be highest during the winter months and lowest during the monsoon ^[21].

1.5. Reproduction

Very little literature about its reproduction is available. Adults prefer to live in rocky and torrential, medium to large rivers ^[24]. Their breeding time starts in the early rainy season ^{[14][24]}. However, Akter et al. ^[2] recorded them breeding in a wide range of months between April and July.

1.6. Habitat and Ecology

B. bagarius is generally found in fast-flowing rivers and takes shelter under stones and bog logs ^[14]. They are inhabitants of both fresh and brackish water environments and occupy the benthopelagic zone of water bodies ^[22]. Their migration pattern is potamodromous ^[22]. They can tolerate the temperature range between 18–25 °C as a tropical fish ^[3] and a pH range of 6.5–7.8 ^[22].

1.7. Population Trends

Globally, the population trend of this species is following a declining tendency ^[4]. In India, their population in southern West Bengal met a significant downfall of about 29.2% within four decades (1960 to 2000) ^[5]. Its abundance in Bangladesh has declined by a considerable amount since the 1990s ^[16], and Paul et al. ^[11] cited about an 80% decrease of this fish in 25 years in Bangladesh.

2. Distribution, IUCN Status, and Economic Importance

2.1. Distribution

It is distributed in South and South-east Asia (**Figure 1**), including Bangladesh, Cambodia, India, Indonesia (Sumatra, Borneo and Java), Laos, Myanmar, Pakistan ^[16], Bhutan, Nepal ^[4], Vietnam ^{[6][15]}, and also in Thailand ^[7].

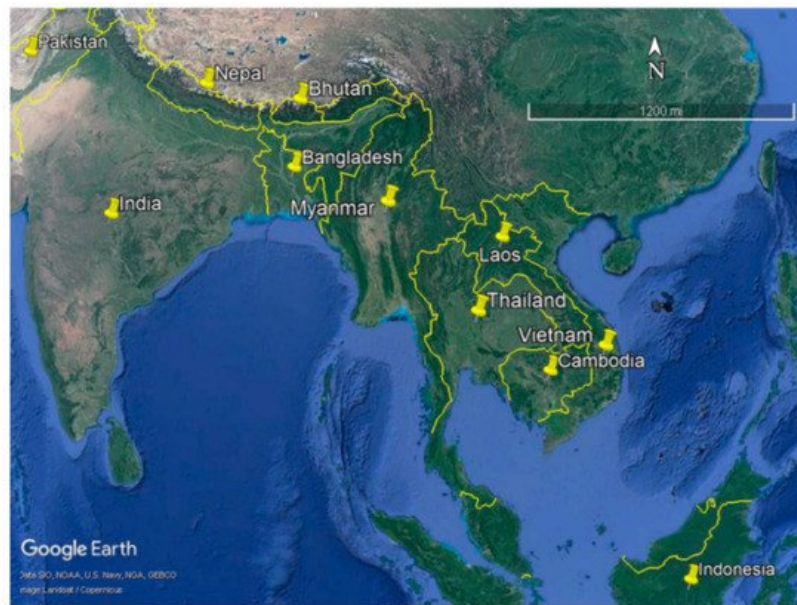


Figure 1. Worldwide distribution of *Bagarius bagarius* (Source: Google Earth Pro).

It is of the last two decades that recorded the distribution of this species is presented in **Figure 2**.

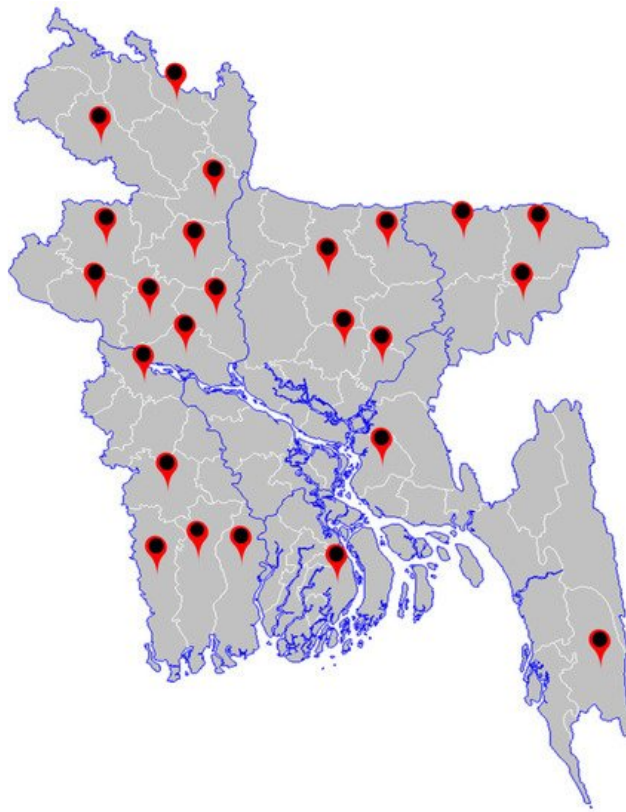


Figure 2. District-wise distribution of *Bagarius bagarius* in Bangladesh.

