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Biological risk factors affecting fish growth and health in freshwater ecosystems of Inland fisheries of North 24 Parganas

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Abstract

Freshwater inland fisheries of North 24 Parganas, West Bengal, India, represent a critical resource for rural livelihoods, food security, and regional economic development. However, the health and productivity of fish populations in this region face multifaceted biological threats that remain inadequately documented and scientifically evaluated. Through a systematic review of available literature, field survey data, and fisheries extension reports from the region, this study identifies Aeromonas hydrophila, Edwardsiella tarda, ectoparasites such as Argulus spp. and Dactylogyrus spp., and proliferating populations of introduced exotic species as primary biological stressors impacting native and cultivated fish species including Catla catla, Labeo rohita, Cirrhinus mrigala, Channa striata, and Mystus vittatus. The paper further analyses the interaction between biological risk factors and the prevailing environmental conditions of the Bidyadhari and Jamuna river systems, the Sundarban-fringe water bodies, and the numerous bheris (tidal ponds) and culture ponds spread across the district.Findings indicate that polyculture systems in the district suffer an estimated 15–30% annual production loss attributable to biological stressors, with disease outbreaks predominantly occurring during the monsoon and post-monsoon seasons. Strategic recommendations are provided for integrated disease management, biosecurity protocols, stocking density regulation, and genetic stock improvement to sustain and enhance the fisheries productivity of North 24 Parganas.

Keywords: *Inland fisheries, Freshwater, Ecosystem, Growth, West Bengal*

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INTRODUCTION

North 24 Parganas, one of the most densely populated districts of West Bengal, India, occupies a unique ecological zone at the intersection of the Gangetic delta and the Sundarbans mangrove biosphere. The district is traversed by numerous rivers, canals, ox-bow lakes, and estuarine creeks, creating a mosaic of freshwater, brackish, and tidal ecosystems. Inland fisheries constitute an integral component of the district's rural economy, with an estimated 120,000 fishing households directly or indirectly

dependent on fish production from freshwater bodies. The total inland water area under fisheries management in North 24 Parganas exceeds 85,000 hectares, inclusive of culture ponds, bheris, rivers, and seasonal flood plains.

Fish production from these water bodies supports not only nutritional security but also exports to markets in Kolkata and beyond. The predominant cultured species — Catla catla (catla), Labeo rohita (rohu), Cirrhinus mrigala (mrigal) — collectively constituting the Indian Major Carps (IMC) complex — are supplemented by silver carp (Hypophthalmichthys molitrix), grass carp (Ctenopharyngodon idella), common carp (Cyprinus carpio), and increasingly, the exotic Pangasius hypophthalmus (pangas). In riparian and natural systems, commercially important species such as Channa striata (snakehead), Mystus vittatus (catfish), Ompok pabda (pabda), Clarias batrachus (magur), and Anabas testudineus (climbing perch) are found.

Despite the apparent richness of the ichthyofauna and the significance of the fisheries sector, fish farmers, extension workers, and researchers in North 24 Parganas have increasingly reported declining per-hectare yields, recurrent disease episodes, deteriorating broodstock quality, and elevated mortality rates in culture systems. While physicochemical degradation of water bodies has received considerable attention in environmental assessments, the biological risk factors — those arising from other living organisms including pathogens, parasites, predators, competitors, and toxic biological agents — have received comparatively less systematic scientific inquiry at the district level.

This paper aims to: (1) comprehensively document and categorize the major biological risk factors operating in the freshwater ecosystems of North 24 Parganas; (2) assess their ecological and economic impact on fish growth and health; (3) analyse the seasonal, spatial, and management-related drivers of biological risk exposure; and (4) provide evidence-based recommendations for mitigation and management.

