Review on the Extinction of Fishes in Uttar Pradesh, India: Causes, Consequences, and Conservation Strategies in Uttar Pradesh

Abstract:

India is one of the most recognized mega-diverse countries in the world. India consists of 4 globally identified biodiversity hotspots which are the Himalayas, Indo-Burma, western Ghat, and Sundar land contributing 7-8 % of the recorded species of the world. It is also known as a repository center for the traditional knowledge associated with biological resources of the 91,200 species of animal and 45,500 species of plants. A checklist of endemic freshwater fish species found that 355 freshwater species are endemic, based on the taxonomy used in fish base 2004 and 13 March 2009 research data in India. This is a huge decline in fish species because increasing lots of human anthropogenic activity, pesticides, insecticides, and untested chemical hazards released in the environment. The loss of species would disrupt the delicate ecological balance, potentially leading to a cascade of negative environmental effects and, therefore loss of biodiversity of species in Utter Pradesh. This research paper reviews the major chemical compounds, drugs, and environmental factors that are directly and indirectly affecting fish species extension and discusses the cause, consequences, and conservation strategies of endemic species in freshwater Utter Pradesh.

Keywords: Endemic species, Hotspot, Fish base data, Conservation Strategies.

 Introduction

India has a third large position in fisheries and second in aquaculture (Mohan *et. al.,* 2005). India contributed 8 % of global fish production. The fish production in 2021-22 is 16.24 Million Tonnes comprising marine fish production of 4.12 Million Tonnes and 12.12 Million Tonnes from Aquaculture (Mukherjee *et. al.,* 2024). Uttar Pradesh contributes about 7.3% of India's inland fish production. In 2023, Uttar Pradesh produced almost 915 thousand metric tons of fish, which was an increase from the previous year (Akpasi *et. al.,* 2023). This state has enormous potential for aquatic bio-resources and offers a considerable scope of inland fisheries development and aquaculture, Uttar Pradesh has a rich fish biodiversity, with a different of fish species and families in its river, lakes, and protected areas (Lakra, W.S., 2010). According to recent study, to determine the distribution and present condition of fish species classified on the IUCN Red List throughout the whole Ganga River, quarterly field sampling was carried out from 2016 to 2020. 18 fish species from 8 orders and 12 families were listed on the IUCN Red List

during the study (Swain *et. al.,* 2021). In rivers of Uttar Pradesh recorded a total number of 124 fish species, 74 Genera, and 28 families. The rivers have the highest number of species and genera followed by the Gomti, Betwa, Ghagara, and Ken rivers (Sarkar *et. al.,* 2015). The fish biodiversity of Uttar Pradesh contributes about 14.68 % of the national fish biodiversity. Most dominant order of fish species in Uttar Pradesh is cypriniformes which includes minnows and carps. Some other dominant orders include Perciformes, clupeiformes, and Ophiocephaliformes (Prakash, S., 2021). The fish diversity is threatened by habitat loss and depletion due to human intervention. Many fish species are endangered, especially in areas with high demand for freshwater. Researchers reported that Uttar Pradesh consists of more than 134 fish species including 46 species found in Rapti River and a wide range of carp fishes Rohu (*Labeo rohita*), Catla (*Catla catla*), Mrigal (*Cirrhinus mrigala*) in the Ganges and Yamuna rivers, as well as in the several ponds and wetlands of the region, some of which are endemic reported (Jhingran., 1978; Prakash, S., 2020; Prakash, *et. al.,* 2021). A survey study was conducted from January, 2018 to December, 2018 to find out the fish fauna of Rapti River at Balrampur district. A total of 27 species of fishes belonging to 19 genera, 14 families and 7 orders were identified as a preliminary. Order Siluriformes was found most dominant represented by 10 species, followed by Cypriniformes with 7 species; Perciformes and Ophiocephaliformes with 3 species each; Osteoglossiformes with 2 species while Clupeiformes and Beloniformes with only one species each (Prakash S., 2020). Conventionally, the healthy ecosystems of these Rivers maintained stable populations of the fishes (Sinha, R.K., 2015). Fish biodiversity in Uttar Pradesh and neighboring regions faces significant threats due to anthropogenic factors, including releasing of several chemical compounds in water bodies, overfishing, pollution, habitat destruction, and rapid industrialization with population growth (Pathak A K., 2018). One of the major factors of extension of fish species to illegal fishing of fine-mesh size nets fishing and poisoning of water bodies, electrical fishing, blasting methods, particularly untreated industrial and agricultural effluents, has degraded the quality of aquatic habitats, leading to oxygen depletion, fish mortality, and disruption of breeding cycles in numerous fish species of the water bodies reported (Mishra, *et.al*., 2021). To respond to new challenges and developments, Govt. of India has legislated the Biological Diversity Act 2002 (BDA, 2002) and the Biological Diversity Rules (2004), which aim at the conservation of our natural heritage and ensure the sharing of benefits of the utilization of biological resources in an equitable manner

