Journal homepage: www.fishtaxa.com

Impact of Urbanization on Fish Biodiversity: Taxonomic Changes in Altered Environments

Sharmin Islam, Minbang Irené
[1] *Department of Animal Biology and Conservation, University of Buea Cameroon.*

Abstract
Global urbanization significantly impacts the environment, especially aquatic habitats, and their resident fish populations. This paper explores the complex interrelationship between urban growth and changes in fish biodiversity due to altered settings. Urbanization has a variety of effects on fish biodiversity. First, fish populations are hampered by migration restrictions and restricted access to vital spawning and feeding grounds due to habitat loss and fragmentation brought on by converting natural landscapes into urban environments. Second, urban areas are renowned for bringing pollutants into waterways, endangering water quality and harming fish health. Thirdly, changes in hydrology may result in habitat degradation and reduce the availability of fish-friendly habitats. The spread of invasive species in urban areas is a fourth effect that alters the makeup of fish communities by upsetting the balance of native ecosystems. Furthermore, hotter conditions in cities may favor fish species that can withstand the heat, changing species distribution. Urban expansion frequently results in the physical modification of aquatic ecosystems, such as the construction of dams and culverts, which obstruct fish movement and change their regular life cycles. A complete conservation strategy must include habitat restoration, pollution control, ethical urban planning, invasive species management, sustainable fishing methods, public awareness campaigns, ongoing research, and monitoring. This study emphasizes the importance of understanding the complex interactions between urbanization and aquatic ecosystems and how essential it is to advance sustainable urban development strategies that give equal weight to meeting human needs and environmental protection.

Keywords: Urbanizations (U), Fish Biodiversity (FBD), Taxonomic (T), Altered Environment (AE)

Citation: Sharmin, I, Minbang, I. 2023. Impact of Urbanization on Fish Biodiversity: Taxonomic Changes in Altered Environments. FishTaxa 29: 1-13.

Introduction

Human-instigated environmental changes have always been the leading cause of habitat destruction, impacting biodiversity. Exceeding human population is one of the driving factors that induces urbanization, and it not only affects terrestrial ecosystems but has also been equally affecting aquatic biodiversity(Williams-Subiza, Brand, & Miserendino, 2022). The transformation of natural landscapes into urban areas destroys the ecosystem's structure and function, causing habitat fragmentation, homogenization, and eventually loss of species. Since freshwater ecosystems have more dynamic and functional habitats, they have been known to cover a high diversity of species(Camara et al., 2023). Urbanization can cause changes in the aquatic ecosystem's morphology and hydrology, thus disturbing its ecological integrity. The impact caused by urbanization on the fish biodiversity and ecosystem depends on various factors, especially how that converted land is being used. Loss and habitat fragmentation are two of the most immediate effects of urbanization on fish biodiversity. As cities grow, natural environments, such as wetlands, streams, and rivers, are frequently changed into structures, highways, and other infrastructure. These changes interrupt the natural flow of water systems and cause the loss of vital aquatic habitats. Fish populations that depend on these environments for breeding, feeding, and protection suffer. Fish populations can become isolated from one another due to habitat

Accepted: 20 December 2022; Published: 22 April 2023

fragmentation, a typical result of urbanization. To complete their life cycles, which include spawning and feeding, fish frequently need to travel through river systems. Fish movement can be physically impeded by urban expansion, such as culverts and dams, preventing them from reaching vital habitats. This fragmentation can cause fish populations to be less genetically diverse and increase the danger of local extinction.

Urban environments are well-known sources of many pollutants, including organic materials, heavy metals, minerals, and chemicals. These pollutants enter aquatic environments through stormwater runoff, industrial discharges, and wastewater treatment plant effluents. They may negatively affect fish and their habitats once they are in the water. Pollution at high concentrations can affect water quality and make many fish species uninhabitable. Some contaminants can impair fish physiology, affecting their general ability to breathe, reproduce, and stay healthy. For instance, excessive fertilizer runoff can result in algal blooms, which lower water oxygen levels and result in fish deaths. Also, hazardous chemicals may build up in fish tissues, endangering fish populations and human consumers.

For example, the practice of urbanized land for vegetation purposes comes up with the usage of various fertilizers and pesticides. When entered into aquatic streams, these chemicals, including nitrogen and potassium, decrease the water quality and disturb the aquatic life. The major effect is experienced by fish assemblages i.e., the diversity and abundance of fish species present at a specific hydro ecosystem(Côte et al., 2022). Conservation initiatives frequently concentrate on habitat restoration, pollution management, the construction of fish-friendly infrastructure, and the adoption of sustainable fishing methods to lessen the harmful effects of urbanization on fish biodiversity. Additionally, knowledge of the precise taxonomic changes in altered urban habitats is crucial for devising strategies for fish conservation. Urbanization, which refers to the growth and development of cities and metropolitan areas, significantly impacts the environment. Urbanization's effects on aquatic habitats and the fish species that live there are among its most essential and frequently disregarded side effects. Cities often encroach on or alter neighboring marine environments as they grow, resulting in changes to the water supply, the availability of habitat, and ecological dynamics that can significantly impact fish species. This paper examines the intricate connection between urbanization and fish biodiversity, highlighting the taxonomic changes in remodeled habitats. The perennial streams that exist for a longer time are more vulnerable to the effect of urbanization, as they exhibit low fish richness and availability. Therefore, such fish assemblages undergo the harsh and rapid effect of urbanization and may face disturbance in resting habitat, breeding, and feeding(Larentis, Kotz Kliemann, Neves, & Delariva, 2022).