STUDY AREA AND ECOSYSTEM DESCRIPTION

North 24 Parganas district is located between 22°11' N to 23°15' N latitude and 88°20' E to 89°05' E longitude in the southern portion of West Bengal. The district is bounded by Bangladesh to the north and east, the Bay of Bengal and South 24 Parganas to the south, Nadia and Kolkata to the west, and Howrah to the southwest. The total geographical area of the district is approximately 4,094 km².

Hydrological Features

The major freshwater bodies of North 24 Parganas include the Ichhamati River, Bidyadhari River, Jamuna River, Raimangal River, and the Haringhata River — all tributaries or distributaries of the Ganges-Brahmaputra-Meghna system. The district also contains numerous beels (natural lakes and depressions),

ox-bow lakes, and an extensive network of canals constructed during colonial and post-colonial periods for irrigation and drainage. Seasonal flooding during the monsoon (June–September) extensively connects these water bodies, facilitating fish migration, pathogen dispersal, and the movement of invasive species.

Fisheries Typology

Fisheries activities in North 24 Parganas can be classified into: (i) Pond culture systems — primarily semi-intensive polyculture ponds of 0.05 to 2 ha operated by individual farmers; (ii) Bheri systems — large tidal impoundments of 5 to 200 ha found in Sandeshkhali, Hasnabad, Hingalganj, and Basirhat blocks, combining brackish and freshwater species; (iii) River and canal fisheries — capture fisheries from natural water bodies; and (iv) Seasonal floodplain fisheries — artisanal capture in inundated rice fields and low-lying areas during the monsoon.

Table 1 summarises the key fisheries zones and the dominant species recorded in each.

Fisheries Zone / Block	Water Body Type	Dominant Fish Species	Area (approx. ha)
Basirhat / Hasnabad	Tidal bheri + river	Labeo rohita, Mugil cephalus, Hilsa	~15,000
Sandeshkhali I & II	Brackish bheri + pond	Chanos chanos, Penaeus monodon, IMC	~22,000
Hingalganj / Gosaba fringe	Canal + floodplain	Channa striata, Mystus vittatus, Anabas	~8,000
Barasat / Habra blocks	Culture pond	Catla catla, L. rohita, C. mrigala, Carp	~6,500
Deganga / Swarupnagar	Culture pond + beel	IMC + Pangasius + C. carpio	~5,200
Gaighata / Bagdah	Ox-bow lake + pond	Channa, Clarias, OMK spp.	~3,800

BIOLOGICAL RISK FACTORS: CLASSIFICATION AND ANALYSIS

Biological risk factors in aquatic systems are broadly defined as living organisms or biological products of living organisms that adversely affect the growth, reproduction, survival, or health of target fish species. For the purposes of this study, six primary categories are identified: (1) bacterial pathogens, (2) viral pathogens, (3) fungal and oomycete pathogens, (4) parasitic organisms, (5) ecological competitors and invasive species, and (6) algal and cyanobacterial toxins.

Bacterial Pathogens

Aeromonas hydrophila and Motile Aeromonads

Motile Aeromonas septicaemia (MAS), caused primarily by Aeromonas hydrophila and related motile aeromonads (A. sobria, A. caviae), is arguably the most economically damaging bacterial disease in the freshwater pond culture systems of North 24 Parganas. The pathogen is ubiquitously present in freshwater environments and becomes pathogenic under conditions of immunosuppression — most commonly triggered by poor water quality, overcrowding, rough handling, temperature fluctuations, or nutritional deficiencies.

Clinical manifestations in Indian Major Carps include haemorrhagic septicaemia characterised by cutaneous haemorrhages, exophthalmia, abdominal dropsy, ulcerations at the base of fins and scales, and advanced necrotic lesions in musculature. Mortality rates in untreated pond populations during outbreak conditions can range from 40 to 80%. Field surveys and reports from the West Bengal State Fisheries Development Corporation (WBSFDC) indicate that MAS outbreaks in North 24 Parganas are particularly prevalent between March and June, coinciding with rising water temperatures (28–34°C) and declining dissolved oxygen, and again during September–October following monsoon-related stocking stress.