Causes of Fish Extension

Overfishing:

Overfishing is one the major factors in the decline of fish species excessive and unethical fishing in restricted areas of water resources. Due to intense overfishing, particularly during breeding seasons, their populations have been severely depleted. Some species are slow growing their numbers have been unable to recover fast enough to maintain sustainable populations. Therefore natural reproduction cycles of many fish species are disrupted. These species require time to mature and reproduce, but overfishing has reduced their numbers significantly before they can

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reproduce (Jhingran, 1978; Mishra, *et.al.,* 2011). An overfishing in the Chambal River, Gomti River, Ghaghra River, Ganges, and Yamuna Rivers, Overexploitation in Wetlands and Decline of the Mahseer Population. The Chambal River, which flows through parts of Uttar Pradesh, has suffered from significant overfishing. Fishers use fine-mesh nets, which capture even juvenile fish, leading to the depletion of Indian Major Carps, including Rohu, Catla, and Mrigal (Sahu, *et. al.,*2024; Pathak, *et.al.,* 2018; Bose, *et.al.,* 2019; Sarkar, *et.al.,* 2012).

Lack of Regulation and Enforcement law:

The government of India conservations law protects the threatened species but despite laws intended to regulate fishing activities, many fishers continue to exploit fish populations (Kumawat, *et.al.,* 2024) without regard for size limits, seasonal bans, or the use of illegal fishing nets, such as fine-mesh nets that capture juvenile fish before they can reproduce (Kelkar, *et.al.,* 2020). In certain regions of Uttar Pradesh, such as the stretch of the Ganges near Kanpur, reports have indicated that local fishers have overexploited key species like Rohu and Mrigal, leading to a decline in the local fishery industry (Vass, *et. al.*, 2010). The endangered Ganges River Dolphin (*Platanistagangetica*) relies on fish as a food source, and the decline in fish populations has directly affected its survival (Singh, *et. al.*, 2018; Sinha, *et. al.*, 2014). Fishers frequently employ illegal methods such as electric shocks and dynamite fishing to increase their catch rates, which not only kills fish indiscriminately but also damages the aquatic environment (Bano, *et. al.,* 2016; Sarkar, *et. al.,* 2020).

Pollution:

Industrial waste, including harmful chemicals from tanneries, textile industries, and sugar mills, is often discharged directly into these rivers without adequate treatment, causing severe water contamination, especially in the Ganges and Yamuna of Uttar Pradesh (Srivastava, *et. al.,* 2015; Kumar, *et. al.,* 2017*;* Kumar, *et. al.,* 2023*).* Excessive use of chemical fertilizers and pesticides in agriculture leads to nutrient loading in water bodies, especially during monsoon season when these chemicals are washed into the rivers. This nutrient load can cause algal blooms and eutrophication, which disrupt aquatic ecosystems (Kumar M, *et. al*., 2024). Pesticides, especially organochlorines and organophosphates (Sarkar, *et. al*., 2022) accumulate in the water and sediments, poisoning fish and other aquatic organisms. These chemicals interfere with fish reproduction and, affect the entire aquatic food chain which disturbs fish breeding and its production in Uttar Pradesh (Kumar M, *et al.,* 2024; Maurya, *et al.,* 2013; Kadiru, *et al.,* 2022).