Similarly, if the urbanized land is used for housing, it interrupts the forested watershed catchment sites. Because when the housing strategies are applied on ground, underground urban channels are made. These urban channels disturb the watersheds, and the fish in that area may get separated from their downstream population, resulting in their isolation from habitat and eventual death. Fish exhibit diversified taxonomic characteristics in aquatic ecosystems; therefore, they directly influence the processing of various ecological factors. They have such a wide taxonomy because of the availability of a range of size, behavior, feeding specificity, and structural forms(Bohus et al., 2023). Due to these characteristics, fish manage trophic networks, energy consumption, and nutrient transformation. Therefore, the impact of human activities is directly related to the taxonomic features of fish and thus affects their functionality. However, different groups of aquatic organisms show different levels of susceptibility to these changes. If the species have a high tolerance to modified habitats, they can survive, excluding the sensitive ones(Trovillion, Sauer, Shay, Crone, & Preston, 2023). Moreover, anthropogenic activities cause a reduction in the space that fish assemblages occupy. This lowering of space not only reduces their functionality but also causes a decrease in fish richness and diversity. This lack of diversity causes the reduction in the level of unique traits occupying species, thereby increasing their vulnerability to habitat changes. This condition also justifies the invasion of other

species in that specific water habitat. The reduced functionality of fish species tends to lessen the ecosystem's productivity and allows foreign aquatic species to invade their space (Gergana, Jaime, & Konstantinos, 2022).

Other than vegetation, when land undergoes continuous transitions, it suffers loss of natural water content and leads to soil erosion. This soil erosion triggers the increase in sedimentation level and lowers the turbidity of nearby waterbodies. This increase in sedimentation not only affects the feeding habitat of fish but also affects their reproductive cycles. Such fish get deprived of spawning habitat and lose their larvae(Yang et al., 2022). Moreover, this soil erosion also leads to the suspension of various solids in the water bodies. These suspended solids can cause various negative impacts on fish biodiversity, including sublethal stress. Depending on the type of solids suspended, they can affect fish vision and can cause a decrease in preying rate. This directly influences their feeding capacity(Zhong et al., 2022). Similarly, if suspended particles can react, they can undergo oxidation and reduce the oxygen level for the aquatic life underwater.

Irrespective of anthropogenic activities, if the land is left unused, it can also hurt the biodiversity of fish and can cause a reduction in heterogeneity which directly impacts biodiversity. Similarly, eutrophication is a phenomenon induced by urbanization. Due to the increase in urbanization, household and sewage waste is multiplied. Aquatic bodies like rivers are being used to dump this excessive urban waste. When this waste from households enters water bodies, it undergoes a phenomenon called eutrophication(Chou et al., 2023). In this process, nutrients like nitrogen and phosphorus accumulate in the water bodies, forming a layer of algal bloom. Due to this process, the sunlight doesn't get directly through the water, and the plants under water lack photosynthesis. This reduction in photosynthesis lowers the oxygen level of water, which in turn causes the death of fish, reducing their biodiversity, functionality, and taxonomic characteristics.

Additionally, temperature also has a significant influence on the fish environment. With an increase in urbanization, the forests are being cleared, which has given rise to temperature fluctuations. These temperature changes can harm fish feeding, as the temperature of the water body influences the fish's mobility and desire to look out for food. It can also affect the pace of fish to move because studies have revealed that most fish show higher speed at higher temperatures. Therefore, maintaining temperature is also essential in regulating fish biodiversity, as a minor change can affect fish's breeding and feeding capabilities.

According to the abovementioned factors, land usage generally negatively impacts fish taxonomy and biodiversity by causing nutrient run-off, increasing sedimentation, waterlogging, wood and leaf debris, and temperature changes. To maintain a healthier fish biodiversity and taxonomy, different landscape changes and human activities should be considered as separate species groups undergo different changes when exposed to different environmental and habitat fluctuations(Paquette, Gregory-Eaves, & Beisner, 2022). It is important to maintain a regulated level between land management and anthropogenic activities to keep aquatic life in a healthier and more diverse environment, as negligence can cause not only the destruction of natural habitat but also the permanent eradication of different species of fish taxonomy for eternity.

Research objectives:

This research articles comprehends the Impact of Urbanization on Fish Biodiversity: Taxonomic Changes in Altered Environments

Literature review:

Researchers claim that changes in fish biodiversity occur due to ecological and evolutionary alternations. These ecological changes are mostly caused by urbanization and result in economic consequences. The changes in the pattern of fish biodiversity due to urbanization depend upon the type of aquatic system. Temporal fluctuations are one of the reasons behind the increased functional diversity of fish species. Also,

the number of native fish species has increased due to the impact of urbanization(Rosso, Langerhans, & Avigliano, 2023). Studies claim that the abundance of various species declines due to various factors like urbanization as well as deforestation. Changes in climatic factor are one of the critical factors that induces species diversity. sudden temperature rise has changed the distribution of fish species in the sea. The fish species richness has been reduced due to drastic changes in climate over the past few years(Mulinge, 2023).Studies explain that temporal and spatial factors affect the fish species in paddy fields. The experimental studies on fish assemblages in paddy fields suggest that temporal changes induce change in fish diversity.These changes help in maintaining the ecosystem of a man-made ecosystem(Aqmal-Naser, Iguchi, & Ahmad, 2023).Studies reveal that fish assemblage structure is disturbed due to the change in anthropogenic land.The fish assemblages are observed in local fish habitats for studying the urbanization impact at various spatial scales (Welsh et al., 2023). Due to the development of impermeable surfaces like highways, parking lots, and buildings, the hydrology of metropolitan areas frequently experiences major changes. These surfaces prevent rainwater from penetrating the soil, increasing surface runoff and causing water bodies adjacent to be quickly drained. Due to changing flow patterns and variable water levels, urban streams and rivers can have an adverse effect on fish populations.