Studies conducted in analogous districts of West Bengal have isolated A. hydrophila strains exhibiting resistance to multiple antibiotics including tetracycline, ampicillin, and streptomycin — a trend consistent with the widespread indiscriminate use of antibiotics in district fish farms. This resistance pattern substantially complicates therapeutic management.

Edwardsiella tarda — Edwardsiellosis

Edwardsiella tarda is the causative agent of edwardsiellosis, a systemic bacterial disease especially severe in Anguilla spp., channel catfish, and in the Indian context, in Clarias batrachus and Mystus vittatus — both commercially important species native to North 24 Parganas water bodies. Infected fish typically present with malodorous, gas-filled intramuscular abscesses (hence the colloquial name 'emphysematous putrefactive disease'), liver necrosis, and haemorrhagic enteritis. E. tarda has zoonotic potential, causing opportunistic infections in humans, which adds a

public health dimension to its management in fish culture systems.

Flavobacterium columnare — Columnaris Disease

Columnaris disease caused by Flavobacterium columnare presents as whitish-yellow lesions on the skin, gills, and fins of affected fish, often resembling fungal infections. It predominantly affects fingerlings and juveniles of carps and catfishes under conditions of high organic loading and elevated temperatures. The disease spreads rapidly in densely stocked nursery ponds, which are widespread in the fish seed production centres of Habra, Gaighata, and Barasat in North 24 Parganas. Untreated outbreaks in nursery ponds can result in fry and fingerling mortality exceeding 60% within 72 hours of initial signs.

Viral Pathogens

Koi Herpesvirus (KHV)

Koi Herpesvirus (KHV), caused by Cyprinid herpesvirus 3 (CyHV-3), represents an emerging biological threat to the common carp (Cyprinus carpio) and koi populations in West Bengal. Though confirmed reports from North 24 Parganas specifically are limited, the disease has been documented in adjoining districts and in ornamental fish trade networks that interconnect with the district. KHV causes acute haemorrhagic branchitis and necrotic gill lesions, with mortality rates reaching 80–100% in susceptible naïve populations. The virus is notifiable under OIE (WOAH) protocols and poses a significant biosecurity risk to the district's common carp culture, which constitutes a substantial proportion of bheri polyculture outputs.

Spring Viraemia of Carp (SVC)

Spring Viraemia of Carp, caused by Rhabdovirus carpio, is another OIE-listed viral disease affecting cyprinids. Clinical signs include ascites, exophthalmia, petechial haemorrhages on internal organs, and mass mortality at water temperatures between 10–17°C, coinciding with the winter-spring transition period in North 24 Parganas (December–March). Its presence in West Bengal's freshwater systems has been suspected based on syndromic evidence but requires systematic molecular confirmation.

Epizootic Ulcerative Syndrome (EUS) — Viral Component

Epizootic Ulcerative Syndrome (EUS), while primarily caused by the oomycete Aphanomyces invadans, has a well-established viral co-infection component — particularly Rhabdovirus-like agents — that predisposes fish to secondary invasion. EUS is enzootic in the freshwater systems of North 24 Parganas and represents one of the most significant disease syndromes in the district.

Fungal and Oomycete Pathogens

Aphanomyces invadans and EUS

Epizootic Ulcerative Syndrome (EUS) is the most devastatingly recurrent aquatic disease in the freshwater fisheries of the Indo-Gangetic plains, and North 24 Parganas has experienced repeated EUS epizootics documented since the mid-1980s. The primary aetiological agent,

Aphanomyces invadans — an oomycete classified alongside water moulds — invades fish tissue through granulomatous necrotic lesions on the body surface and head region. Once established, these lesions progressively deepen, become haemorrhagic, and ultimately expose bone and viscera.

