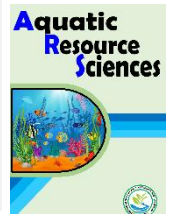




ISSN (online): 3008-0436

ISSN (print): 3008-0428

# Aquatic Resource Sciences

Journal homepage: [www.journal.inrrd.com/ars](http://www.journal.inrrd.com/ars)

## Threatened Species Series

### Threatened fishes of the world *Notopterus notopterus* (Pallas, 1769): Recommendations for Sustainable Conservation

Fatema Jannat Raina<sup>1</sup>, Tasnim Akter Akhi<sup>1</sup>, Md Tanvir Wahid Tamim<sup>2</sup>, Israt Jahan<sup>3</sup>, Rakiba Khatun<sup>1</sup>, Zakiur Rahman Sarker<sup>3</sup>, Md. Ashabul Hoque<sup>1</sup>, Taiyef Morshed Turzo<sup>4</sup>, and Md. Akhtar Hossain<sup>1\*</sup>

<sup>1</sup>Department of Fisheries, Faculty of Fisheries, University of Rajshahi, Rajshahi-6205

<sup>2</sup>Department of Fisheries Management, Faculty of Fisheries, Patuakhali Science and Technology University, Patuakhali-8602

<sup>3</sup>Department of Fisheries Biology and Genetics, Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh-2202

<sup>4</sup>Department of Microbiology, Faculty of Biotechnology and Biomolecular Sciences, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia

#### ARTICLE INFO

##### Article history

Received 03 April 2025

Revised 02 May 2025

Accepted 10 June 2025

Available online 30 June 2025

##### Keywords

*Notopterus notopterus*

Reproductive biology

Conservation

Sustainable management

#### ABSTRACT

*Notopterus notopterus* (Pallas, 1769), commonly known as the bronze featherback or “Foli,” is an important freshwater fish mostly found in South and Southeast Asia belonging to the family Notopteridae. This review summarizes the biology, ecology, threats, and provides recommendations for sustainable conservation of *N. notopterus*. It holds significant nutritional, economic, and cultural value but faces population decline due to overfishing, habitat degradation, and pollution. Though it is listed as “Least Concern” globally, it is considered “Vulnerable” in Bangladesh. The species is carnivorous, inhabiting rivers, beels, and floodplains, and shows positive allometric growth with distinct sexual dimorphism. Heavy metal contamination, overharvesting, habitat degradation causes serious threats to its growth and survival. Captive breeding by using hormonal induction (LHRH-A and domperidone), habitat protection and sustainable fishing practices are key for conservation. The study supports Sustainable Development Goals (SDGs 1, 2, 12, 14, and 15) which can ensure the conservation of threatened fish species, protecting its habitats, and ensuring sustainable livelihoods via measures like habitat protection and captive-breeding for ecological and economic stability as it is essential for future aquaculture development, promote biodiversity, food security, and sustainable resource management.

#### Introduction

The four genera, eight well-known species, and ten nominal species that make up the Osteoglossiform family Notopteridae are found in tropical Africa and South and Southeast Asia. The genus *Notopterus* is a member of the family Notopteridae, *Notopterus notopterus* is a member of the catfish group. The second largest category of freshwater fish is catfishes. While some people adore these fish, some groups, including Jews, have preconceived notions about them (Yanwirsal et al. 2017; Bano et al. 2015). The bronze featherback, or *N. notopterus*, is a famous

species of freshwater fish that is widely distributed in South-East Asia and has significant commercial and cultural value. Currently, *N. notopterus* (Pallas 1769) and *N. synurus* (Bloch & Schneider 1801) are the two separate species that make up the genus *Notopterus*. Among other characteristics, *N. notopterus* specimens can be distinguished from all other oriental freshwater fishes by their unique tapered tail and the corners of their mouth below the eye (rather than behind, as in the other oriental notopterid species *Chitala*) (Lavoué et al. 2020). *N. notopterus* has been recognized as a significant freshwater fish resources due to its high nutritional value and has

\*Corresponding author

Email address: [akhtarhossain625@gmail.com](mailto:akhtarhossain625@gmail.com) (Md. Akhtar Hossain)

been reported to contribute to the nutritional security of rural people in its native ranges. This species of fish has a significant economic impact in South and Southeast Asian nations and is reportedly consumed both fresh and dried. It has recently been seen as having ornamental value and is reportedly well-liked by aquarium fish enthusiasts (Gupta and Ray 2022). Monsoon delays, overexploitation, habitat degradation, pollution, and other human influences are all contributing to the natural population's decline. In Bangladesh, it was facing a high risk of extinction in the wild and classified as "Vulnerable" (IUCN Bangladesh 2015) and it is classified as "Least Concern" globally. The primary threats to this species include habitat degradation, overfishing, and changes in its natural habitat causes degradation of breeding grounds. Some available studies on *N. notopterus* are presented on Table 1. There is currently a dearth of thorough research and documentation on *N. notopterus*, despite its ecological and economic relevance in Bangladesh. The creation of efficient management, captive culture conservation strategies is hampered by this gap. Thus, the purpose of this publication is to act as a fundamental resource for creating suitable conservation and management plans for *N. notopterus* in Bangladesh.