Changes in hydrology may impact fish habitat availability. For many fish species, floodplains serve as significant spawning habitats. Changes in flow patterns may lessen the frequency and length of flood occurrences, which may have an effect on these species' reproductive success. Furthermore, increasing runoff can potentially introduce contaminants and silt into water bodies, further harming fish habitats. Studies highlight that the ongoing global warming gives rise to serious life threats for aquatic life. The biotic component of the aquatic ecosystem gets disturbed due to various global stressors. To maintain the ecosystem, various management strategies have been adopted by aquatic ecosystem management teams(Rocha Pompeu, Peñas, Belmar, & Barquín, 2023).Studies explain that globally, various climatic changes are restricting the whole biodiversity of aquatic ecosystems. Studies claim that the climate will be drier in the future, impacting the ecological communities and fish biodiversity. Complex global changes broadly impacts the fish assemblages triggering the factor that disturb aquatic ecosystem(Woods, Freeman, Krause, & Maloney, 2023).studies suggest that macroinvertebrate species in the sea get disturbed by anthropogenic activities. The composition of the fish community alters because of the alternation in anthropogenic activities. Various management strategies work to maintain the biodiversity of pond species by minimizing the anthropogenic pressure(Stamenković et al., 2023). Studies show that ecological process gets alerted due to the acidification of oceans. The diversity of marine fishes maintains the functioning of the marine ecosystem. The marine species are not immune to the changes of climate, and this climate badly impacts the biodiversity of marine species. Various ecosystem management strategies are adopted by studying the impacts of climate on fish biodiversity. These strategies provide a way to protect the ecosystem from all the bad climatic impacts(Nagelkerken et al., 2023).Studies claim that various agricultural activities change the pattern of aquatic functioning. Moreover, the factors that increase economic diversity also increase taxonomic diversity. These biodiversity-based changes due to structural traits Help in understanding the anthropogenic alternations in streams of neotropical regions(Malacarne, Machado, & Moretto, 2023).Studies show that climatic factors get disturbed due to the changes in atmospheric gases. The increase in carbon dioxide concentrations increases the chances of greenhouse gas penetration in the atmosphere. The gases, when they reach the sea level, disturb its ecosystem. One of the reasons for allergic diseases prevalence in people is these greenhouse gases. To understand the extent of the impact of these gases on biodiversity and urbanization, various management strategies are used by ecosystem managing organizations(Tong et al., 2023).Studies explain that in various water bodies worldwide, one of the major ecological changes that occur is the introduction and the extinction

of fish species. The environmental factors act as stressors that trigger a change in fish biodiversity(Xiang, Dong, Ju, Shi, & Grenouillet, 2023)

Invasive species, which can outcompete or prey on native fish species, are frequently introduced and spread across urban areas. Invasive fish species can swiftly establish themselves in urban water bodies and upset preexisting biological connections. Examples include the Asian carp in North America and the European perch in Australia. Native fish may lose out to invasive species in the competition for resources like food and breeding grounds. Additionally, they could bring in parasites or diseases that the local species are defenseless against. Fish community composition can change due to the introduction of invasive species, which could negatively affect the local biodiversity. Studies predict that various anthropogenic activities disturb the biotic and abiotic components of the ecosystem. The rapid increase in the salinity of coastal ecosystems is because of the increased urbanization around coastal areas(Waldo, Moore, Bickley, Anderson, & Bernal, 2023).Studies explain that human modifications change the biodiversity of the planet. Understanding the change in biodiversity due to human activities is a challenging task. The biodiversity changes in aquatic ecosystems include richness in fish species, temporal fluctuations, and spatial changes. All these changes impact the life of sea species and disturb the pattern of their existence. Appropriately managing these changes in the ecosystem results in properly processing the natural aquatic ecosystem(Dornelas et al., 2023).Studies explain that using bioindicator tools in freshwater helps monitor the ecosystem of the aquatic environment.. Biotic integrity is used as a bioindicator tool designed on a fish model. This bio integrity index provides data on various environmental factors and their impact on fish assemblages. This internalized ecosystem management design system helps maintain the optimized conditions of the sea(Bertora, Grosman, Sanzano, & Rosso, 2023). Since there are frequently more people living in urban areas, local fish populations are subjected to more fishing pressure. Fish biodiversity may suffer from overfishing, especially without legislation and sustainable management techniques. Fish overfishing can result in population declines and imbalances in the aquatic ecosystem. Due to their marketability or desirability, certain species may become more susceptible to exploitation, aggravating the issue. Fish communities' species composition can change due to overfishing, with less exploitable species taking over. Studies suggest that various ecological processes, like the species invasion process, are explained through the taxonomy-based beta-diversity concept. According to the beta-diversity approach, several environmental and biological features impact beta-diversity-based communities of fish species(Aleixo, Florêncio, Lansac-Tôha, Quirino, & Fugi, 2023).Scholars studies explained that the response of fish communities to environmental stressors determines how these stressors impact fish biodiversity. The response of each biodiversity-based component to the environmental stressors is different. The functional trait various fish species possess determines their response toward environmental stressors `For understating the response of several fish species to stressors, the functional trait possessed by each fish species is studied individually(Li et al., 2023). Aquatic environments are frequently physically altered in urban development to meet human demands. This includes building culverts, dams and stormwater management systems. These structures may have unforeseen effects on fish populations even though they are meant to control water flow and prevent flooding. For instance, dams can obstruct fish migration and alter normal flow patterns. Important life cycle events, such as spawning and migration, may be impacted by this. Fish populations may fall as a result of diminished reproductive success brought on by restricted access to spawning grounds. Culverts and drainage systems can make similar physical barriers that restrict fish movement and access to suitable habitats. Studies explain that at the global level, the altered ecosystem of marine and coastal areas results due to climatic factors. human based salinity of oceans results because of the acidification of ecosystem due to various human activities. Climatic changes disturb the water cycle and lead to salinity onset by inducing ocean currents. salinity changes ocean physical as well as biological functioning.