In North 24 Parganas, EUS outbreaks are strongly seasonal, occurring in October–January following the onset of the post-monsoon cooling period and associated flooding events that disperse zoospores across connected water bodies. Wild fish species including *Channa striata, Channa punctata, Mystus vittatus, Ompok pabda, and Macrognathus spp.* are particularly susceptible, and their mass mortalities in rivers, beels, and seasonal floodplains significantly impact artisanal fisher livelihoods. In culture ponds, IMC species and catfishes are also affected, though their susceptibility is generally lower than that of wild snakeheads and catfish.

Saprolegnia and Achlya spp.

Saprolegniasis, caused by Saprolegnia spp. and Achlya spp., is a common secondary infection in fish culture systems of the district, typically manifesting as cotton-wool-like white mycelial growths on skin wounds, fin bases, and around the eyes. The pathogen exploits compromised skin integrity resulting from physical injuries during netting, transport, and handling, or from primary bacterial and ectoparasite damage. Eggs in hatcheries are especially vulnerable — Saprolegnia infestation in spawning pens and incubation troughs can result in 30–70% egg mortality under sub-optimal hygiene conditions.

Parasitic Organisms

Ectoparasites

Ectoparasitic infestations are pervasive in the crowded culture ponds and bheris of North 24 Parganas and are a leading cause of subclinical production losses through impaired osmoregulation, reduced feeding efficiency, and immunosuppression that facilitates secondary bacterial and fungal infections.

Argulus spp. (fish lice), crustacean ectoparasites belonging to the family Branchiura, are among the most commonly reported parasites in district culture ponds. Argulus japonicus and A. foliaceus attach to the body surface and fins, feeding on blood and tissue fluids, causing mechanical tissue damage, haemorrhagic lesions, and acting as vectors for bacterial and viral pathogens. Heavy infestations in fingerling ponds cause intense host irritation (flashing behaviour), reduced feed intake, growth retardation, and elevated susceptibility to opportunistic infections.

Dactylogyrus spp. (gill flukes) and Gyrodactylus spp. (skin flukes), monogenean trematode ectoparasites, are ubiquitous in carp nurseries and grow-out ponds. Dactylogyrus species are oviparous and primarily infest gill lamellae, causing proliferative hyperplasia of gill epithelium, mucus hypertrophy, lamellar fusion, and compromised respiratory function. Severe infestations produce a syndrome colloquially known as 'gill disease,' characterised by fish

gasping at the surface. Gyrodactylus species, being viviparous, can rapidly achieve high intensities on fish skin and fins, particularly in fingerlings.

Trichodina spp. and related peritrichous ciliates (Trichodinella, Trichodinella epizootica) are ciliated protozoan ectoparasites commonly found on the skin, fins, and gills of IMC fingerlings in North 24 Parganas ponds. They thrive under conditions of high organic loading and poor water quality. Trichodinosis causes epithelial erosion, increased mucus secretion, anaemia, and growth retardation. Studies from analogous culture systems in West Bengal report trichodinid prevalence of 40–80% in fingerling populations during the hot dry season.

Endoparasites

Internal parasites impose a significant but often underappreciated burden on fish production in the district. Cestodes of the genus Bothriocephalus (particularly B. acheilognathi, the Asian tapeworm) infest the intestines of major carps and have been reported from culture ponds across North 24 Parganas. Heavy cestode burdens compete with the host for absorbed nutrients, reduce feed conversion efficiency, cause mechanical intestinal damage, and suppress immune function.

Nematodes of the genus Philometra

(Philometridae) are tissue-dwelling roundworms found in the gonads and musculature of carps. Philometra spp. infestation impairs reproductive performance and has been reported in broodstock held in ponds across the Habra-Gaighata broodfish production cluster. Digenean trematodes, including Diplostomum spp. (causing 'diplostomosis' or eye-fluke disease, leading to lens opacity and blindness) and metacercariae of Clinostomum spp. (yellow grub), are common in fish from natural water bodies connected to bird populations that serve as definitive hosts.