### Taxonomic remarks

Kingdom: Animalia

Phylum: Chordata

Class: Actinopterygii

Order: Osteoglossiformes

Family: Notopteridae

Genus: *Notopterus*

Species: *N. notopterus*



**Fig. 1:** *Notopterus notopterus* (Gupta and Ray 2022)

### Synonyms

*Notopterus primaevus* (Pallas, 1769)

*Gymnotus notopterus* (Pallas, 1769)

*Notopterus kapirot* (Lacepède, 1800)

*Mystus kapirot* (Lacepède, 1800)

*Notopterus kopiroi* (Lacepède, 1800)

*Clupea synura* (Bloch & Schneider, 1801)

*Osteoglossum cynurus* (Bloch & Schneider, 1801)

*Mystus badgee* (Sykes, 1839)

*Notopterus pallasii* (Valenciennes, 1848)

*Notopterus bontianus* (Valenciennes, 1848)

*Glanis imberbis* (Gronow, 1854)

*Notopterus osmani* (Rahimullah & Das, 1991)

### Morphological characters

The fish species *N. notopterus* is distinguished by a few unique physical traits (Fig. 1). They have an almost straight dorsal head profile and a strongly compressed, elongated, and laterally flattened body. Their tail is distinctively tapered, and the corners of their mouth are located below the eye (inferior mouth) with many small teeth. Its combination of a long, continuous fin that fuses with the tail fin to enable undulating, ribbon-like movements and a small, feather-shaped dorsal fin is its most distinctive characteristic (Munti et al. 2024; Wibowo et al. 2024). The dorsal fin is short, while the anal fin is long and continuous with the caudal fin. They have tiny, cycloid scales distinguished by its plain brown adult coloration and the convex or only slightly concave dorsal head profile; juveniles (<5 cm SL) with dark bars on the whole body (Kottelat 1998); silvery-white with numerous fine grey spots on body and head (Talwar and Jhingran 1991). A prominent lateral line is present, almost straight and complete. The swim bladder is utilized to breathe air and is still attached to the stomach. Four possible uses for this swim bladder include maintaining buoyancy, facilitating airborne respiration, serving as an additional auditory organ, and producing sound (Yanwirsal et al. 2017).

The available fin formula is-

D. (100–110); P. (13–15); V. (6); A. (110–130); C.0 (Mustafa et al. 2014)

D. (7–9); P1. (15–17); P2. (5–6); A. (99–110) (Kottelat et al. 1993).

### Common name

The fish *N. notopterus* is referred to as Foley or Foli in Bangladesh. Although the common name varies widely among various nations, it is typically referred to as Foli in Bangladesh and Phouli in India, Nga-pe in Myanmar, Lepsi in Nepal (Roberts 1992). The local language and cultural background may influence the particular name.

### Distribution and Abundance

Numerous factors, including environmental circumstances, food supply fluctuation, and climate change, affect fish abundance. Fish distribution and

abundance is impacted by habitat loss and degradation, which take precedence (Pallas 1769). The species is

**Habitat and Ecology**

In addition to artificial habitats like irrigation canals and

**Table 1.** Available studies on *Notopterus notopterus* from different countries

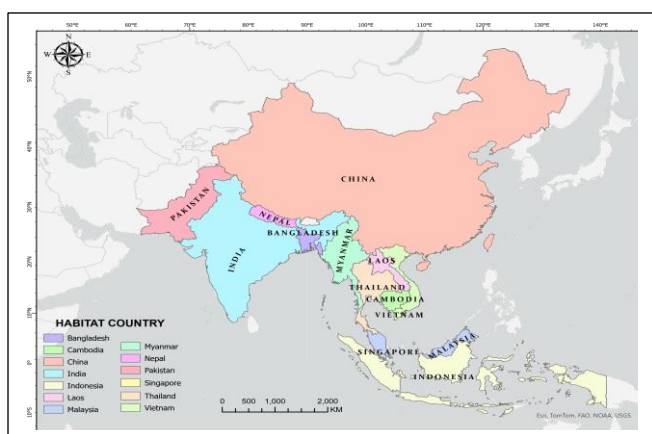
Aspects	Country	References
Feeding and reproductive biology	Indonesia	Muslim et al. (2024)
Genetic and morphological evidence	Indonesia	Wibowo et al. (2024)
Morphological and meristic characteristics	Indonesia	Munti et al. (2024)
Growth and Survival	Indonesia	Muslim and Simanjuntak (2023)
Larvae rearing at different feeding regimes	Vietnam	Devkota et al. (2023)
Embryonic developmental stages in induced breeding	Myanmar	Thu et al. (2023)
Hemato-biochemical alteration as a biomonitoring tool to assess riverine pollution and ecology	India	Tiwari et al. (2023)
Growth and survival in aquarium	Indonesia	Muslim et al. (2023)
Length-length and length-weight relationship	India	Chandran et al. (2020)
Nutritional composition	India	Kulkarni et al. (2020)
Cultivation technology at different stocking densities and types of feed	Indonesia	Sukendi et al. (2020)
Reproduction and development in captivity	Berlin	Yanwirsal et al. (2017)
Multivariate analysis of potential biomarkers of oxidative stress in tissues from as a function of concentration of heavy metals	India	Mohanty & Samanta (2016)
Population Dynamics	Bangladesh	Mustafa et al. (2014)
Genetic Diversity revealed by DNA Microsatellite Markers	Bangladesh	Gupta et al. (2013)
Food and feeding habits	India	Srivastava et al. (2012)