By studying the salinity-based data, it becomes easier to predict the changes induced by marine alternations(Röthig et al., 2023). The urban heat island effect is the tendency for metropolitan regions to have warmer temperatures than the nearby rural areas. High temperatures can directly impact fish physiology and behavior. Fish are ectothermic, which means the environment regulates their body temperature. So their metabolic rates, development, and reproduction can all be dramatically impacted by changes in water temperature. Some fish species can survive in urban settings with high water temperatures because they are more thermally resistant than other fish species. The distribution of fish species may change as a result of this advantage, with heat-tolerant species becoming more prevalent in urban water bodies. On the other hand, in urbanized areas, species that are sensitive to temperature may see their populations decline or possibly become extinct locally. Studies explain that changes in beta diversity induce changes in various fish communities. Human activities play a huge role in impacting the beta biodiversity. the human activities impact the metacommunity structure, thereby quantifying the beta diversity dimensions(Stoczynski, Scott, Bower, & Peoples, 2023).studies explain a deep relationship between fish biodiversity as well as environmental factor. Because of the complex diversity and topography features associated with estuaries rivers, a large fish composition is present in this river. For conserving the estuary species, it is important to understand the factors that change or impact fish species composition (Itsukushima, 2023).Furthermore, estuaries are among the most important aquatic ecosystems. Climatic fluctuation greatly impacts this ecosystem. Atmospheric as well as social chemical changes induce climatic changes that disturb the ecosystem functioning. Also, the fish habituating in estuaries face water pollution and habitat destruction problems. Also, problems disturb the biodiversity of fish species and increase their vulnerability chances. To save the estuarine ecosystem from severe climatic changes effective coping strategies are adopted by the estuaries river managing teams(Whitfield, Gillanders, & Able, 2024).

Effect of Urbanization on Fish Biodiversity:

Humans have been causing major environmental shifts, becoming a violent source of disturbing fish habitat. One of those shifts is caused by urbanization. With the increasing human population, the fish population strives to maintain their habitat and show productive responses toward their degrading environment. There are many effects of urbanization on the fish population out of which, a few have been discussed below.

One of the major impacts of urbanization on the fish population is the loss of their diversity. This loss of diversity can occur by any human act. For example, the demand for land is increasing with an increase in human population. Due to this, the non-populated lands, especially near waterbodies, are also being converted for human use. This act not only intrudes with the habitat of fish assemblages but also makes them susceptible to excessive catchment. The loss of fish habitat occurs because of wastes being discharged by the nearby human population (Mantyka-Pringle et al., 2014). These wastes either block the water surface and reduce the oxygen levels of fish or allow the incorporation of organic chemicals and wastes into fish bodies, which ultimately clogs the fish gills, choking them to death. Similarly, suppose the land nearby is being used for vegetation purposes. In that case, it is easier to predict that fertilizers being used in that area are making their direct discharge into that waterbody(van Soesbergen et al., 2019). This act adds up nitrogen, phosphorus, and potassium-like fertilizer chemicals into the water, which results in causing eutrophication(Oertli & Parris, 2019). Eutrophication adds up to the formation of algal scums over the water's surface. These algal scums use the oxygen present in water, causing problems in fish respiration and also, they block the sunlight passageway into the water, making it difficult for plants underwater to process photosynthesis and release oxygen.

Similarly, the waterbodies inhabiting the earth for a long time contain less fish richness and are more liable towards erasing fish species from that place. This results in a diminution of fish biodiversity. Moreover,

the increase in urbanization also leads to changes in stream water discharge. Due to road making and usage of lands excessively, the rainwater flows more smoothly and rapidly toward streams and rivers causing a huge change in their water flow(Olds et al., 2018). Sometimes, this water flow becomes so unsafe that it results in frequent floods. These floods cause changes in fish habitats and also affect their speeds.

Steps of Reduce Urbanization's Effects on Fish Biodiversity:

These difficulties can be addressed using several tactics and interventions:

1.Habitat restoration: It can help to lessen the consequences of habitat loss and fragmentation by restoring degraded habitats and generating fish-friendly conditions. This can entail removing obstructions like dams, enhancing fish passage, and restoring natural flow patterns.

