Impact of Exotic Species on Native Fish Species

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ABSTRACT

The article examines the ecological trade-offs of introducing exotic fish species into India's freshwater ecosystems, noting that while the presence of 626 alien varieties has bolstered aquaculture yields and food security, it simultaneously threatens the survival of India's 936 indigenous species. Driven by the demand for fast-growing breeds like Tilapia and Thai-pangus, as well as recreational angling and biological control needs, these introductions have led to significant biodiversity loss through competition, predation, and the spread of pathogens. The text highlights specific instances of ecological displacement, such as the decline of native *Catla* due to Silver carp and the extinction of *Schizothorax* sp. in Dal Lake caused by Mirror carp, alongside the environmental degradation caused by invasive flora like the water hyacinth. Ultimately, the authors argue that to sustain economic benefits while protecting native fauna, India must implement a rigorous management framework that includes mandatory quarantine, health certifications, and strict risk assessments for all imported aquatic species.

INTRODUCTION

Globally, 1,451 fish species are known to have settled in new environments outside their natural range (Seebens *et al.* 2023), and many have become invasive, causing damage to native wildlife, essential services, and human welfare (IUCN 2000). India is a vast nation holding 4% of the planet's freshwater resources across 25 distinct river basins (India-WRIS 2012). The country supports approximately 936 indigenous

freshwater fish species (AqGRISI 2024), many of which are unique to the region (Dahanukar *et al.* 2004; Singh and Sarma 2015). However, India now contains 626 non-native fish types, with 16 specifically identified as invasive in inland waters where they harm local biodiversity and reduce commercial catches; these invasions, often facilitated by agricultural activities and environmental changes, disrupt ecosystems and the livelihoods of fisherfolk (Singh, 2025). The history of foreign fish began with the brown trout, *Salmo trutta fario*, which was introduced in 1863 for recreational fishing (Singh and Lakra 2011). In recent times, numerous foreign organisms—known as exotic species—have entered Indian environments through accidental or incidental means, bringing both benefits and harms to the local ecosystem. Several non-native fish, such as Grass carp (*Ctenopharyngodon idella*), Silver carp (*Hypophthalmichthys molitrix*), Tilapia (*Oreochromis* spp.), and Brown trout (*Salmo trutta fario*), were introduced to boost fish farming and fishery production; however, these additions now pose serious threats to indigenous biodiversity (Khuroo *et al.,* 2012). A striking example of this negative impact is the water hyacinth (*Eichhornia crassipes*), infamously known as the "Terror of Bengal." This invasive plant spreads uncontrollably across water bodies, choking out native life by monopolizing space and cutting off essential supplies of sunlight and oxygen (Gopal, 1987; Patel, 2012).

Why Exotic Fishes are introduced

While inland fish farming in India has traditionally focused on carp, the sector is transforming quickly as farmers look to branch out using foreign species that mature rapidly (Singh and Lakra, 2011). These non-native fish are increasingly preferred because they generate higher yields and help meet shifting consumer trends. Consequently, exotic varieties like Thai-pangus (*Pangasianodon hypophthalmus*), African Catfish (*Clarias gariepinus*), Red-Tilapia (*Oreochromis niloticus*), Red-Bellied-Pacu (*Piaractus brachypomus*), and Bighead Carp (*Hypophthalmichthys nobilis*) are now grown commercially to supply both local buyers and international markets (Singh and Lakra, 2011). A large number of these varieties were initially brought in against regulations for farming, yet they have since expanded into numerous other water bodies, likely driven by both natural movement and human actions. Once introduced, they possess the capacity to settle, become invasive, and outdo indigenous fish, resulting in their population booms in new habitats (Lakra *et al.,* 2008; De Silva *et al.,* 2009). Because they are adaptable to broad environmental conditions, they hold the potential to thrive in nearly any type of ecosystem (De Silva *et al.,* 2009). Many of these species disrupt biodiversity and exert heavy pressure on local fish populations, leading to their classification as invasive within Indian waterways (Garcia-Berthou, 2007; Singh and Lakra, 2011). This is particularly concerning given the serious, permanent harm these invasive fish inflict on the environment and society, damaging everything from genetic lines to species survival and entire ecosystems (De Silva *et al.,* 2009; Singh and Lakra, 2011). Bringing in non-native fish is essentially a strategic move to utilize their unique characteristics, such as eating habits or speed of growth, to solve economic or environmental challenges. The biggest driver is the fish farming industry, which aims to boost production and guarantee a steady income for farmers. For instance, the African Tilapia (*Oreochromis* sp.) is farmed globally because it is hardy and multiplies quickly, providing food security in places where local fish are scarce. Similarly, the sport fishing sector stocks waters with popular game fish like the North American Rainbow Trout (*Oncorhynchus mykiss*) and Common Carp (*Cyprinus carpio*) to attract tourists and