found in slow-moving or stagnant waters with abundant vegetation in Bangladesh, India, Nepal, China, Cambodia, Indonesia, Malaysia, Myanmar, Pakistan, Singapore, Thailand, Vietnam, Laos (Rainboth 1996; Kottelat 1993; Talwar 1991; Rahman 1989). It is widely distributed in freshwater systems throughout Bangladesh.

paddy fields, this potamodromous species lives in fresh and brackish waterways in swamp forests, floodplains, still or stagnant backwaters and ponds, lakes, and river mouths (Yanwirsal et al. 2017). There have also been reports of the species being cultivated in rice fields. During the flood season, *N. notopterus* migrates to floodplains from the river in the Mekong River basin, and during the dry season, it returns to the main river or other permanent water bodies. In the majority of India, it is frequently seen in tanks (Kottelat 1993; Roberts 1993; Talwar 1991).

**Food and feeding behavior**

*N. Notopterus* is generally carnivorous, bottom feeder and euphagic (eats a wide variety of food). Shrimps, teleosts, and aquatic insects and larvae made up the majority of the food of the *N. notopterus* with minor amounts of plant matter, detritus, fish scales, and diatoms (Yap 1988). The fish is also capable of adjusting its diet based on the availability of food. Feeding activity peaked in December, decreased in



**Fig. 2:** Distribution of *Notopterus notopterus*

January as a result of low temperatures slowing digestion, improved from February to April with moderate temperatures (Kulkarni et al. 2020).

### Nutritional Profile

*N. notopterus* is a rich source of protein and essential nutrients (Kulkarni et al. 2020). A comparative nutritional profile is given in Table 2. Its balanced HPD (Highest Posterior Density) is good for our body's growth and development. It offers health benefits like muscle repair, heart health, maintain cholesterol and cognitive function.

**Table 2:** Nutrient profile of *Notopterus notopterus* (Bogard et al. 2015)

	Calcium (mg/100)	Iron (mg/100)	Selenium (µg/100g)	Zinc (mg/100)	Vitamin A (µg/100g)	Total Omega 3 PUFA (g/100g)	Protein (g/100g)
<b>Median</b>	190	1.26	33.5	1.19	20.1	0.175	17.4
<b>Lower 90% HPD</b>	79	0.60	12.4	0.64	5.3	0.097	15.6
<b>Upper 90% HPD</b>	465	2.73	105.5	2.18	72.1	0.306	19.4

### Growth Patterns

Kaushik et al. (2019) calculated the length weight for this species, with  $a = 0.0059$  and  $b = 3.09$ , form factor  $a_{3.0} 0.0078$ , (15.4-26.1) cm TL, according to LWR estimates, which indicates a positive allometric growth pattern. Kaur and Rawal (2017) calculated the 'b' value between total length and total weight was found to be 3.57 which also showed significant positive allometric growth. Chandran et al. (2020) calculated the length weight for this species in multiple rivers in India such as Godavari, Tamsa, Sharda, Gomti, Son, Betwa, Chambal, Krishna, Yamuna respectively, where Godavari, Tamsa, Sarada, Betwa, Chambal, Krishna, Yamuna showed positive allometric growth pattern, while Gomti, Son River showed negative allometric growth pattern (Table 3).

### Form factor

We calculate the form factor with the formula:  $a_{3.0} = 10 \log_a - s(b-3)$  (Froese 2006) where  $a$  and  $b$  represent the LWRs' regression parameters and  $s$  represents the slope of  $\log a$  vs.  $b$ . A mean slope ( $s$ ) of -1.358 was used for the regression analysis of  $\log a$  vs.  $b$ . The calculated form factor ( $a_{3.0}$ ) as to vary between 0.0071 and 0.0171, indicating moderately elongated body shape, as shown in (Table 3).

