International Journal of Fauna and Biological Studies

Available online at www.faunajournal.com

International Journal of Fauna And Biological Studies

Ranjit Singh
Department of Botany,
DSN PG College, Unnao,
Uttar Pradesh, India

Ashok Kumar Verma
Department of Zoology,
HNB Govt. PG College, Naini-
Prayagraj, Uttar Pradesh, India

Sadguru Prakash
Department of Zoology,
MLK PG College, Balrampur,
Uttar Pradesh, India

The web of life: Role of pollution in biodiversity decline

Ranjit Singh, Ashok Kumar Verma and Sadguru Prakash

DOI: https://doi.org/10.22271/23940522.2023.v10.i3a.1003

Abstract
The mechanisms that sustain all life on Earth, including human existence, depend on a wide range of biodiversity. Human beings impact the planet's biodiversity in different ways, either unintentional or intentional. The biggest threat to biodiversity to date is anthropogenic, as the humans have tried to reshape the natural habitats in order to make way for farmland or to harvest natural resources. Loss of biodiversity appears to influence ecosystems as much as climate change, pollution and other major forms of environmental stress. A healthy and balanced ecosystem is maintained by a diverse range of flora, fauna and microbes. The present review article narrates the role of various pollution in biodiversity decline that ultimately influence the web of life.

Keywords: Pollution, biodiversity, ecosystems, conservation, anthropogenic activities, society

Introduction
The 'web of life' is a metaphor that beautifully encapsulates the intricate interconnections between living organisms and their environments. This delicate tapestry is highly susceptible to the impacts of pollution. Environmental pollution, particularly due to human activities, has become a cause of global concern, as the anthropogenic activities influence the biodiversity (Prakash and Verma, 2022) [22]. A pollutant is a substance that may be defined as constituents in the wrong amount at the wrong place or at the wrong time. Air, soil and water pollution can harm species by degrading their habitats, physically harming them, or increasing their vulnerability to diseases or predation. Some pollutants, such as pesticides and heavy metals, can be passed up the food chain, therefore contaminating many levels of the ecosystem.

Pollution, in its various forms threats on biodiversity. Biodiversity, representing the richness of life on Earth in all its forms, is essential for ecosystem stability, resilience, and human well-being (Ashok, 2016) [2]. The environmental pollution is considered as one of the most important universal challenge facing both developed and developing countries. Understanding the multifaceted ways in which pollution impacts biodiversity is crucial for devising effective conservation strategies and sustainable environmental management because sustainable development with environmental ethics is the need of today (Ashok, 2017) [3].

Continuous population growth, increased economic movements in addition to climate change; all participate in spoilage of natural resources, so threatening the biodiversity and the whole ecosystem as well. Only a small change in pattern of climate has severe impact on the biodiversity, altering the habitats of the species and presenting a threat for their survival, making them vulnerable to extinction (Prakash and Srivastava, 2019; Verma, 2021) [12, 23]. The maintenance of present-day biodiversity and ecological balance both are necessary for mutual survival of living beings including humans (Kumar, 2017; Verma, 2018) [8, 22]. The MEA (2005a) [10] announced that degradation of aquatic biodiversity in freshwater ecosystem is double in comparison to other ecosystems. One of the biggest difficulties of the twenty-first century may be resolving the environmental issues of pollution, water shortages, global warming, and biodiversity loss (Elisha and Felix, 2020) [4]. Therefore, their capability to present ecosystem services decreases causing negative impacts on human health. People depend on biodiversity in their daily lives, in ways that are not always apparent or appreciated. Human health ultimately depends upon ecosystem products and services, which are requisite for good human health and productive livelihoods (WHO, 2015) [27]. Biodiversity loss can have significant direct human health impacts if ecosystem services are no longer adequate to meet social needs.

