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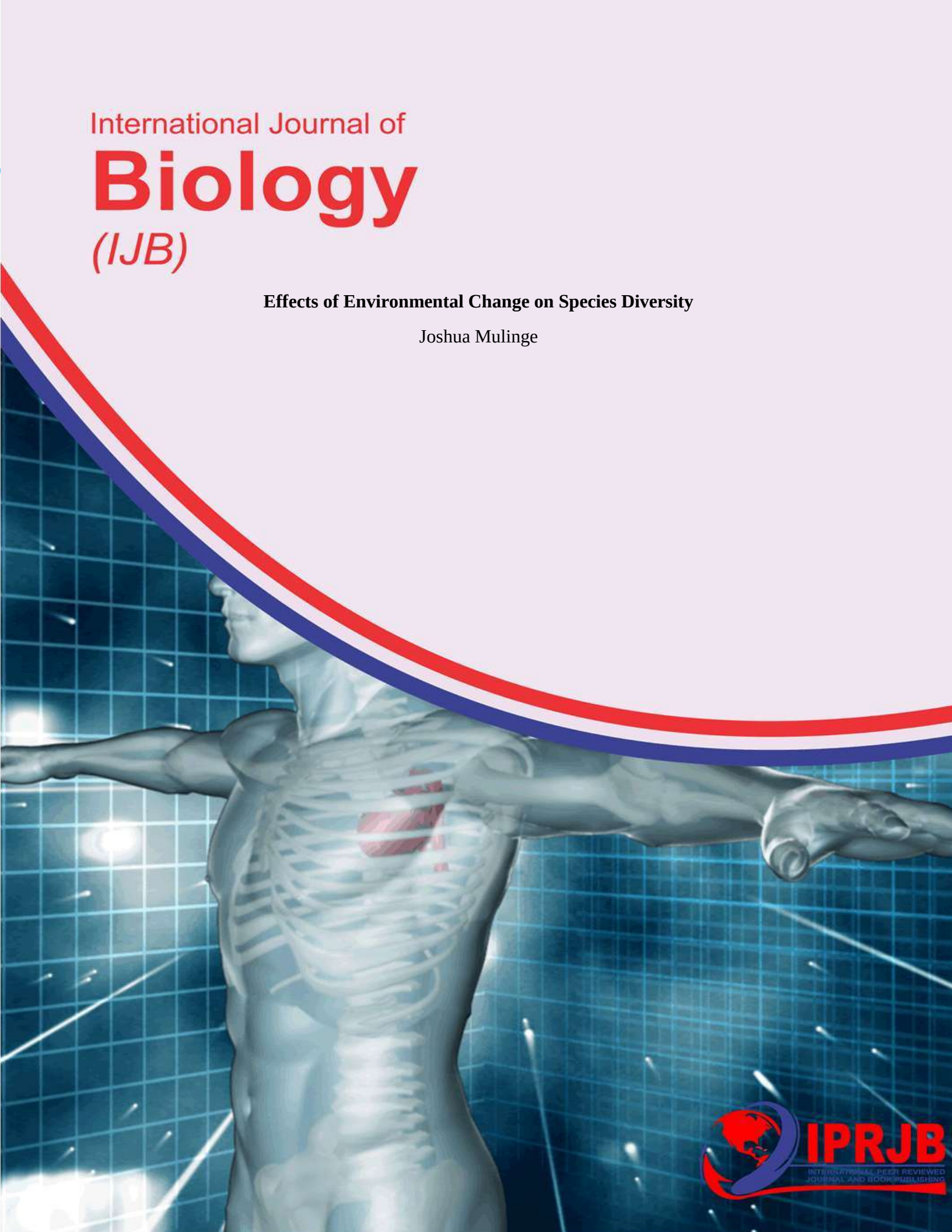

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Abstract

Purpose: The aim of the study is to assess the effects of environmental changes on species diversity

Methodology: This study adopted a desktop methodology. This study used secondary data from which include review of existing literature from already published studies and reports that was easily accessed through online journals and libraries

Findings: The study found that environmental changes, such as deforestation, habitat fragmentation, and urbanization, lead to a decline in species diversity. Climate change has emerged as a critical driver of changes in species diversity. Rising temperatures, altered precipitation patterns, and sea-level rise have caused shifts in species distributions, changes in community composition, and reductions in species richness. Pollution including water and air pollution, has detrimental effects on species diversity especially in aquatic ecosystems.

Unique Contribution to Theory, Practice and Policy: The study was anchored on the theory of island biogeography which was propounded by Robert MacArthur and E. O. Wilson and niche theory which was originally proposed by G.E. Hutchinson. The study recommended that conservation efforts should prioritize habitat preservation and restoration. Protecting and restoring natural habitats is crucial for maintaining species diversity. Conservation practices should focus on minimizing habitat loss, creating ecological corridors, and rehabilitating degraded habitats. Environmental policies and regulations should be designed to mitigate the drivers of environmental change and promote sustainable practices.