### Sexual dimorphism and reproductive biology

One of the vital physiological processes that is essential to the life cycle of any organism, including fish, is reproduction (Muslim et al. 2024). According to Muslim et al. (2024) the differences between male and female *N. notopterus* can be identified morphologically. Both male and female show sexual dimorphism. Females have a boarder, triangular anal fin and a gravid spot while males have a slender body with a more pointed anal fin and higher blood glucose level (Rahman 1989).

The fecundity or the number of eggs a female can

produce has varied across different studies. According to Ukkatawewat (1984), the absolute fecundity rate is minimum 1,200 to maximum 3000 in Thailand. According to Paul et al. (2022), the female can produce 105 – 1500 eggs in fishes of 18.5 – 30.5 cm in Brahmaputra river, India.

They reach to their sexual maturity at the length of 15cm (average). The spawning season is typically June through August in regions like *beels*, reservior, with spawning occuring once a year at night when the water temperature is 25-280. Males guard the adhesive eggs until they hatch. It breeds in the rainy season via external fertilization. It occurs when the male fertilizes the females's adhesive eggs after she deposits them onto a substrate like rocks, bricks etc (River and Sumatra 2023).

According to Kohinoor et al. (2012), the vitellogenic stage (VG) began to emerge in May and progressed chronologically through June. The oocyte's vitellogenic stage (VG) and maximum ova diameter peaked in June. June marked the apex of the female fish's gonad weight and GSI fluctuations, indicating ovarian maturity and a clear spawning season.

**Table 3.** Growth pattern of *Notopterus notopterus* from different water bodies

Locality/Habitat	TL (cm)	<i>a</i>	<i>b</i>	Sex	<i>r</i> <sup>2</sup>	<i>a</i> <sub>3.0</sub>	References
Gomti river, India	5.7-27.6	0.00890	2.950	Unsexed	0.980	0.0076	Sani et al. (2016)
Indus River, southern Punjab, Pakistan	14.4-29.4	0.01370	2.830	Male	0.925	0.0081	Naeem et al. (2010)
Indus River, southern Punjab, Pakistan	14.4-29.4	0.01210	2.870	Mixed	0.918	0.0081	Naeem et al. (2010)
Indus River, southern Punjab, Pakistan	18.5-27.9	0.00190	3.440	Female	0.920	0.0075	Naeem et al. (2010)
Betwa river, Uttar Pradesh, India	7.3-29.0	0.01760	2.990	Unsexed	0.950	0.0171	Sani et al. (2010)
Chi river, Thailand	10.3-28.0	0.00650	3.033	Unsexed	0.965	0.0071	Satrawaha and Pilasamorn, (2009)
ponds and wild tanks, Cuttack, Orissa State, India	2.0-39.1	0.01100	2.968	Unsexed	0.990	0.0091	Parameswaran and Sinha, (1966)

Feeding activity peaked in December, decreased in January as a result of low temperatures slowing digestion, improved from February to April with moderate temperatures, then decreased once more during the breeding season (May–July), and then

**Genetics**

According to Arkhipchuk (1999); NBFGR (1998); Khuda-Bukhsh and Barat (1987); *N. notopterus* possesses diploid chromosome number 42 in India. There are no significant differences found in the

**Table 4:** Gonadal Activity and Maturity Stages in *Notopterus notopterus* (Sathish et al. 2014)

Age group	Length	Phase	Gonadal stage	Ovarian activity	Testicular activity
0 year	–	Throughout the year	Immature	Immature stage; differentiation of germinal cells is difficult	Germinal cells in early stages; no clear differentiation
1 year	17-21 cm	Pre-spawning: Feb-Jul Spawning: Mar-Aug Resting: Sep-Jan	Maturing	All 9 stages of oogenesis observed; Oogonium to migratory nucleus	All stages of spermatogenesis present in lobules
		Spawning (Mar)	Active Spawning	Tertiary nucleus ova (2.3%); Migratory nucleus ova (1.26%)	Spermatids (26.13%); Spermatozoa (25.86%)
		Spawning (Aug)	Active spawning	Tertiary nucleus ova (7.1%); migratory nucleus ova (2.1%)	Spermatids (19.26%); Spermatozoa (35.29%)
2 years	22-26cm	Pre-spawning/Spawning	Fully mature	All stages of oogenesis; high tertiary nucleolus and migratory nucleus stages	Testis lobules with all spermatogenetic stages

increased as spent fish resumed active feeding, as evidenced by rising gastrosomatic index values (Srivastava et al. 2012; Kulkarni et al. 2020).

previous studies. It shows karyotypic stability where the

**Table 5:** Histochemical and Electron Microscopic Studies on the Pituitary Gonadotropic Cells in Relation to Different Age Group (Sathish et al. 2018)