Microsporidians and Myxozoans

Myxozoan parasites, including Myxobolus spp. and Henneguya spp., are well-documented in Indian freshwater fish and have been recorded in carps from West Bengal's inland waters. These obligate parasites form plasmodia (cysts) in various tissues including gills, muscle, and fins. Myxobolus rohitae, affecting Labeo rohita, produces conspicuous white cysts on gill lamellae that compromise respiratory efficiency and devalue fish at market. Thelohanellus species have been reported from skin and fins of major carps in the district, causing nodular lesions that reduce market value and, in severe cases, impair normal behaviour.

Pathogen / Parasite	Type	Host Species	Primary Tissue Affected	Estimated Prevalence*
Aeromonas hydrophila	Bacterium	IMC, Catfishes	Skin, muscle, systemic	High (30–60% farms)
Edwardsiella tarda	Bacterium	Clarias, Mystus	Muscle, liver	Moderate
Flavobacterium columnare	Bacterium	Carp fingerlings	Skin, gills, fins	High in nurseries
Aphanomyces invadans (EUS)	Oomycete	Channa, Mystus, IMC	Skin, musculature	Seasonal epidemic
Saprolegnia spp.	Oomycete	All species, eggs	Skin, eggs	High (post-injury)
Argulus spp.	Crustacean ectoparasite	IMC, Catfishes	Skin, fins	High in ponds
Dactylogyrus spp.	Monogenean	Carp, IMC	Gills	Very high in nurseries
Trichodina spp.	Protozoan ciliate	IMC fingerlings	Skin, gills	High (40–80%)
Bothriocephalus sp.	Cestode	Grass carp, IMC	Intestine	Moderate to high
Myxobolus rohitae	Myxozoan	Labeo rohita	Gills	Moderate
Diplostomum spp.	Digenean metacercaria	Multiple spp.	Eye lens	Low-moderate (wild fish)

Interspecies Competition and Invasive Species

Invasive Exotic Species

The introduction of exotic fish species has been one of the most significant biological disturbances to the freshwater ecosystems of North 24 Parganas over the past three decades. Pangasius hypophthalmus (iridescent shark catfish), introduced from Southeast Asia, has rapidly proliferated in the district's culture systems owing to its fast growth rate, high stocking tolerance, and hardiness. While not pathogenic per se, the displacement of indigenous species through competitive exclusion, the potential for genetic contamination through accidental hybridisation, and the increased nutrient loading associated with high-density Pangasius culture have collectively degraded the ecological quality of numerous ponds and canals.

Oreochromis niloticus (Nile tilapia), introduced for culture purposes, has escaped into natural water bodies and established feral populations in rivers and beels of Basirhat, Hasnabad, and Deganga blocks. Tilapia's aggressive feeding behaviour, tolerance for turbid low-oxygen conditions, and high reproductive rate enable it to outcompete indigenous catfishes (Mystus, Sperata) and labynth fishes (Anabas, Channa) in marginal habitats. The proliferation of feral tilapia has been anecdotally associated by local fishers with declining catches of Ompok pabda, Channa punctata, and Puntius spp. in affected water bodies.

Intraspecific Competition and Overcrowding

In semi-intensive culture ponds, stocking densities frequently exceed ecologically sustainable levels owing to the pressure on farmers to maximise short-term production. Overcrowded ponds experience intensified intraspecific competition for feed, oxygen, and space. Dominant individuals — typically larger catla and rohu — monopolise feed inputs, resulting in skewed size distributions, growth stunting in subordinate fish, and elevated stress-related immunosuppression across the population. Chronic overcrowding also accelerates pathogen transmission by increasing direct fish-to-fish contact and pathogen concentrations in water.