Corresponding Author:
Sadguru Prakash
Department of Zoology,
MLK PG College, Balrampur,
Uttar Pradesh, India

Types of Pollution and their impact on Biodiversity

1. Habitat Destruction and Alteration

Pollution which is the addition of any substance or any form of energy to the environment at a rate faster than it can be dispersed, diluted, decomposed, recycled, or stored in some harmless form contributes to biodiversity loss by creating health problems in exposed organisms. In some cases, exposure may occur in doses high enough to kill outright or create reproductive problems that threaten the species survival. Pollution also affects biodiversity by causing habitat destruction and alteration. Habitat destruction is the primary cause of species endangerment (Prakash and Verma, 2016) [14] and extinction worldwide and currently ranked as a top reason. Anthropogenic destruction of habitats has accelerated greatly in the latter half of the twentieth century. Other important causes of habitat destruction include mining, logging, and urban sprawl.

Any thinning or destruction of an existing natural habitat reduces or eliminates the food resources and living space for most species. Species that cannot migrate are often wiped out. Natural habitats are often destroyed through human activity for the purpose of harvesting natural resources, urbanization, industrial development construction of highways and deforestation (Kumar and Verma, 2017) [7]. The conversion of natural habitats into agricultural land, urbanization and infrastructure or industrial development and irresponsible waste disposal practices leads to the destruction and fragmentation of habitats, which is the primary cause of biodiversity loss and have been proved harmful for public health (Verma and Prakash, 2020) [24].

Habitat loss is a process of environmental change in which a natural habitat is rendered functionally unable to support the species present. This process may be natural or unnatural, and may be caused by habitat fragmentation, geological processes, climate change, or human activities such as the introduction of invasive species or ecosystem nutrient depletion. In the process of habitat destruction, the organisms that previously used the site are displaced or destroyed, reducing genetic as well as overall biodiversity.

2. Water Pollution

Water pollution is a pervasive threat to aquatic biodiversity. Contamination of water bodies by the discharges of industrial effluents and agricultural runoff containing pollutants such as heavy metals, pesticides and fertilizers, nutrients and oil spills can have catastrophic effects on freshwater and marine ecosystems. Aquatic organisms face direct harm, and the contamination of water bodies disrupts food chains, ultimately affecting the biodiversity of these environments.

3. Air Pollution

Air pollution is a foremost crisis of recent decades, which has a great toxicological impact on climate change. Airborne pollutants including particulate matter, nitrogen oxides, and sulfur dioxide, originating from industrial processes, transportation, and other human activities, have far-reaching consequences on both terrestrial and aquatic ecosystems. Acid rain, a byproduct of air pollution, can alter soil and water chemistry, negatively impacting plants, microorganisms, and aquatic life. The subsequent imbalance in these ecosystems further accelerates the decline of biodiversity.

Another potentially serious threat is releasing of greenhouse gases. Green house effect has led to increase in migration of tree species towards high altitude. Climate change and global warming are a great concern of today as they affect the natural ecosystem. At higher altitudes and latitudes, alpine and boreal forests are expected to expand northwards and shift their tree lines upwards at the expanse of low stature tundra and alpine communities (Srivastava et al., 2019) [18].

According to FAO (2000) [5], due to these changes, about 9% of all known plant species are at the verge of extension. There are some however the benefit of air pollution for instance, appearance of many aphids is stimulated by air pollutants (Singh and Singh, 2019) [17]. Other species are resistant to them and expand to fill the space left by the disappearance of more sensitive kinds.

4. Chemical Pollution

The release of synthetic chemicals into the environment poses a significant threat to biodiversity. Pesticides and herbicides designed to control pests in agriculture can have detrimental effects on both targeted and non-targeted species and disrupting ecological interactions. Additionally, industrial chemicals can contaminate soil and water, decline the certain species, and disrupt food webs, ultimately leading to long-term ecological imbalances and biodiversity loss.