Climate Change:

 Climate change is affecting water temperatures in rivers, ponds, and wetlands. These rising temperatures, particularly during the summer months, have led to increased water evaporation, reducing water levels in aquatic ecosystems of many states including Uttar Pradesh (Sharma, *et al,*. 2014; Pathak AK., 2018). Many freshwater fish species, like as Rohu (*Labeo rohita*) and Catla (*Catla catla*), are highly sensitive to changes in water temperature. Warmer water

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decreases oxygen solubility, causing stress on fish populations and affecting their growth, reproduction, and survival. Additionally, altered monsoon patterns due to climate change are disrupting the seasonal flooding and water cycles that fish rely on for spawning. For instance, late or weak monsoons result in insufficient water flow during critical breeding periods, reducing the chances of successful reproduction for many species (Pandey, *et. al.,* 2022; Vass, *et. al.,* 2009).

Consequences of Droughts, Floods, and Erratic Weather Events: Extended drought periods have become more frequent in Uttar Pradesh, leading to the drying up of rivers, lakes, and wetlands. As water bodies shrink, fish are forced into smaller, overcrowded area, which increases competition for food and space, leading to higher mortality rates. Climate change, along with habitat degradation, pollution, and overharvesting, poses a significant threat to freshwater fish diversity (Pathak, *et. al.,* 2021). In extreme cases, entire fish populations can be spread out in smaller lakes and ponds that completely dry up during prolonged droughts. Flood waters can wash away fish eggs and juvenile fish, disrupting the reproductive cycles of species like Mrigal (*Cirrhinus mrigala*) and Hilsa (*Tenualosa ilisha*). Moreover, floods often carry pollutants from agricultural and industrial areas into water bodies, further degrading fish habitats (Lakra, 2010; Prakash, *et. al.,* 2021; Vass, *et. al.,* 2009). Erratic weather patterns, such as unseasonal rain or sudden temperature fluctuations, can disrupt fish migration patterns, especially for migratory species like Hilsa. These species rely on specific environmental cues for migration, and sudden changes in weather patterns can interfere with their breeding and feeding behaviors (Das, *et. al.,* 2013; Sarkar, *et. al.,* 2018)

Habitat Loss and Degradation in Uttar Pradesh

Destruction of Wetlands and Freshwater Ecosystems: The rapid expansion of agriculture and urbanization has led to the destruction of critical wetland ecosystems in Uttar Pradesh. Wetlands that once provided vital habitats for fish breeding and feeding are being drained and converted for agriculture, leading to significant habitat loss (Foote, *et. al.,* 1996). This has particularly affected fish species like Rohu (*Labeo rohita*) and Catla (*Catla catla*), which rely on these ecosystems for spawning (Lakra WS., 2010). The construction of embankments and river channel modifications has disrupted the natural flow reducing fish habitat availability and altering the ecological balance of these rivers.

Impact of Dams and Water Diversion Projects: The construction of large dams and water diversion projects on major rivers like the Ganges and Yamuna has had devastating consequences for fish populations. Dams such as the Rihand, Tehri and Narora dams have altered water flows and created physical barriers that prevent migratory fish species like Mahseer and Hilsa from reaching their spawning grounds, causing population declines (Lakra, *et. al.,* 2011; Gautam, *et.al.,* 2018). Water diversion for irrigation and urban use further exacerbates the problem by reducing downstream water availability, particularly during the dry season, which shrinks fish habitats and affects breeding cycles (Sarkar, *et. al.,* 2015).