Parameter test	Young/Immature Fish	Adult/Mature Fish
Histochemical staining	weak/moderate; fewer granules visible	Dense cytoplasmic granules
Number and size of secretory granules	few, small granules dispersed in cytoplasm	Numerous and larger
Cytoplasmic organization	Poorly developed	Well, developed
Nucleus	small, less euchromatin	Large, more euchromatin
Cell morphology	smaller and less distinct boundaries	Larger, polygonal cells with clear boundaries
Electron Microscopy	Few organelles, limited golgi and ER	Prominent Golgi complex, ER and many mitochondria
Functional Implication	Lower gonadotropic activity	Higher gonadotropic activity

**Table 6:** Heavy metals content in six tissues of *Notopterus notopterus* (Budijono et al. 2020)

Metal	Order of Concentration (High → Low)	Observation
Cadmium (Cd)	Muscles → Reproductive Organs → Liver → Kidney → Gills → Bone	Cd levels in some tissues exceeded permissible limits.
Chromium (Cr)	Liver → Bone → Kidney → Muscles → Reproductive Organs → Gills	Elevated Cr levels detected; potential contamination concern.
Lead (Pb)	Gills → Kidney → Bone → Muscles → Liver → Reproductive Organs	among the highest; above safety limits.
Zinc (Zn)	Gills → Bone → Reproductive Organs → Kidney → Liver → Muscles	within or slightly below permissible limits.
Iron (Fe)	Gills → Muscles → Liver → Kidney → Reproductive Organs → Bone	high accumulation, exceeding allowable limits.
Copper (Cu)	Bone → Liver → Kidney	within safe limits compared to Fe, Pb, and Cd.

**Table 7:** Spawning season of *Notopterus notopterus* from different waterbodies

Region	Spawning season	References
Mekong mainstream	May-June	Sokheng et al. (1999)
Cambodia	Jun-July	Lim et al. (1999)
Thailand	May-June Aug-Sep	Ukkatawewat, (1984)
Bangladesh	May-June	Rahman, (1989)

population is genetically stable in terms of chromosome structure and number.

### Conservation status

The extremely large extent of occurrence (EOO: 11,564,600 km<sup>2</sup>) mediates this, and it is not believed that any global population decline is likely to meet (or be close to meeting) the threshold for a threatened category, even though this species may be declining in some parts of its range due to overfishing, pollution, and consequent habitat loss. As a result, *N. notopterus* is rated as Least Concern (Ng, 2020). But it is considered as a vulnerable species in Bangladesh due to

overfishing, aquarium trade. This classification reflects a high risk of extinction in the wild (IUCN Bangladesh, 2015).

### Threats

This species is threatened by both over harvesting for the food and aquarium trade, and pollution throughout its range, while it is unclear how these factors will affect the population as a whole (Mustafa et al. 2014). This species faces intense fishing pressure in nations like Cambodia, where illicit fishing equipment like mosquito net fences captures a lot of juveniles and tiny fish and restricts its ability to travel between areas

(Muslim and Simanjuntak (2023). Heavy metal concentrations in fish tissue have increased noticeably as a result of pollution from household, industrial, and agricultural sources, which has also deteriorated this species' freshwater environment (Mohanty and Samanta 2016).

### Conservation action

In addition to studying its taxonomy, ecology, harvest, and possible dangers, more research on population patterns in the wild is necessary to comprehend the current state of this widespread species. Throughout its range, this species is widely dispersed and can be found in a number of protected areas (IUCN and UNEP-WCMC 2019).

### Conservation recommendation

Any fish species can be effectively conserved through large-scale cultivation, which guarantees supply and lessens strain on natural stocks. A thorough understanding of the feeding and reproductive biology of a new candidate species is necessary for its successful culture. Consolidating the knowledge on the morphological traits, feeding and reproductive biology, and culture of the bronze featherback, as well as determining the extent of future study to assist its conservation and fishing, have been the main goals of this review (Gupta and Ray 2022). Kandel et al. (2025) found that the LHRH-A and domperidone treatment was identified as the most effective and reliable method for successful captive breeding of *N. notopterus*.

### In connection to the Sustainable Development Goals (SDGs)

The conservation of the threatened fish species *N. notopterus* in Bangladesh can be joined with several Sustainable Development Goals (SDGs). These goals include life below water (SDG 14), life on land (SDG 15), no poverty (SDG 1), zero hunger (SDG 2), and responsible consumption and production (SDG 12). Conservation practices can help to maintain biodiversity, promote sustainable fishing practices, and ensure the health of freshwater habitats. By putting these strategies into practice, *N. notopterus* conservation can support Bangladesh's larger objectives of sustainability, economic stability, and food security while advancing an all-encompassing strategy for social and environmental well-being.

### Conflict of Interest

There is no competing interest that might influence the research work.