5. Noise Pollution

Noise pollution has the potential to affect the physiology, behaviour and reproduction of a range of animal taxa. Types of effects include changes in foraging and reproductive behaviours, reduction in animal fitness, increased risk of predation and reduced reproductive success (Maheshwari et al., 2020) [9].

6. Microplastic Pollution

Plastic pollution is a threat for the environment. The proliferation of plastics in the environment has given rise to a new form of pollution known as microplastics pollution. These small particles, often the result of the breakdown of larger plastic items, infiltrate ecosystems on land and in water. It affects human-beings and other living creatures (Verma and Prakash, 2022) [25]. One significant component in the dispersion of microplastics is sewage. Since sewage sludge is frequently used as fertilizer on fields, thousands of tons of microplastics wind up in our soils every year. Land becomes infertile due to the presence of these tiny microplastic particles and plants do not grow properly in this field. This may contribute to the problem of food crises.

Microplastics can enter food chains, posing a threat to various organisms and potentially causing harm to their health and reproductive success and leading to biodiversity loss. Any improper handling of the disposal of plastic garbage might have a negative effect on the environment. It is possible to eradicate the scourge known as plastic pollution if the mechanism for disposing of plastic trash is reliable and the discarded plastic is recycled sustainably.

7. Endocrine Disruption

Certain agricultural (pesticides and fertilizers) and pharmaceutical compounds along with industrial wastes that act as pollutants, are endocrine-disrupting chemicals (EDCs). These chemicals alter the function of the endocrine system and consequently cause adverse effects to humans. The release of particular EDCs into the environment has been shown to negatively affect certain wildlife populations (Kar et

al., 2021) [6]. The EDCs can lead to reproductive abnormalities, reduced fertility, and altered behavior, all of which can have profound implications for population dynamics affected species and the overall biodiversity of that area (Tanabe, 2002) [19]. Hence, the threat posed by EDCs cannot be overlooked as it can potentially harm fish-consuming fauna vis-`a-vis human health due to biomagnification.

8. Pesticides Pollution
Pesticides are used to kill the pests and insects which attack on crops and harm them (Prakash and Verma, 2014) [13]. Different kinds of pesticides have been used for crop protection for centuries. Pesticides benefit the crops; however, they also impose a serious negative impact on the environment. Pesticides have a major effect on biological diversity, alongside habitat loss and climate change. They can have short-term toxic effects on directly exposed organisms, and long-term effects can result from changes to habitats and the food chain. Excessive use of pesticides may lead to the destruction of biodiversity. Many birds, aquatic organisms and animals are under the threat of harmful pesticides for their survival (PRB, 2010) [16].

Synthetic pesticides have the ability to accumulate in the tissues of organisms. Through a process known as biomagnification, these pesticides become more concentrated as they move up the food chain. This phenomenon poses a threat to top predators, where high levels of contamination can result in adverse health effects and contribute to the decline of species at higher trophic levels.

In biomagnifications (a) small concentration of pollutants enters the bodies of animal that are in low level in the food chain *i.e.* primary consumer and (b) the secondary consumers eat primary consumers and therefore the concentration of pollutants will increase in their bodies. When the top consumer eats secondary consumers and other prey, the pollutants concentration eventually increases many folds in its body. Therefore, the higher the trophic level, the greater will be the pesticide concentration. This process disrupts the whole ecosystem as more species in higher trophic levels will die due to greater toxicity in their bodies. This will eventually increase the population of secondary consumers and decrease the population of primary consumers (Warsi, 2015) [26].

9. Invasive species
Invasive species may arrive in new areas through natural migration or through the human introduction. Native species are subjected to competition for food and space due to the introduction of invasive species. Anonymous (2007) [1] reported that changes in climate affects the normal life cycle of plant. The invasive species are threat to native species being more tolerant to climatic variations. When invasive species are at higher levels of the food chain, they can deplete populations of the prey they feed on. Variation in temperature and precipitation patterns can result in more frequent droughts and droughts and floods making indigenous plants more vulnerable to pests and diseases (Tibbetts, 2007) [20].