2.Pollution Control: By putting in place efficient pollution control measures like wastewater treatment and stormwater management systems, the entry of contaminants into aquatic environments may be minimized.

3.Management of Invasive Species: Monitoring and eradicating invasive species helps shield native fish populations from competition and predators.

4.Urban Planning: By using sustainable urban planning techniques like low-impact construction and green infrastructure, you may lessen the number of impervious surfaces and keep hydrological changes to a minimum.

5.Sustainable Fishing Methods: Setting and enforcing catch quotas and size restrictions are examples of sustainable fishing rules that can assist in preventing overfishing.

6.Education and Outreach: Increasing public support for conservation initiatives can be achieved by bringing attention to the value of aquatic ecosystems and fish species.

7.Research and Monitoring: To comprehend the unique taxonomic changes taking place in urban areas and to create successful conservation strategies, ongoing research and monitoring of fish populations and their

habitats is essential.

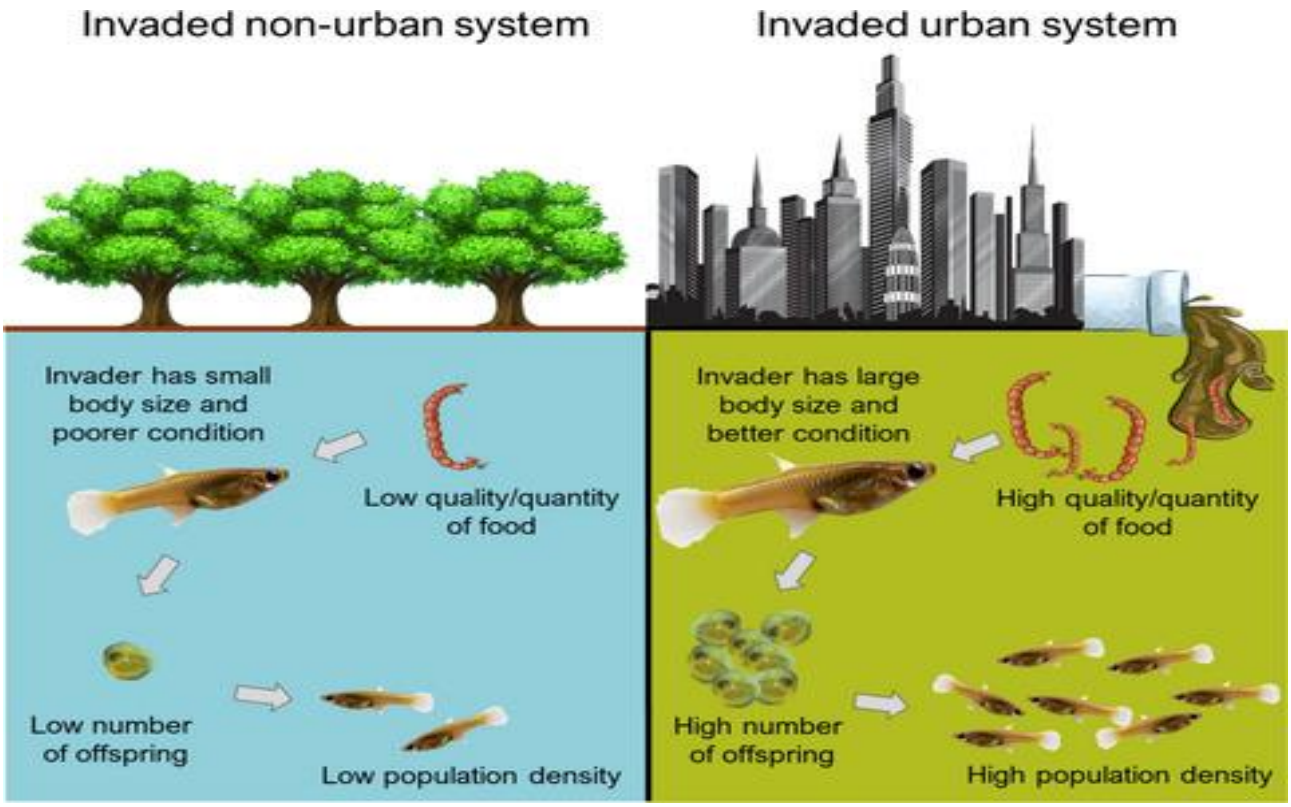
Claims of Impact of Urbanization on Fish Biodiversity:

The study of the impact of urbanization has palpable advantages, especially for studying the changes in fish biodiversity, caused by alteration in its environments. Major research made in these fields has given clear insights into urbanization being lethal to fish taxonomy. Fish are a diverse group of species found in freshwater. Their diverse nature is due to the availability of a range of morphological, behavioral, feed-related, and structural properties. One major application is finding changes in fish habitat and spatial scales over a wide range of water environments.

Also, the study of the effect of urbanization lets the researchers find out the consequences of species pool and local environment. The changes caused by urbanization affect the assembly of fish present because alteration in hydrological events causes the reduction of space for fish species residing in that pool. This lack of space induces a change in fish richness and food availability. This reduction causes fish groups to lose certain biological traits, resulting in their endangerment.

Additionally, temperature also has a great impact on the fish atmosphere. With an upsurge in urbanization, the forests are being cleared which in turn has given rise to temperature variations. These temperature deviations can harm fish feeding, as the temperature of the water body influences the fish's mobility and desire to look out for food. Therefore, urbanization impact analysis on habitats can help in saving fish biodiversity.