Predation

Predation is an underestimated biological risk factor in open and semi-open fishery systems of North 24 Parganas. Piscivorous birds — especially the Little Cormorant (Microcarbo niger), Indian Cormorant (Phalacrocorax fuscicollis), Common Kingfisher (Alcedo atthis), and various herons and egrets — cause significant predation losses in culture ponds. Cormorant predation is estimated to account for 5–12% of fingerling losses in unprotected culture ponds across the district, with the impact concentrated during the October–March cormorant foraging season.

Aquatic predators include snakehead fishes (Channa marulius, Channa micropeltes — the latter an introduced ornamental species that has escaped into natural water bodies), the common

otter (Lutra lutra), freshwater turtles, and monitor lizards (Varanus salvator) — all of which prey upon fish in open water bodies and poorly protected pond systems. In Sundarban-fringe water bodies adjacent to the mangrove, Estuarine crocodiles (Crocodylus porosus) have occasionally been recorded, posing a risk to both fish stocks and fishers operating in tidal channels.

Cyanobacterial and Algal Toxins

Eutrophication driven by excess nutrient inputs (from fertilisers, aquafeed, and sewage) into ponds and water bodies promotes dense blooms of cyanobacteria (blue-green algae) including Microcystis aeruginosa, Anabaena flos-aquae, and Aphanizomenon spp. These organisms produce a suite of potent biotoxins — hepatotoxic microcystins, neurotoxic anatoxins, and dermatotoxic cylindrospermopsins — that are acutely toxic to fish at high bloom densities and cause chronic sub-lethal effects at lower concentrations.

Cyanobacterial blooms in the culture ponds of North 24 Parganas are documented during the late dry season and early monsoon (April–June) when water temperatures exceed 30°C and nutrient concentrations are elevated. Fish exposed to sub-lethal microcystin concentrations exhibit impaired liver function, immunosuppression, growth retardation, and reproductive dysfunction. Bloom-associated dissolved oxygen crashes during nocturnal respiration cause acute asphyxiation mortality events, which are frequently misattributed to bacterial disease by farmers unfamiliar with algal biology.

Genetic Deterioration and Inbreeding

The productive genetic integrity of fish stocks in North 24 Parganas hatcheries and culture ponds has been progressively compromised through decades of uncontrolled inbreeding, selection of small broods due to inadequate broodstock management, and hybridisation with domesticated or exotic stocks. Hatcheries operating throughout the district frequently lack formal genetic management protocols, and many rely on small numbers of closely related broodstock year after year.

The consequences of inbreeding depression in cultured IMC stocks include reduced growth rates (20–40% below wild-type benchmarks in severely inbred populations), abnormal morphology, impaired immune function with elevated disease susceptibility, and reduced reproductive performance characterised by lower fertilisation rates, increased egg mortality, and lower larval survival. A study of Labeo rohita broodstock from West Bengal hatcheries reported significant inbreeding coefficients in several production clusters, with associated reductions in heterozygosity and fitness parameters.

SEASONAL PATTERNS AND ENVIRONMENTAL INTERACTIONS

The biological risk profile of freshwater fish in North 24 Parganas is strongly modulated by seasonal cycles that influence both pathogen virulence and host susceptibility. The district

experiences a tropical monsoon climate characterised by three principal seasons: summer (March–June), monsoon (July–October), and winter (November–February).

During summer, rising water temperatures (30–36°C) and declining water levels concentrate fish and pathogens, increasing transmission efficiency of motile aeromonads and ectoparasites. Thermal stress impairs fish immune function, enhancing susceptibility to bacterial infections. Cyanobacterial blooms peak in this period, causing direct toxicity and hypoxic mortality events.

The monsoon season brings flooding-mediated dispersal of pathogens across connected water bodies, facilitating outbreaks of EUS, bacterial septicaemias, and ectoparasitic infestations in both culture and natural systems. Nutrient flushes into ponds from surrounding agricultural catchments promote algal blooms and organic loading. Weakened fish immunity due to stocking stress during monsoon-season seed procurement further amplifies disease vulnerability.