provide food. Beyond making money or providing sport, exotic fish are also used for health reasons; the Mosquito Fish (*Gambusia affinis*) is widely used to eat larvae and fight malaria, while many other species are imported simply to supply the pet aquarium market (Raman *et al*., 2013).

Table 1. List of Exotic species, year of introduction and its native place

Common Name	Scientific Name	Year of Introduction	Native Place
Tilapia	*Oreochromis mossambicus*	1952	Africa
Thai-pangus	*Pangasianodon hypophthalmus*	1997	Southeast Asia
Bighead Carp	*Hypophthalmichthys nobilis*	1987	China, Russia
Silver Carp	*Hypophthalmichthys molitrix*	1959	China and Eastern Siberia
Common Carp	*Cyprinus carpio*	1957	Europe
Grass Carp	*Ctenopharyngodon idella*	1957	China
Atlantic Salmon	*Salmo salar*	1908	North America and Europe
Rainbow Trout	*Oncorhynchus mykiss*	1907	North America and Asia
Brown trout	*Salmo trutta fario*	1863-1907	Europe
Guppy	*Poecilia reticulata*	1908	South America
Mosquito Fish	*Gambusia affinis*	1928	North and Central America
African Catfish	*Clarias gariepinus*	1990	Africa
Bellied-Pacu	*Piaractus brachypomus*	2003-2004	South America

Impact of Exotic fishes on native

Exotic Fish has both positive as well as negative impact but maximum is negative impact.

Negative impact

In India, researchers have thoroughly investigated many different aspects of freshwater non-native fish (NNF- Non-Native Fishes). This work covers their existence in local waters (Kurup *et al.* 2006; Das *et al.* 2013; Gurumayum 2021), their biological traits (Raj *et al.* 2021b; Singh *et al*. 2021), and patterns in their population numbers (Kumar 2000; Raghavan et al. 2008). Studies also focus on the damage they cause—such as the drop in native fish catches in the Ganga River (Singh *et al.* 2013)—and methods to control them, like preserving the upper reaches of Himalayan rivers as safe havens for local species (Sharma *et al.* 2021). Furthermore, scientists have examined these foreign fish as carriers of diseases (Tripathi *et al.* 2022) and studied their relationship with pollutants, specifically looking at heavy metal contamination and how toxins build up in their bodies for safety research (Singh *et al.* 2012).In addition to tracking their numbers, researchers are studying non-native fish (NNF) as carriers of diseases (Tripathi *et al.* 2022) and analyzing how they absorb dangerous pollutants like heavy metals, which serves as a key indicator for water toxicity (Singh *et al.* 2012). The catastrophic potential of these invaders is evident from the Nile perch (*Lates niloticus)* in Africa's Lake Victoria, which drove over 200 native species to extinction, permanently damaging the ecosystem and the local fishing economy (Bernery *et al.* 2022; Bacher *et al.* 2023). In India, similar resource wars are taking place: the Silver carp has out-competed the native Catla in Govindsagar reservoir and the *Osteobrama belangeri* in Loktak Lake, while the Mirror Carp (*Cyprinus carpio var. specularis*) caused the complete extinction of *Schizothorax* in Dal Lake. Native Mrigal fish are also declining in Karnataka's reservoirs due to pressure from introduced Tilapia and Common Carp (CIFRI), and in Kerala, the Red-bellied Pacu (*Piaractus brachypomus*) has become a serious threat in Vembanad Lake, where it frequently escapes from farms during floods to wreak havoc on local biodiversity (Roshni *et al.,* 2014).