Furthermore, the urbanization analysis on fish regimes has allowed the researchers to work on conserving endangered fish species. This analysis discloses the indirect changes caused by channel modification and resistant exterior cover in urban lands, that ultimately cause changes in flow regime, circulation of scavenging, refugia, and reproduction habitats of fish. By studying these changes, the taxonomic history of fish groups can be obtained to learn about the sensitivity and tolerance capacity of fish exposed to urbanization.



Taxonomic Changes Induced by Altered Environments:

Since urbanization deals directly with environmental alteration for fish species, it greatly affects fish taxonomy. Changes in fish richness, specific traits, and changes in occurrence and abundance over some time give taxonomic diversity. A study has proven that the taxonomic diversity of fish species increases with an increase in fish richness, whereas functional diversity related to habitats and ecosystems shows a gradual decrease, with an increase in fish richness at a site.

Changes induced by urbanization persuade differences in fish habitual characteristics and disturb their evolutionary history. Because, fish groups that are tolerant towards external environment changes, modify their innate characteristics to meet the challenges. This modification alters their environment and evolutionary history. Since this evolutionary history is the base for taxonomic diversity, it causes disruptions in taxonomic statistics. Although this disruption seems like no big issue for dealing with present fish groups, the groups of fish that are reluctant towards habitual changes i.e., functional diversity face endangerment.

To deal with this endangerment issue and ultimately conservation of species, the taxonomic characteristics of those species should be known. Therefore, for species to be saved and conserved by applying effective approaches and strategies that can serve the cause of reducing species extinction, the taxonomic diversity of fish needs to be secured.

Hence, urbanization has been proven fatal to fish assemblages. Different site changes and human actions should be deliberated to maintain a healthier fish biodiversity and taxonomy as different species groups undergo different variations when exposed to different ecological and habitat fluctuations. Consequently, urbanization directly influences environmental alteration and evolutionary history that mark the basis of taxonomic diversity. Disruption in this taxonomic diversity leads to unfeasible and impracticable conservation strategies, which ultimately result in a decrease in fish biodiversity.

Correlations

		urbanization	urbanization 2	urbanization 3	urbanization 4	biodiversity	bio-diversity 2	bio diversity 3
urbanization	Pearson Correlation	1	.531**	.111	-.204	-.135	.283	-.386*
	Sig. (2-tailed)		.003	.558	.280	.478	.130	.035
	N	30	30	30	30	30	30	30
urbanization 2	Pearson Correlation	.531**	1	.236	-.416*	.030	.014	-.163
	Sig. (2-tailed)	.003		.210	.022	.874	.943	.389
	N	30	30	30	30	30	30	30
urbanization 3	Pearson Correlation	.111	.236	1	-.241	.013	.416*	-.172
	Sig. (2-tailed)	.558	.210		.200	.948	.022	.363
	N	30	30	30	30	30	30	30
urbanization 4	Pearson Correlation	-.204	-.416*	-.241	1	-.211	.202	.113
	Sig. (2-tailed)	.280	.022	.200		.263	.283	.551
	N	30	30	30	30	30	30	30
bio-diversity	Pearson Correlation	-.135	.030	.013	-.211	1	-.265	.400*
	Sig. (2-tailed)	.478	.874	.948	.263		.157	.028
	N	30	30	30	30	30	30	30
bio-diversity 2	Pearson Correlation	.283	.014	.416*	.202	-.265	1	-.365*
	Sig. (2-tailed)	.130	.943	.022	.283	.157		.048
	N	30	30	30	30	30	30	30
bio diversity 3	Pearson Correlation	-.386*	-.163	-.172	.113	.400*	-.365*	1
	Sig. (2-tailed)	.035	.389	.363	.551	.028	.048	
	N	30	30	30	30	30	30	30

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

The above result describes that correlation analysis between the urbanization and fish bio diversity. The result shows that correlation urbanization present positive and significant relation between urbanization and bio diversity related to them. the rate is 0.113, 0.400, 1 respectively.

Urbanization may significantly impact fish biodiversity, which may result in altered ecosystems and taxonomic groups. The various human activities connected to urban growth, which can change the physical, chemical, and biological properties of aquatic environments, are the main causes of these changes. The following are some of the main ways that urbanization impacts fish biodiversity and causes changes in taxonomy:

1.Loss and fragmentation of habitats

• Natural landscapes are frequently transformed into developed settings due to urbanization, which causes the loss of significant aquatic habitats like wetlands, streams, and rivers.

• As a result of this habitat loss, the remaining aquatic habitats may become fragmented, making it more challenging for fish populations to move, locate adequate breeding sites, and obtain food sources.

2.Water contamination

• A wide range of contaminants, including heavy metals, fertilizers, chemicals, and organic waste, are released into aquatic ecosystems by urban areas.

• Pollutant levels that are too high can degrade the water's quality and harm fish by preventing them from thriving and reproducing. There may be differences in the makeup of fish communities because certain species are more resilient to pollution than others.

3.Modified Hydrology

• Through channelization and impervious surfaces like roads and buildings, urbanization can alter the natural flow patterns of rivers and streams.

• Hydrological changes can affect fish by influencing the availability of good breeding and feeding grounds and the timing of crucial life cycle events like spawning and migration.

4.Exotic Species:

• Invasive species that can displace or prey on native fish species are frequently introduced and spread across urban environments.

• By displacing native fish and upsetting ecological interactions, invasive species can alter the makeup of fish communities.