2.2. Conservation Status

It is in the near threatened category in the world ^[4] and threatened in India ^[8] and in Bangladesh. The conservation status of this species is in the critically endangered category ^[16], though Paul et al. ^[11] suggested reclassifying *B. bagarius* into a lower threatened status for Bangladesh. However, its population is suffering from various anthropogenic and environmental threats in Bangladesh ^[25].

2.3. Economic Importance

It is a vital edible fish and manages a high price in the Bangladeshi ^[26] and Indian ^[18] markets. It is renowned for its unique taste, flavor, and fewer spines ^{[18][26]}. This fish contains 18.05% protein, 8.25% fat, 0.5% ash, and 73.20% moisture as proximate composition ^[27]. Sub-adults and juveniles are often used as ornamental fish, while the adults attract recreational anglers ^[4]. Its meat has a discredit of being spoiled rapidly and that leads to illness of consumer. Alice

et al. [26] suggested to use MAP (modified atmosphere packaging) with 50% CO₂ and 50% N₂ for extension of its shelf life.

3. Status of Inland Fish Habitats in Bangladesh

Bangladesh is a country dominated by wetlands, with more than half of its area covered by freshwater and brackish water habitats. Inland fish habitats are diverse and unique, relying on extensive networks of floodplains, large and small rivers, beels (relatively large surface, static water bodies that collect surface run-off through internal drainage channels), haors (back swamps or bowl-shaped depressions between river natural levees), baors (oxbow lakes created by meandering rivers that change course, and two cut-offs from the main course), ponds, lakes, and seasonally cultured waters (**Table 2**). Ecosystem services from the fisheries resources have long been vital in the economy, culture, tradition, and eating habits of people. From the beginning of time, fish has been an important element of the Bangladeshi people's existence [28]. In both rural and urban parts of Bangladesh, people rely heavily on fish to meet their protein demands. Fish habitats in Bangladesh have been degrading rapidly due to industrial pollution, agro-chemicals, establishment and development of unplanned infrastructures, uncontrolled soil and sand withdrawal, sedimentation, the rise of char (silt bed), lack of rainfall, shallow water depth and flow, deforestation, and climate change [25][29][30][31][32][33][34][35].

Table 2. The inland fish habitats of Bangladesh and production in 2019–2020.

Name of the Habitats	Area (ha)	Production (kg/ha)
A. Open waters		
i. Floodplains	2,651,567	294
ii. River and tributaries	8,53,863	389
iii. Beels	114,161	903
iv. Kaptai Lake	68,800	185
v. Sundarbans	177,700	118
B. Closed waters		
i. Ponds	404,497	5059
ii. Prawn/Shrimp farms	257,888	1047
iii. Baors	5671	1934
iv. Seasonal cultured water bodies	151,942	1487

4. Major Threats

The fish diversity of Bangladesh, especially the population of *B. bagarius*, is suffering from various anthropogenic and environmental threats in Bangladesh.

4.1. Over-Fishing and Indiscriminate Harvesting

Different [16][31][36][37][38] showed overfishing as a threat to *B. bagarius* in different water bodies of Bangladesh. The ever-expanding human population and the development of fishing technologies are the primary causes that lie behind the overexploitation of freshwater fish [39]. Besides these facts, the high market price of *B. bagarius* in Bangladesh [26] attracts fishers to capture them regardless of their size and stage in life cycle.

4.2. Habitat Degradation

Fragmentation of water bodies by constructing dams, construction of bridges, alteration of water flow in rivers and canals for hydropower generation and water extraction, light and sound pollution adjacent to the natural water bodies, and use of wetlands for the route of mechanical water vessels are vital examples of human intervention in the natural habitats of *B. bagarius* in Bangladesh. Construction of roads, dams, and bridges across water bodies creates obstacles to the normal migration of this fish. Rapid urbanization in Bangladesh is also responsible for the degradation of natural habitats for *B. bagarius*. Light and sound pollution are common phenomena of urbanization that are proven as stressors for freshwater fishes [40]. Moreover, encroachment of wetlands for industrial, agricultural, and urban development is continuously destroying their habitats.

4.3. Siltation

As a benthic insectivore and a simple lithophilous spawner, *B. bagarius* is highly sensitive to siltation ^[41]. Increased deforestation in Bangladesh leads to excessive soil erosion that eventually results in increased siltation in the natural water bodies, which is responsible for decreased depth and increased turbidity in the habitat of *B. bagarius*. In some coastal areas of Bangladesh, people deliberately trap silt for land reclamation. Rapid urban development can also result in a high level of siltation ^[42]. Many scientists agree that siltation is a threat to *B. bagarius*, as it is ultimately destroying the habitats of this fish ^{[16][31][36]}.

4.4. Water Pollution

Different point and non-point sources are responsible for surface water pollution in Bangladesh (**Table 3**). Pollutants from these sources cause significant changes in the thermal, physical, and chemical properties of the bodies of water which make these wetlands unsuitable for *B. bagarius* ^[43].