### Acknowledgement

The authors would like to express their sincere gratitude to Prof. Dr. Md. Yeamin Hossain for his invaluable support and guidance throughout the preparation of this review. His expertise in fish biology and conservation was instrumental in shaping the recommendations for the sustainable management of *Notopterus notopterus*.

### References

- Arkipchuk VV (1999). Chromosome database. Database of Dr. Victor Arkipchuk.
- Bano N, Salam A & Naeem M (2015). Morphometric Study of *Notopterus* (Male) in Relation to Body Size and Condition Factor. *Academic Research International*, 6(6), 159-165.
- Budijono B, Hasbi M & Sibagariang RD (2020). Heavy metals content in tissues of feather back fish (*Notopterus notopterus*) from the Sail River, Pekanbaru. In *IOP Conference Series: Earth and Environmental Science*, 430(1), 012034 p. IOP Publishing.
- Bloch ME and Schneider JG 1801 ((before) 10 Nov.) M. E. Blochii, *Systema Ichthyologiae Iconibus cx Illustratum. Post obitum auctoris opus inchoatum absolvit, correxit, interpolavit Jo. Gottlob Schneider, Saxo. Berolini. Sumtibus Auctoris Impressum et Bibliopolio Sanderiano Commisum. i-lx + 1-584, Pls. 1-110.* [For authorship of species and translation of introduction see Karrer et al. 1994 [ref. 21826]. Publication date see Paepke 1999:18 [ref. 24282]. See Fricke 1999:666 [ref. 24106] for 1800 edition.]
- Bogard JR, Thilsted SH, Marks GC, Wahab MA, Hossain MAR, Jakobsen J and Stangoulis J (2015). Nutrient composition of important fish species in Bangladesh and potential contribution to recommended nutrient intakes. *Journal of Food Composition and Analysis* 42:120-133.
- Chandran R, Singh RK, Singh A, Paul P, Sah RS, Kumar R, Mohindra V, Lal KK and Jena JK (2020). Spatio-temporal variations in length-weight relationship and condition factor of two notopterids, *Chitala chitala* (Hamilton, 1822) and *Notopterus notopterus* (Pallas, 1769).

- Indian Journal of Fisheries, 67(2), pp.120-124.67(2), 120-124.
- Cuvier G and Valenciennes A (1848) Histoire naturelle des poissons. Tome vingt et unième. Suite du livre vingt et unième et des Clupéoïdes. Livre vingt-deuxième. De la famille des Salmonoïdes. v. 21: i-xiv + 1 p. + 1-536, Pls. 607-633. [Valenciennes authored volume. i-xiii [+ iii] + 1-391 in Strasbourg edition
- Devkota M, Tam BM & Soe TN (2023). Larval rearing of Knife fish (*Notopterus notopterus*) in different feeding regimes.
- Froese R (2006). Cube law, condition factor and weight-length relationships: history, meta-analysis and recommendations. Journal of applied ichthyology, 22(4), 241-253.
- Gray JE (1854). Catalogue of fish collected and described by Laurence Theodore Gronow, now in the British Museum. London. i-vii + 1-196. [Gray's role apparently limited to seeing existing manuscript through publication; descriptions are from Gronow.
- Gupta S & Ray A (2022). Review on biology and culture potential of *Notopterus notopterus* (Pallas, 1769). International Journal of Aquatic Biology, 10(2), 78-91.
- Gupta A, Lal KK, Punia P, Singh RK, Mohindra V, Sah RS, Kumar R, Luhariya RK, Dwivedi AK, Masih P and Mishra RM (2013). Characterization of polymorphic microsatellite markers and genetic diversity in wild bronze featherback, *Notopterus notopterus* (Pallas, 1769). Molecular biology reports, 40(12), 6625-6631 pp.
- Kandel K, Devkota M, Jha BR & Tam BM (2025). Induced Breeding of *Notopterus notopterus* Using Pituitary Gland Extract (Pge), Human Chorionic Gonadotropin (Hcg) and Luteinizing Hormone Releasing Hormone-Analog (Lhrh-A) Hormones. Human Chorionic Gonadotropin (Hcg) and Luteinizing Hormone Releasing Hormone-Analog (Lhrh-A) Hormones.
- Kaushik KK, Sahu P & Nath R (2019). Length-weight relationship of *Notopterus notopterus* (Pallas, 1769), *Anabas testudineus* (Bloch, 1792) and *Clarias batrachus* (Linnaeus, 1758) from Pokoriya River, Morigaon, Assam, India. International Journal of Environmental Science and Technology Research, 8(10), 3087-3088.
- Kottelat M, Whitten AJ, Kartikasari SN and Wirjoatmodjo S (1993). Freshwater fishes of Western Indonesia and Sulawesi. Periplus Editions, Hong Kong. 221 p.
- Kottelat M (1998). Fishes of the Nam Theun and Xe Bangfai basins, Laos, with diagnoses of twenty-two new species (Teleostei: Cyprinidae, Balitoridae, Cobitidae, Coiidae and Odontobutidae). Ichthyological Exploration of Freshwaters, 9(1):1-128.
- Kulkarni Raghavendra S & Sudarshan S (2020). Nutritional compositions in a locally available fresh water fish, *Notopterus notopterus*: A review. International Journal of Zoological Investigations, 6(1), 94-106.
- Khuda-Bukhsh AR and Barat A (1987). Chromosomes in fifteen species of Indian teleost (Pisces). Caryologia 40(1-2):131-144.
- Lavoué S, Ghazali SZ, Jamaluddin JAF, Nor SAM & Zain KM (2020). Genetic evidence for the recognition of two allopatric species of Asian bronze featherback *Notopterus* (Teleostei, Osteoglossomorpha, Notopteridae). Zoosystematics & Evolution, 96(2).
- Lacepède BGE (1800). Histoire naturelle des poissons. v. 2: i-lxiv + 1-632, Pls. 1-20. [Publication date: Hureau & Monod 1973, v. 2:323 [ref. 6590].
- Lim P, Lek S, Touch ST, Mao SO and Chhouk B (1999). Diversity and spatial distribution of freshwater fish in Great Lake and Tonle Sap River (Cambodia, Southeast Asia). Aquatic Living Resources. 12(6):379-386.
- List IR (2004). The IUCN red list of threatened species. Di sponí vel em:< [http://www.iucn.org/info/cat\\_e\\_go\\_ries\\_cri\\_te\\_ria2001.html](http://www.iucn.org/info/cat_e_go_ries_cri_te_ria2001.html)>. Aces so em, 12.
- Mohanty D & Samanta L (2016). Multivariate analysis of potential biomarkers of oxidative stress in *Notopterus notopterus* tissues from Mahanadi River as a function of concentration of heavy metals. Chemosphere, 155, 28-38.
- Mustafa MG, Singha S, Islam MR & Mallick N (2014). Population dynamics of *Notopterus notopterus* (Pallas, 1769) from the Kaptai reservoir of Bangladesh. SAARC Journal of Agriculture, 12(2), 112-122.
- Muslim M, Pitriani E & Agustina H (2023). Growth and survival of bronze featherback (*Notopterus notopterus*) adapted on box container and