5.Temperature Variations

• The urban heat island effect, which raises temperatures in urban areas, may impact the physiology and behavior of fish.

• As urban areas heat up, some fish species may be more thermally resistant than others, changing species distribution.

6.Habitat modification

• Physical changes to aquatic ecosystems may arise from urban growth, such as the construction of dams, culverts, and stormwater management systems.

• The physical barriers these alterations can erect for fish can prevent them from reaching breeding places and hinder their migration capacity.

7.Overfishing:

• Since frequent more people live in urban settings, there may be more fishing pressure on the local fish populations.

• Certain fish species may become less common due to overfishing, which could result in population decreases and changes to the makeup of communities.

Conclusion:

In conclusion, urbanization has many different and complex effects on fish biodiversity and the ensuing taxonomic changes in altered settings. The effects on aquatic habitats and the fish species that live there cannot be disregarded as cities grow and flourish. The following are the main conclusions from this investigation into how urbanization affects fish biodiversity. Urbanization causes the destruction and fragmentation of vital aquatic habitats, pos problems for fish populations' survival and migration. When different contaminants are released into urban water bodies, the water quality is lowered, the health of the fish is harmed, and there is a risk to both fish populations and customers. The availability of acceptable habitats for fish can be impacted by flow patterns and hydrology changes, affecting their capacity to reproduce and overall survival. Invasive species can reproduce in urban settings, disrupting local fish communities and perhaps changing the ecosystem's equilibrium. Fish distribution patterns can change due to elevated urban temperatures, which could impact species sensitive to the heat. Physical changes to aquatic ecosystems, such as culverts and dams, can obstruct fish movement and reduce their regular migratory patterns. Large human populations in cities can result in overfishing, which can disturb the equilibrium of fish populations and endanger delicate species. A diversified strategy is required to reduce these effects and maintain fish biodiversity in urbanized areas. A complete conservation strategy must include habitat restoration, pollution control, invasive species management, sustainable urban planning, ethical fishing practices, public awareness campaigns, ongoing research, and monitoring. As a result of the extensive and complex effects of urbanization on fish biodiversity, changed settings have resulted in changes in taxonomic composition. Changes in fish communities and species composition in urban water bodies result from overfishing, water pollution, changing hydrology, invasive species, temperature changes, and habitat destruction. To ensure that fish populations may survive, mitigating these effects calls for a combination of conservation initiatives, sustainable practices, and public awareness.

We must understand how the health of aquatic ecosystems and urban growth are intertwined. Diverse and wholesome fish populations must continue to exist, which calls for sustainable urbanization practices that consider the requirements of both human and environmental systems. We may work to build more sustainable and equable urban environments that are advantageous to both inhabitants and the natural world by addressing the issues brought on by urbanization and adopting proactive measures to safeguard fish biodiversity.

References

Aleixo, M. H. F., Florêncio, F. M., Lansac-Tôha, F. M., Quirino, B. A., & Fugi, R. (2023). Influence of species invasion, seasonality, and connectivity on fish functional and taxonomic beta-diversity in a Neotropical floodplain. *Biological Invasions*, 1-15.

Aqmal-Naser, M., Iguchi, K. i., & Ahmad, A. B. (2023). Spatial-temporal effects on fish diversity and assemblages in a highly modified environment. *Urban Ecosystems*, 1-13.

Bertora, A., Grosman, F., Sanzano, P., & Rosso, J. J. (2023). Impoverished fish assemblages of temperate Neotropical streams respond to environmental degradation and support a sensitive Index of Biotic Integrity. *Hydrobiologia*, 1-26.

Bohus, A., Gál, B., Barta, B., Szivák, I., Karadi-Kovacs, K., Boda, P., . . . Schmera, D. (2023). Effects of urbanization-induced local alterations on the diversity and assemblage structure of macroinvertebrates in low-order streams. *Hydrobiologia, 850*(4), 881-899.

Camara, E. M., de Andrade-Tubino, M. F., Franco, T. P., Neves, L. M., dos Santos, L. N., dos Santos, A. F. G. N., & Araújo, F. G. (2023). Temporal dimensions of taxonomic and functional fish beta diversity: scaling