Keywords: *Environmental Changes, Species, Diversity*

INTRODUCTION

Species diversity refers to the variety of different species present in a particular ecosystem or geographic region. Developed economies like the USA, Japan, and the UK have experienced significant impacts on their species diversity due to urbanization, habitat destruction, pollution, and climate change. According to a study by Smith (2017), the USA has witnessed a decline in species diversity, particularly in habitats such as forests and wetlands. For instance, the loss of native plant species in the United States has been estimated to be around 4,600 species over the past century. Another example can be seen in Japan, where intensive industrialization and urban development have led to the degradation of natural habitats. A study by Nakano (2016) found that several freshwater fish species in Japan have become endangered or extinct due to habitat loss and water pollution, resulting in a decline in species diversity in rivers and lakes.

In the United States, habitat loss and fragmentation have been major drivers of declining species diversity. The conversion of natural landscapes into agricultural fields, urban areas, and infrastructure development has resulted in the loss of crucial habitats for many species. According to a study by Leidner and Haddad (2011), over 50% of the original wetland areas in the contiguous United States have been lost, leading to a decline in wetland-dependent species diversity. Another contributing factor is pollution, particularly in aquatic ecosystems. Industrial and agricultural pollutants, as well as chemical contaminants, have affected water quality and harmed aquatic organisms, leading to reduced species diversity in rivers, lakes, and coastal areas.

Similarly, in the United Kingdom, habitat loss and degradation have impacted species diversity. The intensification of agriculture, urbanization, and land-use changes have resulted in the fragmentation and degradation of natural habitats. A study by Oliver (2015) highlighted that the UK has experienced declines in species diversity across various taxonomic groups, including birds, butterflies, and bees. The loss of hedgerows, woodlands, and wetlands has particularly affected species that rely on these habitats. Climate change also poses a significant threat to species diversity in the UK, as changes in temperature and precipitation patterns can disrupt ecosystems and affect the distribution and abundance of species.

In developing economies, similar trends of declining species diversity can be observed. For example, in Brazil, one of the world's most biodiverse countries, deforestation rates have soared in recent years. This has resulted in the loss of numerous plant and animal species, including those found in the Amazon rainforest. A study by Da Silva (2018) highlights that deforestation and land-use changes have led to significant declines in species diversity in the Brazilian Amazon. In India, rapid industrialization and urban expansion have also contributed to the loss of species diversity. A study by Ali (2019) reports that habitat destruction and pollution have resulted in the decline of several species, particularly in freshwater ecosystems and forests. The loss of species diversity in these developing economies not only affects ecological balance but also has significant socioeconomic implications.

In developing economies like Brazil, India, and Indonesia, rapid population growth, agricultural expansion, and deforestation have significantly impacted species diversity. Brazil, as home to the Amazon rainforest, faces substantial challenges in preserving its rich biodiversity. The expansion of agricultural frontiers, primarily for soybean cultivation and cattle ranching, has resulted in widespread deforestation, leading to habitat loss and species extinctions. A study by Laurance

(2014) highlights that deforestation rates in the Brazilian Amazon have a strong negative impact on bird and mammal species richness, reducing overall species diversity.

In India, habitat destruction and land-use changes have led to the decline of several species. Forest ecosystems, in particular, have faced severe degradation due to logging, agricultural encroachment, and infrastructure development. The loss of forest cover has negatively affected species such as tigers, elephants, and endemic bird species. A study by Roy (2019) emphasizes the need for conservation efforts to mitigate the impacts of habitat loss and protect India's diverse range of species.

In Indonesia, deforestation driven by palm oil plantations and timber extraction has resulted in a significant loss of species diversity, particularly in tropical rainforests. The conversion of natural habitats into monoculture plantations has fragmented landscapes, isolating species populations and reducing gene flow. A study by Meijaard (2018) indicates that habitat loss and fragmentation have led to the decline of various endangered species in Indonesia, including orangutans and Sumatran tigers.

In sub-Saharan economies, species diversity is also under threat. In countries like Kenya, Tanzania, and South Africa, the expansion of agriculture, illegal wildlife trade, and climate change have had detrimental effects on biodiversity. For instance, in Kenya, the population of certain iconic species such as elephants and rhinos has significantly declined due to poaching and habitat loss. A study by Njumbi (2016) reveals that the decline in species diversity in Kenya's national parks and reserves is a result of various factors, including illegal hunting and land-use changes. Similarly, in South Africa, habitat destruction and poaching have led to a decline in species diversity, particularly among endangered species like the African lion and African elephant. These trends highlight the urgent need for conservation efforts and sustainable development practices in sub-Saharan economies to protect and restore species diversity.