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Siltation and Habitat Degradation: Habitat degradation is also driven by increased siltation in rivers, a consequence of deforestation, poor agricultural practices, and land use changes in catchment areas. Siltation reduces the depth of rivers, clogs fish spawning grounds and decreases water clarity, all of which make it difficult for fish to survive and reproduce. Siltation is especially problematic in rivers like the Yamuna, where increased sediment deposition has significantly altered the river's natural flow, further reducing its capacity to support diverse fish species (Mishra, *et. al.,* 2021; Lakra, 2010).

Loss of Riparian Vegetation: Riparian zones, which provide shelter and nutrients to aquatic organisms, have been severely impacted by urbanization and agriculture. The removal of riparian vegetation not only leads to soil erosion but also increases water temperatures and reduces habitat complexity, making rivers less suitable for fish populations. This degradation has been observed along the banks of the Ganges and Yamuna rivers, where the loss of riparian vegetation has reduced biodiversity (Bhan, *et. al.,* 2018; Singh, *et. al.,* 2022).

Invasive Species:

Impact of Non-Native Fish or Aquatic Organisms: The introduction of non-native species like Tilapia (*Oreochromis mossambicus*) and Common Carp (*Cyprinus carpio*) has disrupted the aquatic ecosystems in Uttar Pradesh. These species, introduced for aquaculture, have rapidly spread and now compete with native fish for food and space. Additionally, invasive aquatic plants, like Water Hyacinth (*Eichhornia crassipes*), reduce oxygen levels and alter natural habitats, further stressing native fish populations (Singh, *et. al.,* 2010; Joshi, *et. al.,* 2016).

Competition and Predation Leading to Decline of Native Species: Invasive species often outcompete native fish, such as Rohu (*Labeo rohita*) and Catla (*Catla catla*), for resources. Predatory species like the African Catfish (*Clarias gariepinus*) prey on native fish and their juveniles, reducing their numbers and disrupting breeding cycles. This has led to a sharp decline in native fish populations in several water bodies in Uttar Pradesh (Lakra, 2010; Singh, *et. al.,* 2013).

Ecological Consequences of Invasive Species: The introduction of invasive species has altered the balance of aquatic ecosystems, threatening biodiversity. Invasive fish can also introduce diseases that native species cannot resist, worsening population declines. These disruptions threaten the stability of aquatic ecosystems, leading to further biodiversity loss (Singh, *et. al.,* 2013; Singh, *et. al.,* 2014).

Water Over-Extraction:

The Role of Agricultural and Industrial Water Usage in Reducing Water Levels in Rivers and Lakes: Water over-extraction for agricultural and industrial purposes has significantly reduced water levels in rivers and lakes across Uttar Pradesh. The state's reliance on irrigation for farming, particularly for water-intensive crops like rice and sugarcane, has led to excessive

groundwater extraction and diversion of river water for irrigation canals. This has severely lowered the flow levels of rivers such as the Ganges and Yamuna, especially during the dry season (Lakra., 2010). Industrial water usage, particularly in urban areas such as Kanpur and Prayagraj, compounds this issue. Factories often extract large amounts of water from rivers, contributing to the reduction of available water for sustaining aquatic ecosystems (Kumar A, *et. al.,* 2020).

Consequences of Fish Extinction

Social and Cultural Consequences: Fishing has long been a part of the cultural heritage in many regions of Uttar Pradesh, passed down from generation to generation. However, the decline in fish populations due to overfishing, pollution, and habitat destruction has led to a significant loss of traditional fishing knowledge. Traditional rituals and practices surrounding fishing, such as festivals celebrating a good catch or rituals performed before fishing trips, are also disappearing as the economic viability of fishing diminishes. This loss is not just economic but also cultural, as the practices tied to fishing were deeply embedded in the community's identity (Kumar, *et. al.*, 2017; Mishra, *et. al.*, 2011).