Table 3. Sources of water pollution in inland waters of Bangladesh.

Pollutant Type	Point Sources	Non-Point Sources
Pathogens	Raw sewage	Agricultural runoff and waste
	Solid urban waste	Leachate from septic tank, waste of animal
	Excreta of human and animal	
Heavy metals	Industrial discharges mainly from tannery and textile industries	Pesticide runoff
	Mine effluents	Smelting
	Power plants	
	Pharmaceutical wastes	
Organic chemicals	Industrial discharges mainly from tannery and textile industries	Agricultural runoff
	Wastes from urban areas	Runoff from agro farms, pasture, and household wastes
Nutrients	Wastewater of treatment plants	Agricultural runoff
	Excreta of human and animal	Household wastes
Thermal	Electric power plants	
	Effluents from industries	
Sedimentation	Construction related runoff from sites, smaller than 20,000 m ²	Construction related runoff from sites, larger than 20,000 m ²
		Agricultural runoff
		Soil erosion
Radioactivity		Natural occurring radioactivity

Source: Modified from Hasan et al. ^[43].

4.5. Invasive Fish Species

Among many other drivers of freshwater biodiversity deterioration, invasive species are deliberated as a momentous one ^[40]. Since the late 1950s, more than 24 exotic fish species have been introduced in the aquaculture of Bangladesh. Deliberate and accidental invasion of these fishes in the natural waters are creating pressure on the native species like *B. bagarius* as most of them are fierce competitor. Moreover, there is evidence of an outbreak of a deadly fish disease named Epizootic Ulcerative Syndrome in the natural water bodies of Bangladesh by an invasive fish named *Barbonemus gonionotus*. Therefore, invasive fishes are treated as threats to *B. bagarius* in these ^{[16][25][37][38][44]}.

4.6. Climate Change

Climate change has the potential to threaten approximately half of the freshwater fish throughout the globe [45]. Bangladesh has been ranked first among the countries susceptible to the drastic effects of climate change [46]. Therefore, *B. bagarius* in Bangladesh is susceptible to the effects of climate change. **Figure 4** delineates the climate change derived impacts on this fish. One of the most important effects of climate change is elevated temperatures. Temperature in Bangladesh has increased by around 0.5 °C over the past 100 years and it was predicted that, by 2100, temperature will increase by 3–3.5 °C [47]. This rise in temperature will increase the water temperature, which will lead to reduced dissolved oxygen, growth of cyanobacterial blooms, and enhancement of the bioaccumulation potential of pesticides and harmful metals [47]. All of these events are clear threats to any freshwater fish species, including *B. bagarius* (**Figure 3**). Additionally, elevated water temperatures are likely to affect the normal physiology of freshwater fishes. Climate change is changing the rainfall pattern throughout the world. A change in rainfall pattern has the potential to affect the breeding biology of *B. bagarius* as it breeds in the rainy season [24]. Increased temperature is responsible for sea level rise. This raised sea level, lowered freshwater flow in rivers due to reduced depth as a result of siltation, facilitates saline water intrusion in the rivers. As *B. bagarius* occupies freshwater and brackish water regions, saline water intrusion will affect its niche and will shrink its habitat.

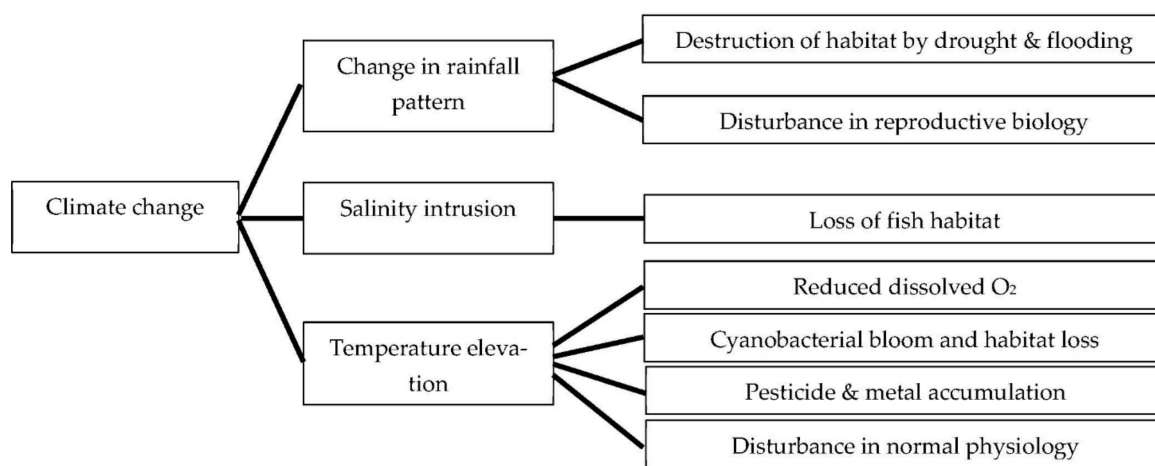


Figure 3. Effects of climate change on *B. bagarius*

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