10. Genetic Pollution
The release of genetically modified organisms or the hybridization of closely related species can lead to the loss of genetic diversity, which is crucial for species' adaptability and resilience. The genetic diversity acts like buffer in biodiversity (Verma, 2017) [21].

11. Climate Change
Climate change refers to variations in the global climate or regional climate over a long time period. While not traditionally considered pollution, human-induced climate change is closely tied to the release of greenhouse gases, such as carbon dioxide. Climate change disrupts ecosystems by altering temperature and precipitation patterns, resulting changes in climate patterns disturbed the distribution and behavior of species. These changes, in turn, contribute to the decline of biodiversity, as species struggle to adapt to rapidly changing environmental conditions. The MEA (2005b) [11] predicts that a changing global climate change to be the principal threatens to the biological diversity and ecosystem (Anonymous, 2007) [1].

Conservation and Mitigation Strategies
1. Sustainable Resource Management
Implementing sustainable resource management practices is critical for mitigating pollution and preserving biodiversity. This includes responsible waste disposal, sustainable agriculture, and the adoption of cleaner industrial technologies. By minimizing the ecological footprint of human activities, it is possible to reduce the impact of pollution on natural habitats and ecosystems.

2. Conservation of Critical Habitats
Identifying and conserving critical habitats is essential for safeguarding biodiversity. Protected areas, wildlife reserves, and marine sanctuaries play a crucial role in providing safe havens for diverse species. Efforts to restore degraded habitats and create connectivity between fragmented landscapes contribute to the resilience of ecosystems facing the challenges posed by pollution.

3. International Cooperation
Given that pollution often transcends national borders, international cooperation is vital in addressing its global impacts on biodiversity. Collaborative efforts between countries, organizations, and communities can lead to the development of effective policies, regulations, and initiatives aimed at reducing pollution and promoting sustainable practices.

4. Pollution Prevention and Cleanup Technologies
Advancements in pollution prevention and cleanup technologies are useful for mitigating the impact of pollution on biodiversity. Innovations in wastewater treatment, air quality management, and the development of eco-friendly alternatives to harmful chemicals contribute to reducing the release of pollutants into the environment.

5. Public Awareness and Education
Raising public awareness and promoting environmental education are crucial components of any strategy to combat pollution and biodiversity decline. Informed and engaged citizens are more likely to support and participate in conservation efforts, leading to greater collective action in addressing the root causes of pollution.

Conclusion
The intricate web of life, woven by the threads of biodiversity, faces unprecedented challenges from the pervasive influence of pollution. The multifaceted impact on

habitat loss; balanced ecosystems demand an urgent and coordinated efforts to address the root causes and mitigate the consequences. Addressing the role of pollution in biodiversity decline requires concerted efforts in pollution control, sustainable resource management and global cooperation to mitigate the impact of human activities on the environment. Through sustainable practices, conservation initiatives and global cooperation, humanity can contribute to the restoration and preservation of the web of life, ensuring a harmonious coexistence with the diverse array of species that share our planet. It is the responsibility of each and every one to safeguard biodiversity for the benefit of present and future generations. Sustainable practices, conservation measures and the development of cleaner technologies are essential components of any strategy aimed at preserving biodiversity and the integrity of the web of life.