- aquarium. GSC Advanced Research and Reviews, 16(3), 133-137.
- Muslim M, Syaifudin M, Taqwa FH & Saputra MI (2024). Sexual dimorphism and reproductive biology of bronze featherback (*Notopterus notopterus*, Pallas 1769) from Kelekar River, Ogan Ilir, South Sumatra, Indonesia. Baghdad Science Journal, 21(10), 24.
- Muslim M & Simanjuntak WJ (2023). Growth and survival of bronze featherback (*Notopterus notopterus*, Pallas 1769) reared on bucket. Magna Scientia Advanced Research and Reviews, 9(1), 101-105.
- Naeem M, Salam A, Gillani Q & Ishtiaq A (2010). Length-weight relationships of *Notopterus notopterus* and introduced *Oreochromis niloticus* from the Indus River, southern Punjab, Pakistan. Journal of applied ichthyology, 26(4), 620-620.
- NBFRG (1998). Fish chromosome atlas. National Bureau of Fish Genetic Resources Special Publication, No. 1. Lucknow, India, 332 p.
- Ng HH (2020). *Notopterus notopterus*. The IUCN Red List of Threatened Species 2020: e.T166433A60584003. <https://dx.doi.org/10.2305/IUCN.UK.20201.RLTS.T166433A60584003.en>
- Pallas PS (1769). Spicilegia Zoologica quibus novae imprimis et obscurae animalium species iconibus, descriptionibus atque commentariis illustrantur. Berolini, Gottl. August. Lange. v. 1 (fasc. 7): 1-42, Pls. 1-6.
- Parameswaran S and M Sinha (1966). Observations on the biology of the feather-back, *Notopterus notopterus* (Pallas). Indian J. Fish. 13(1 & 2):232-250.
- Paul MG, Nath P & Dutta A (2022). Length-weight relationship, relative condition factor and fecundity of *Notopterus notopterus* (Pallas, 1769) from river Brahmaputra in Dhubri, Assam, India. Journal of Fisheries, 10(3), 103201-103201.
- Rahman AKA (1989). Freshwater fishes of Bangladesh. Zoological Society of Bangladesh. Department of Zoology, University of Dhaka. 364 p.
- Rainboth WJ (1996). Fishes of the Cambodian Mekong. FAO species identification field guide for fishery purposes. FAO, Rome, 265 p.
- River OI & Sumatra S (2023). Sexual dimorphism and reproductive biology of bronze. Baghdad Science Journal.
- Roberts TR (1992). Systematic revision of the old-world freshwater fish family Notopteridae. Ichthyology Exploration Freshwater, 2(4):361-383.
- Sathish SV, Sathishagouda S, Kulkarni RS & Patil SJ (2018). Histochemical and electron microscopic studies on the pituitary gonadotropic cells in relation to different age group of fish *Notopterus notopterus*. International Journal of Current Research in Life Sciences, 7(02), 1163-1172.
- Sathish SV & RS K (2014). Age related seasonal changes in the gonadal activity of the fish *Notopterus notopterus* (Pallas). International Journal of Science and Research, 3(11), 3020-3026.
- Santhanam R (2015). Nutritional freshwater life. CRC Press.
- 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, 787-788.
- Sani R, Gupta BK, Sarkar UK, Pandey A, Dubey VK and Lakra WS (2016). Length-weight relationships of 14 Indian freshwater fish species from the Betwa (Yamuna River tributary) and Gomti (Ganga River tributary) rivers. J. Appl. Ichthyol. 26:456-459.
- Sokheng C, Chhea CK, Viravong S, Bouakhamvongsa K, Suntornratana U, Yoorong N, Tung NT, Bao TQ, Poulsen AF and Jørgensen JV (1999). Fish migrations and spawning habits in the Mekong mainstream: a survey using local knowledge (basin-wide). Assessment of Mekong fisheries: Fish Migrations and Spawning and the Impact of Water Management Project (AMFC). AMFP Report 2/99. Vientiane, Lao, P.D.R.
- Srivastava SM, Singh SP & Pandey AK (2012). Food and feeding habits of threatened *Notopterus notopterus* in Gomti river, Lucknow (India). Journal of Experimental Zoology, 15(2), 395-402.
- Sukendi S, Thamrin T, Putra RM & Yulindra A (2020). Cultivation technology of bronze featherback (*Notopterus notopterus*, Pallas 1769) at different stocking densities and types of feed. In IOP Conference Series: Earth and