Positive impact

The introduction of exotic fish species has increased aquaculture production due to their

high growth rates, disease resistance, and adaptability (De Silva & Davy, 2010; FAO, 2020). If hybridization can be controlled, such as between bighead carp (*Hypophthalmichthys nobilis*) and silver carp (*H. molitrix*), it may produce hybrids with superior growth, food conversion, and disease resistance traits (Li *et al.,* 2013). The introduction of Mosquito fish (*Gambusia affinis*) has proven effective in controlling mosquito larvae and limiting mosquito-borne diseases. Introducing exotic species may also increase ecosystem richness by filling ecological niches not utilized by native species (Gozlan, 2008). Some exotic species provide food sources for native predators; for instance, Tilapia species have served as consistent prey for various native fish and bird species (Canonico *et al.,* 2005). Additionally, fishes such as Grass carp (*Ctenopharyngodon idella*) can help control excessive aquatic vegetation and Silver carp (*H. molitrix*) consumes excess algal blooms, improving habitats for native species.

Water Hyacinth-

Originating in South America, the water hyacinth (*Eichhornia crassipes*) has become one of the most widespread and problematic invasive water plants globally. This free-floating species is famous for causing significant shifts in both natural ecosystems and human economies (Center, 1994). It grows at an incredible speed, using its complex root system to form thick, tangled mats that blanket the water's surface (Mitchell, 1985). The plant spreads through two methods: asexual reproduction and sexual reproduction via seeds, which typically sprout within six months and actually germinate better in dry conditions (Ueki & Oki, 1979). Fluctuations in the amount of water hyacinth can heavily impact local wildlife and people; however, whether these impacts are seen as good or bad often depends on how that specific body of water is utilized (Gibbons, Gibbons & Sytsma, 1994). Regardless of perception, once water hyacinth settles in an area, getting rid of it completely is an extremely difficult task.

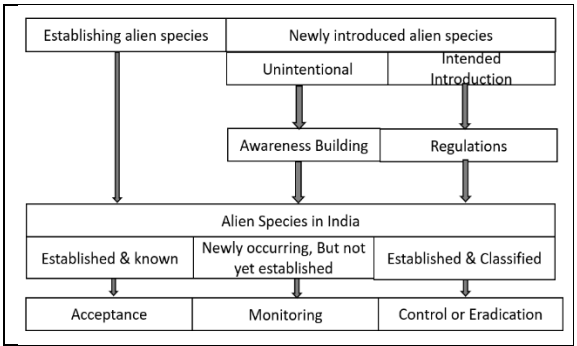
Table 2. Major Exotic species

	
Hypophthalmichthys molitrix	*Pangasianodon hypophthalmus*
	
Oreochromis mossambicus	*Catla catla*
	
Piaractus brachypomus	Aristichthys nobilis
	
Poecilia reticulata	*Eichhornia crassipes*

Management-

The expansion of Indian aquaculture has made the introduction of non-native species largely unavoidable due to their high value in international markets (**De Silva *et al.* 2009).** The availability of established breeding techniques which enhance global competitiveness. While producers have consistently advocated for importing new strains to improve production, authorities must carefully weigh these economic benefits against potential environmental and biodiversity threats. Currently, the regulation of these imports is managed by the National

Committee for Introduction of Exotic Aquatic Species in Indian Waters, under the Union Ministry of Agriculture, Department of Animal Husbandry, Dairying and Fisheries in New Delhi. However, lacking specific legislation for invasive species, the country relies on the Strategic Guidelines and National Plan formulated by the National Bureau of Fish Genetic Resources. To better manage these introductions and protect native fauna, a framework involving mandatory quarantine and health certification has been proposed, including specific protocols for species such as *O. mossambicus*, *P. hypophthalmus*. Given the risks to biodiversity, it is imperative that all imports undergo strict risk assessment by the National Committee and that farmers adhere rigorously to sanitary and phyto-sanitary standards, potentially utilizing quarantine infrastructure developed through public-private partnerships.



Modality to handle the issues of alien fish introductions.

CONCLUSION

The Worldwide introduction of exotic sp. including India has mostly harmed native species. Their impact on environment, biology and genetic has generally been negative. Besides directly affecting ecosystem, some fish species extinct due to reduced genetic diversity and loss of unique traits. Exotic species have the potential to greatly disturb the natural equilibrium of ecosystems, endangering the existence of indigenous species. It is crucial to manage the introduction and proliferation of these species through regulations, public awareness, and proactive restoration initiatives to safeguard biodiversity and ensure the health of ecosystems.

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