References

1. Anonymous. Biodiversity and Climate Change: Convention on Biological Diversity; c2007. www.biodiv.org.
2. Ashok KV. Biodiversity: Its different levels and values. International Journal on Environmental Sciences. 2016;7(2):143-145.
3. Ashok KV. Environmental Ethics: Need to Rethink. International Journal on Environmental Sciences. 2017;8(1):7-9.
4. Elisha OD, Felix MJ. The loss of biodiversity and ecosystems: a threat to the functioning of our planet, economy and human society. International Journal of Economics, Environmental Development and Society. 2020;1(1):30-44.
5. FAO. Wildlife in a changing climate. FAO Forestry Paper 176. Eds (Edgar Kaeslin, Ian Redmond, Nigel Dudley), FAO, Rome; c2012. p. 108.
6. Kar S, Sangem P, Anusha N, Senthilkumaran B. Endocrine disruptors in teleosts: Evaluating environmental risks and biomarkers. Aquaculture and Fisheries. 2021;6(1):1-26.
7. Ajay K, Verma AK. Biodiversity loss and its Ecological impact in India. International Journal on Biological Sciences. 2017;8(2):156-160.
8. Kumar AV. Necessity of Ecological Balance for Widespread Biodiversity. Indian Journal of Biology. 2017;4(2):158-160.
9. Maheshwari RK, Poonia R, Rathore MS, Kakodia AK, Kumar A, Sharma S. Clinical Manifestations and Protective Measures of Environmental Noise: An Overview. International Journal of Biological Innovations. 2020;2(1):36-41.
10. MEA. Millennium Ecosystem Assessment. Ecosystems and Human Well-being: Biodiversity Synthesis. World Resources Institute; c2005a.
11. MEA. Millennium Ecosystem Assessment. Living Beyond Our Means: Natural Assets and Human Well-being. Island Press; c2005b.
12. Prakash S, Srivastava S. Impact of Climate change on Biodiversity: An Overview. International Journal of Biological Innovations. 2019;1(2):60-65.
13. Prakash S, Verma AK. Effect of Organophosphorus pesticide (Chlorpyrifos) on the haematology of *Heteropneustes fossilis* (Bloch). International Journal of Fauna and Biological Studies. 2014;1(5):95-98.
14. Prakash S, Verma AK. Marital fidelity and congregation of Indian sarus crane, *Grus antigone antigone* in and around Alwara lake of district Kaushambi (Uttar Pradesh), India. International Journal of Biological Research. 2016;4(1):10-13.
15. Prakash S, Verma AK. Anthropogenic activities and Biodiversity threats. International Journal of Biological Innovations. 2022;4(1):94-103.
16. PRB. Pesticides reduce biodiversity (June, Pesticides News). 2010;88:4-7.
17. Singh R, Singh G. Species Diversity of Indian Aphids (Hemiptera: Aphididae). International Journal of Biological Innovations. 2019;1(1):23-29.
18. Srivastava S, Shukla SN, Singh P. Climate change and Biodiversity management: A review. International Journal on Environmental Sciences. 2019;10(2):71-75.
19. Tanabe S. Contamination and toxic effects of persistent endocrine disrupters in marine mammals and birds. Marine Pollution Bulletin. 2002;45(1-12):69-77.
20. Tibbetts J. Health effects of climate change. Environmental Health Perspectives. 2007;115:196-203.
21. Verma AK. Genetic diversity as Buffer in Biodiversity. Indian Journal of Biology. 2017;4(1):61-63.
22. Verma AK. Ecological Balance: An Indispensable Need for Human Survival. Journal of Experimental Zoology India. 2018;21(1):407-409.
23. Verma AK. Influence of climate change on balanced ecosystem, biodiversity and sustainable development: An overview. International Journal of Biological Innovations. 2021;3(2):331-337.
24. Verma AK, Prakash S. E-wastes and their impact on environment and public health. International Journal of Applied Research. 2020;6(9):164-168.
25. Verma AK, Prakash S. Microplastics as an emerging threat to the fresh water fishes: A review. International Journal of Biological Innovations. 2022;4(2):368-374.
26. Warsi F. How do pesticides affect ecosystems? In: Pesticides; 2015. Available from http://farhanwarsi.tripod.com/id9.html.
27. WHO. World Health Organization: Biodiversity and Health; 2015. https://www.who.int/news-room/fact-sheets/detail/biodiversity-and-health