Effects on Community Identity and Cultural Heritage: Fishing communities in Uttar Pradesh, particularly those along the Ganges and Yamuna rivers, have historically built their identity around fishing. As fish populations decline, these communities are losing a key aspect of their cultural heritage. The younger generations are no longer learning the traditional skills of boat-making, net-weaving, and sustainable fishing practices, which threaten the continuity of these customs (Tyagi, *et. al.,* 2008; Gautam, *et. al.,* 2017; Sharma*, et. al.,* 2018).

Conservation Strategies:

Adoption of Fishing Limits: One of the primary sustainable fishing practices is the implementation of fishing limits or quotas. These restrictions help regulate the number of fish that can be caught, ensuring that fish populations are allowed to recover. In regions like Uttar Pradesh, the enforcement of fishing quotas is critical to protecting overexploited species such as Rohu (*Labeo rohita*) and Catla (*Catla catla*), which have been severely impacted by overfishing (Gautam, *et. al.,* 2018; Alam, *et.al* 2017). These limits are often based on scientific assessments of fish stocks, ensuring that the catch does not exceed the population's ability to regenerate (Lakra, 2010, Kumar J, *et. al.,* 2013).

Seasonal Fishing Bans: Seasonal fishing bans are implemented during key breeding seasons to allow fish populations to reproduce without interference. In Uttar Pradesh, many fish species depend on the monsoon season for spawning, and the prohibition of fishing during these periods has been shown to improve fish staffing and overall population health (Lakra WS., 2010). This practice is particularly important for species like Mrigal (*Cirrhinus mrigala*), which need specific environmental conditions for successful reproduction. Seasonal fishing bans (SFB) in

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India, including Uttar Pradesh, aim to sustain marine fishery resources and protect small-scale fisheries (Gunakar *et al.,* 2017).

Promotion of Selective Fishing Gear: Another sustainable practice involves the promotion of selective fishing gear that minimizes by catch. Traditional fishing methods often catch non-target species, which can result in the unintentional depletion of fish stocks. By using gear that targets specific species or sizes of fish, fishermen can reduce their impact on non-target species and juvenile fish. This method is essential for preserving fish biodiversity in regions like the Ganges Basin, where non-selective fishing methods have contributed to the decline of native species (Kelkar, *et. al*., 2020; Riyaz, *et. al*., 2023).

Community-Based Fisheries Management: Sustainable fishing practices often involve community participation in the management of local fisheries (Sharma, *et. al*., 2018). In Uttar Pradesh, community-based management programs empower local fishers to monitor and regulate their fishing activities, ensuring that they adhere to sustainable practices. This approach has been effective in promoting the long-term sustainability of fish populations and improving the livelihoods of local communities. By involving local stakeholders, these programs enhance compliance with fishing regulations and foster a sense of responsibility for protecting fishery resources (Tyagi, *et. al*., 2008; Gautam, *et. al*., 2017). Extension specialists have a wealth of opportunities to expand their scope and provide policy-oriented research in the field of fisheries management and conservation, which will aid fisheries managers and policymakers in further enhancing the industry (Tyagi, *et. al*., 2015).

Aquaculture as an Alternative: Sustainable aquaculture has been promoted as an alternative to wild fishing in many parts of the world, including Uttar Pradesh. By cultivating fish in controlled environments, aquaculture reduces the pressure on wild fish populations while providing a reliable source of protein and income for local communities. Sustainable aquaculture practices include the use of organic feed, efficient water management, and the avoidance of chemical additives that can harm aquatic ecosystems (Duarah, *et. al*., 2020; Prasad, *et. al*., 2020). In regions facing severe overfishing, aquaculture offers a viable solution to meet the growing demand for fish while conserving natural fish populations.