environmental drivers in tropical transitional ecosystems. *Hydrobiologia, 850*(8), 1911-1940.
Chou, L. M., Ng, C. S. L., Toh, K. B., Tun, K., Cheo, P. R., & Ng, J. Y. (2023). Marinas can co-function as biodiversity sanctuaries. *Nourishing Tomorrow: Clean Engineering And Nature-friendly Living*, 179.
Côte, J., Jacquin, L., Veyssière, C., Manzi, S., Etienne, R., Perrault, A., . . . White, J. (2022). Changes in fish skin microbiota along gradients of eutrophication in human-altered rivers. *FEMS Microbiology Ecology, 98*(1), fiac006.
Dornelas, M., Chase, J. M., Gotelli, N. J., Magurran, A. E., McGill, B. J., Antão, L. H., . . . Martins, I. S. (2023). Looking back on biodiversity change: lessons for the road ahead. *Philosophical Transactions of the Royal Society B, 378*(1881), 20220199.
Gergana, T. T., Jaime, M. C., & Konstantinos, P. D. (2022). Aetiology and Therapeutic Options of Acute Subclavian Vein Thrombosis. *Vascular & Endovascular Review, 5*. doi:https://doi.org/10.15420/ver.2021.20
Itsukushima, R. (2023). Broad-Scale Environmental Factors Determining Fish Species Composition of River Estuaries in the Japanese Archipelago. *Estuaries and Coasts*, 1-15.
Larentis, C., Kotz Kliemann, B. C., Neves, M. P., & Delariva, R. L. (2022). Effects of human disturbance on habitat and fish diversity in Neotropical streams. *Plos one, 17*(9), e0274191.
Li, Y., Wang, J., Ju, P., Zhang, C., Liu, B., & Wang, Y. (2023). Different responses of taxonomic diversity and functional diversity to environmental changes: A case study of fish communities in the Zhoushan Fishing Ground, China.
Malacarne, T. J., Machado, N. R., & Moretto, Y. (2023). Influence of land use on the structure and functional diversity of aquatic insects in neotropical streams. *Hydrobiologia*, 1-16.
Mulinge, J. (2023). Effects of Environmental Change on Species Diversity. *International Journal of Biology, 3*(1), 43-53.
Nagelkerken, I., Allan, B. J., Booth, D. J., Donelson, J. M., Edgar, G. J., Ravasi, T., . . . Mellin, C. (2023). The effects of climate change on the ecology of fishes. *PLOS Climate, 2*(8), e0000258.
Paquette, C., Gregory-Eaves, I., & Beisner, B. E. (2022). Environmental drivers of taxonomic and functional variation in zooplankton diversity and composition in freshwater lakes across Canadian continental watersheds. *Limnology and Oceanography, 67*(5), 1081-1097.
Rocha Pompeu, C., Peñas, F. J., Belmar, O., & Barquín, J. (2023). Large-scale factors controlling biological communities in the Iberian Peninsula: an insight into global change effects on river ecosystems. *Aquatic Sciences, 85*(4), 1-17.
Rosso, J. J., Langerhans, R. B., & Avigliano, E. (2023). Fish as sentinels of urbanization impacts in aquatic ecosystems. *Frontiers in Environmental Science, 11*, 1190398.
Röthig, T., Trevathan-Tackett, S. M., Voolstra, C. R., Ross, C., Chaffron, S., Durack, P. J., . . . Sweet, M. (2023). Human-induced salinity changes impact marine organisms and ecosystems. *Global Change Biology*.
Stamenković, O., Stojković Piperac, M., Milošević, D., Čerba, D., Cvijanović, D., Gronau, A., . . . Buzhdygan, O. (2023). Multiple anthropogenic pressures and local environmental gradients in ponds governing the taxonomic and functional diversity of epiphytic macroinvertebrates. *Hydrobiologia*, 1-21.
Stoczynski, L., Scott, M. C., Bower, L., & Peoples, B. K. (2023). Effects of environment and metacommunity delineation on multiple dimensions of stream fish beta diversity. *Frontiers in Ecology and Evolution, 11*, 1077994.
Tong, S., Beggs, P. J., Davies, J. M., Jiang, F., Kinney, P. L., Liu, S., . . . Ebi, K. L. (2023). Compound impacts of climate change, urbanization and biodiversity loss on allergic disease. *International Journal of Epidemiology, 52*(3), 655-663.
Trovillion, D. C., Sauer, E. L., Shay, G., Crone, E. R., & Preston, D. L. (2023). Habitat complexity, connectivity, and introduced fish drive pond community structure along an urban to rural gradient. *Ecological Applications*, e2828.
Waldo, B., Moore, K., Bickley, S., Anderson, C. J., & Bernal, M. A. (2023). Salinity fluctuations due to urbanization of coastal environments and their potential effect on the genetic divergence of the Gulf killifish (Fundulus grandis). *Environmental Biology of Fishes*, 1-12.
Welsh, D. P., Ludlam, J. P., Downs, E. L., Gordon, E. S., Clark, E. V., Levy, B., . . . O'Connor, A. M. (2023). Stream fish community structure across an urban gradient in a northeastern US watershed. *Environmental Biology of Fishes*, 1-17.
Whitfield, A. K., Gillanders, B. M., & Able, K. W. (2024). Climate Change Effects on Fish Populations. In *Climate Change and Estuaries* (pp. 475-506): CRC Press.

Williams-Subiza, E. A., Brand, C., & Miserendino, M. L. (2022). Compositional shifts in freshwater macroinvertebrate communities over 30 years of urbanization. *Ecological Engineering, 183*, 106738.

Woods, T., Freeman, M. C., Krause, K. P., & Maloney, K. O. (2023). Observed and projected functional reorganization of riverine fish assemblages from global change. *Global Change Biology*.

Xiang, T., Dong, X., Ju, T., Shi, L., & Grenouillet, G. (2023). Anthropogenic activities and environmental filtering have reshaped freshwater fish biodiversity patterns in China over the past 120 years. *Journal of Environmental Management, 344*, 118374.

Yang, Y., Chen, H., Al, M. A., Ndayishimiye, J. C., Yang, J. R., Isabwe, A., . . . Yang, J. (2022). Urbanization reduces resource use efficiency of phytoplankton community by altering the environment and decreasing biodiversity. *journal of environmental sciences, 112*, 140-151.

Zhong, W., Zhang, J., Wang, Z., Lin, J., Huang, X., Liu, W., . . . Zhang, X. (2022). Holistic impact evaluation of human activities on the coastal fish biodiversity in the Chinese coastal environment. *Environmental Science & Technology, 56*(10), 6574-6583.