- Environmental Science, 430(1) 012027 p. IOP Publishing.
- Sykes WH (1839). On the fishes of the Deccan. Proceedings of the Zoological Society of London 1838 (pt 6) (for 27 Nov. 1838): 157-165. [Publication date from Duncan 1937 [ref. 13606]. See also Sykes 1839 [ref. 4306] and Sykes 1841 [ref. 18868].
- Talwar PK and Jhingran AG (1991). Inland fishes of India and adjacent countries. In 2 vols. Oxford & IBH Publishing Co., New Delhi, Bombay, Calcutta. v. 1-2: i-xvii + 36 unnumbered + 1-1158, 1 pl, 1 map. [V. 1, i-liv + 1-541, 1 map; v. 2, i-xxii + 543-1158, 1 pl. Also reprinted, Balkema, Rotterdam, 1992.]
- Tiwari NK, Mohanty TR, Das Gupta S, Roy S, Swain HS, Baitha R, Ramteke MH and Das BK (2023). Hemato-biochemical alteration in the bronze featherback *Notopterus notopterus* (Pallas, 1769) as a biomonitoring tool to assess riverine pollution and ecology: a case study from the middle and lower stretch of river Ganga. Environmental Science and Pollution Research, 30(16), pp.46826-46846.
- Ukkatawewat S (1984). The taxonomic characters and biology of some important freshwater fishes in Thailand. Manuscript. National Inland Fisheries Institute, Department of Fisheries, Ministry of Agriculture, Bangkok, Thailand, 55 p.
- Kaur V & Rawal YK (2017). Length-Weight Relationship (LWR) in *Notopterus notopterus* (Pallas) from Sukhna Lake, Chandigarh. IOSR Journal of Pharmacy and Biological Sciences, 12(4), 63-65.
- Wibowo A, Haryono H, Kurniawan K, Prakoso VA, Dahruddin H, Surbani IL, Muslimin B, Jaya YYP, Sudarsono S, Stuart IG and Ahnelt H (2024). Genetic and morphological evidence of a single species of bronze featherback (*Notopterus notopterus*) in Sundaland. Global Ecology and Conservation, 49, p.e02786.
- Yanwirsal H, Bartsch P & Kirschbaum F (2017). Reproduction and development of the asian bronze featherback *Notopterus notopterus* (Pallas, 1769) (Osteoglossiformes, Notopteridae) in captivity. Zoosystematics and Evolution, 93(2), 299-324.
- Yap SY (1988). Food resource utilization partitioning of fifteen fish species at Bukit Merah Reservoir, Malaysia. Hydrobiologia 157:143-160.

**How to cite this article:** Raina FJ, Akhi TA, Tamim MTW, Jahan I, Khatun MR, Sarker ZR, Hoque MA, Turzo TM, & Hossain MA (2025). Threatened fishes of the world *Notopterus notopterus* (Pallas, 1769): Recommendations for sustainable conservation. Aquatic Resource Sciences, 02, 23-32.