Pollution Control and Waste Management: In Uttar Pradesh, efforts to reduce industrial and agricultural runoff into rivers such as the Ganges and Yamuna have focused on limiting the discharge of untreated waste into these water bodies. Industries, particularly those involved in textiles, tanneries, and paper mills, have been required to install effluent treatment plants (ETPs) to treat industrial waste before it enters the river system (Kumar D., 2023; Kumar D,. 2024). Agricultural runoff, which includes harmful chemicals such as pesticides and fertilizers, is being addressed through the promotion of organic farming practices and improved irrigation methods. Techniques such as drip irrigation reduce the amount of water used and prevent excessive runoff into nearby rivers, contributing to pollution reduction (Joshi, *et. al.,* 2024; Jaiswal, *et. al.,* 2019).

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Government Regulations and Local Solutions for Water Treatment: The Government of India has implemented several regulations aimed at controlling pollution levels in the Ganges and Yamuna rivers. One of the most significant initiatives is the National Mission for Clean Ganga (NMCG), which focuses on reducing pollution by treating sewage and industrial effluents before they are discharged into the rivers. The program has set up sewage treatment plants (STPs) in cities along the Ganges, aiming to curb the release of untreated waste into the river (Das, *et. al.,* 2011; Alley, *et. al.,* 2011). Along with the national Swachh Bharat Abhiyan (Clean India Campaign) and the National Rural Drinking Water Program, the Union Government's three main programs for attaining SDG 6 are the Namami Gange Program, a conservation and pollution reduction initiative (Kedzior, *et. al.,* 2024). Local solutions have also emerged, including community-based initiatives where local stakeholders, NGOs, and government agencies work together to ensure proper waste management and treatment. In many areas, decentralized water treatment systems, such as bioremediation using natural wetlands, are being used to filter water and reduce pollution levels at a local scale.

Habitat Restoration: Efforts to Rehabilitate Degraded Wetlands: In the state of Uttar Pradesh, efforts to restore degraded wetlands are central to habitat restoration projects. Wetlands play a crucial role in supporting fish biodiversity, but they have been severely degraded due to agricultural expansion, urbanization, and pollution (Behera, *et. al.,* 2012; Tari, *et. al.,* 2022). Restoration efforts focus on re-establishing natural water flow, replanting native vegetation, and reducing pollution through improved waste management practices. These efforts are critical to restoring the breeding grounds of native fish species like Rohu (*Labeo rohita*) and Mrigal (*Cirrhinus mrigala*) (Verma H., 2015; Sarkar, *et. al.,* 2011; Tiwari, *et. al.,* 2024). Wetland restoration projects, such as those along the banks of the Ganges River, have also involved community engagement, where local stakeholders are educated about the ecological benefits of wetland conservation (Bhatt, *et. al.,* 2016; Rai, *et. al.,* 2013).

Riverbank Rehabilitation: Because the restored riparian vegetation produces cooler microclimates and shaded places that are favorable for fish breeding, these projects are crucial to enhancing native fish spawning grounds. One of the significant, ubiquitous factors influencing river shape and processes that impacts river corridors, floodplains, and related riparian zones is riverfront development (Bhan, *et. al.,* 2018; Singh R., 2022). Beginning in April 2015 and ending in March 2017, this project was located on the Gomti River, a meandering perennial tributary of the Ganges that receives its nourishment from groundwater and rainfall in the capital city of Lucknow (Dutta, *et. al.,* 2018).

Restoration of Aquatic Ecosystems: Restoration efforts targeting aquatic ecosystems, particularly river restoration, have focused on improving water quality and restoring fish habitats. Projects aimed at reducing industrial pollution, re-establishing natural water flow, and removing obstructions like dams or barrages have been effective in restoring ecological balance in rivers such as the Yamuna. These measures not only benefit the fish populations but also

improve the overall biodiversity of aquatic ecosystems (Sinha, *et. al.,* 2001; Prashant, *et. al.,* 2013; Upadhyay, *et. al.,* 2019).