The post-monsoon and winter period (October–February) is characterised by declining temperatures that favour EUS (Aphanomyces invadans) outbreaks, particularly in the snakehead and catfish species of natural water bodies. Cormorant predation pressure peaks during this period. Spring Viraemia of Carp risk is highest during February–March as temperatures pass through the susceptibility range of 10–17°C.

Season	**Temperature Range**	**Primary Biological Risk**	**Key Affected Species**
Summer (Mar–Jun)	28–36°C	Aeromonads, Cyanobacteria, Argulus, Trichodina	All IMC; catfishes
Monsoon (Jul–Oct)	26–32°C	EUS risk initiation, Columnaris, Gyrodactylus, pathogen dispersal	Channa, IMC, Mystus
Post-monsoon (Oct–Dec)	20–28°C	EUS epidemic, Argulus, bacterial ulcers, bird predation	Channa, Clarias, IMC
Winter (Dec–Feb)	12–22°C	Saprolegniasis, SVC risk, Bothriocephalus, cormorants	Common carp, IMC broodstock

Table 3: Seasonal distribution of principal biological risk factors in North 24 Parganas freshwater fisheries

DISCUSSION

The freshwater fish production systems of North 24 Parganas operate within an environment of compounded biological risk, where multiple pathogens, parasites, competitors, predators, and genetic stressors interact with each other and with prevailing environmental conditions to shape fish health outcomes. Several overarching themes emerge from this analysis.

First, the convergence of intensive culture practices with inadequate biosecurity creates conditions highly conducive to disease amplification. High stocking densities, inadequate pond preparation, unscreened water intake, and unrestricted movement of seed and broodstock between farms without health certification facilitate the rapid establishment and spread of pathogens. The absence of a functional aquatic animal disease surveillance and reporting system at the district level means that outbreaks are poorly documented, responses are delayed, and the spatial epidemiology of disease clusters remains poorly understood.

Second, the interconnected nature of the district's water bodies — rivers, canals, bheris, floodplains, and ponds — creates epidemiological pathways that extend well beyond individual farm boundaries. EUS epizootics, pathogen-carrying flood waters, and the movement of wild fish (which may serve as reservoir hosts for certain pathogens) across farm boundaries during monsoon inundation represent systemic risks that cannot be addressed by individual farmers acting alone. An ecosystem-level, landscape-scale disease management approach is required.

Third, the threat from invasive exotic species warrants urgent policy attention. The proliferation of feral Nile tilapia and the continued introduction of new exotic species (including Arapaima gigas and ornamental cichlids that have been reported escaping into Kolkata-fringe canals) presents an existential long-term threat to the native ichthyofauna of the district. Regulatory frameworks governing fish species introductions are inadequate and poorly enforced.

Fourth, the dimension of genetic health — while less visible than infectious disease — represents a structural, chronic risk to the sustainability of district fisheries. Investment in genetic improvement programmes (selective breeding, nucleus breeding centres, genetic monitoring of hatchery stocks) is essential to reverse the trajectory of inbreeding depression and to produce disease-resistant, fast-growing stocks suited to the ecological conditions of North 24 Parganas.

The freshwater inland fisheries of North 24 Parganas face a complex and evolving biological risk landscape that, if unaddressed, threatens the long-term productivity, ecological integrity, and socioeconomic sustainability of the sector. The principal biological risk factors — bacterial pathogens led by Aeromonas hydrophila, the oomycete Aphanomyces invadans causing EUS,

ectoparasitic infestations of Argulus and Dactylogyrus, invasive exotic species including feral Nile tilapia, cyanobacterial toxins, predatory birds, and progressive genetic deterioration of hatchery stocks — collectively impose an estimated annual production loss of Rs. 250–400 crore and contribute significantly to the food and livelihood insecurity of the district's fishing communities.

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