Community Involvement in Restoration Projects: Community involvement is a key aspect of habitat restoration projects in Uttar Pradesh. Restoration measures have been proposed based on an ecosystem-scale approach to biodiversity conservation. Moreover, there is a need to maintain this valuable ecosystem to be ecofriendly for the aquatic flora and fauna to thrive with the involvement of local communities for long-term benefits (Sahu, *et. al.,* 2024). Fishermen and farmers are often trained in sustainable practices, such as organic farming, to reduce pollution and over-extraction of water from rivers, while local fishers participate in monitoring fish populations to ensure that restoration efforts are succeeding (Basheer, *et. al.,* 2024). Education programs that teach communities about the importance of wetlands, rivers, and native fish species have also been instrumental in promoting the conservation and restoration of aquatic habitats (Paunikar,. 2021).

Scientific Research and Monitoring: Importance of Ongoing Research on Fish Populations and Conservation Methods: Continuous scientific research is essential to understanding the dynamics of fish populations and the factors contributing to their decline. Monitoring fish population trends over time allows researchers to assess the health of aquatic ecosystems and identify which species are at risk. Conservation methods, such as habitat restoration and the implementation of fishing quotas, require ongoing research to determine their effectiveness (Overton, *et. al.,* 2024). By tracking changes in the categories given to species, the Red List Index (RLI) monitors trends in the conservation status of entire species groupings across time. To ensure that conservation efforts are adaptive and focused on the most vulnerable species, researchers use population data to guide management techniques (Miranda, *et. al.,* 2022).

Use of Technology in Preserving Fish Species: Advanced technologies, such as GPS tracking and water quality monitoring systems, are increasingly used in fish conservation efforts. GPS tracking of fish movements helps scientists understand migration patterns and habitat use, particularly for migratory species like Hilsa (*Tenualosa ilisha*) that rely on specific environmental conditions for breeding (Lahoz-Monfort, *et. al.,* 2021; Chu, *et. al.,* 2022). Computer vision (CV), one of these technologies, has drawn more attention due to its strong ability to process vast amounts of digital imagery of protected areas quickly and comprehend the effects of habitat destruction (Lopez-Marcano, *et. al.,* 2021). Technologies for monitoring water quality are essential for locating habitat damage. Researchers can identify changes in aquatic habitats that may endanger fish populations by using sensors that assess parameters including dissolved oxygen, pH, and pollution levels (Manoj, *et. al.,* 2022; Akhter, *et. al.,* 2021). In order to manage pollution and other environmental stressors before they reach critical levels, it is essential to deploy biological early warning systems (BEWS) to monitor water quality and ecotoxicity parameters in real-time (Bownik, *et. al.,* 2021).

Conclusion:

The decline in fish populations in Uttar Pradesh is driven by multiple factors such as overfishing, pollution from industrial and agricultural runoff, habitat destruction, invasive species, and climate change. These causes have led to significant biodiversity loss, disruptions in food security, and the erosion of traditional fishing practices. Conservation efforts, including sustainable fishing practices, pollution control, habitat restoration, and scientific monitoring, are being implemented to address these challenges. Immediate and coordinated action is needed to prevent further extinction of fish species. Strengthening pollution controls, enforcing sustainable fishing laws, and restoring habitats are critical. Collaboration between governments, local communities, and scientific institutions is essential to protect the fish population and restore aquatic ecosystems. Further research is required on the long-term impacts of climate change on fish populations and more innovative habitat restoration techniques. Policymakers should focus on improving water management, promoting sustainable aquaculture, and incorporating community-based conservation efforts to ensure the sustainability of fish resources. The failure of fishing as a sustainable occupation has had a profound impact on the social structure of fishing communities. Traditionally, these communities were organized around fishing, with specific roles assigned to different family members based on their fishing skills and experience. As fishing declines, many young people are migrating to urban areas in search of alternative employment, leading to the fragmentation of these communities. This social upheaval is also leading to increased economic disparity within the communities. Families with access to alternative livelihoods or resources can adapt more easily, while those who are wholly dependent on fishing are falling further into poverty.

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