Sub-Saharan Africa is known for its rich biodiversity, but the region faces numerous challenges that impact species diversity. Habitat loss and degradation due to expanding agriculture, deforestation, and infrastructure development are major threats. In countries like Kenya, Tanzania, and South Africa, the conversion of natural habitats into agricultural land, including large-scale commercial farming and livestock grazing, has resulted in the loss of critical ecosystems. This has led to a decline in species diversity, particularly for species with specialized habitat requirements. A study by Newmark (2015) highlights that protected areas in sub-Saharan Africa face immense pressure from human activities, contributing to the reduction in species diversity.

Illegal wildlife trade is another significant threat to species diversity in sub-Saharan Africa. The poaching of iconic species such as elephants and rhinos for their ivory and horns has had devastating effects on their populations. This not only affects the targeted species but also disrupts ecological interactions and can lead to cascading impacts on other species within the ecosystem. A study by Di Minin (2015) emphasizes the urgent need for increased law enforcement and conservation measures to combat wildlife poaching and protect species diversity in sub-Saharan Africa.

Climate change is an emerging challenge that further exacerbates the threats to species diversity in sub-Saharan economies. Rising temperatures, changing rainfall patterns, and extreme weather

events can disrupt ecosystems, alter species' habitats, and impact their survival and reproductive success. A study by Midgley (2019) suggests that climate change will likely have profound consequences for biodiversity in sub-Saharan Africa, particularly for species already facing habitat loss and fragmentation.

Environmental change refers to alterations in natural systems and processes caused by human activities or natural forces. These changes can have significant impacts on species diversity, leading to shifts in ecological communities and the potential loss of biodiversity. One effect of environmental change is habitat loss and fragmentation. As natural habitats are converted for agriculture, urbanization, or resource extraction, species lose their suitable habitats, resulting in reduced species diversity. For example, deforestation in the Amazon rainforest has led to the fragmentation of habitats, isolating species populations and reducing species richness (Laurance, 2014).

Pollution, including air, water, and soil pollution, can have detrimental effects on species diversity. Pollution reduces the quality of habitats, compromises food sources, and can lead to direct toxicity to organisms. For instance, water pollution from industrial and agricultural activities harms aquatic ecosystems, leading to declines in fish populations and other aquatic organisms. A study by Beck, (2016) found that pollution negatively impacts species diversity in freshwater ecosystems, resulting in changes to community structure and the loss of sensitive species.

Lastly, human activities such as overexploitation, invasive species introduction, and habitat degradation contribute to the decline of species diversity. Overexploitation of species, such as illegal hunting and fishing, can deplete populations and disrupt ecological balances. Invasive species can outcompete native species for resources, leading to declines or extirpation of native species. A study by Simberloff, (2013) highlights that invasive species pose one of the greatest threats to biodiversity worldwide.

Finally, environmental change can contribute to the spread of invasive species. As ecosystems are disrupted and habitats are modified, invasive species may find favorable conditions to establish and thrive, outcompeting native species. Invasive species can reduce native species diversity by preying upon or outcompeting native species for resources. For instance, the introduction of non-native plant species in an ecosystem can lead to the displacement of native plants and subsequent changes in the composition and diversity of species within that ecosystem (Vilà, 2011).

Statement of the Problem

The ongoing environmental changes driven by human activities and natural forces pose a significant threat to species diversity worldwide (IPBES, 2019). As habitats are lost and fragmented, environmental conditions are altered, pollution increases, and invasive species spread, the delicate balance of ecological communities is disrupted, leading to the potential loss of species and reduced overall biodiversity. Understanding the specific effects of environmental changes on species diversity is crucial for developing effective conservation strategies and mitigating further biodiversity decline.

Theoretical Review

The Theory of Island Biogeography

The Theory of Island Biogeography, originated by Robert MacArthur and E. O. Wilson in the 1960s, suggests that species diversity on an island is determined by two main factors: immigration and extinction rates. According to this theory, larger islands have a higher immigration rate because they present a larger target for colonization by species. Conversely, smaller islands have higher extinction rates due to factors such as limited resources and increased competition. This theory is relevant to the topic of the effect of environmental changes on species diversity as it provides insights into how changes in habitat size and isolation can impact species richness and composition. For instance, deforestation or fragmentation of habitats can reduce the size and connectivity of islands, leading to increased extinction rates and decreased species diversity (Lomolino, 2017).

The Niche Theory

The Niche Theory, originally proposed by G.E. Hutchinson in 1957, examines the relationship between species diversity and ecological niches. The theory suggests that species diversity is influenced by the availability and partitioning of resources within an ecosystem. Each species occupies a unique ecological niche, defined by its specific requirements and interactions with the environment and other species. The theory posits that increased species diversity can be achieved through niche differentiation, where species evolve distinct ecological roles to reduce competition and coexist.

The Niche Theory is highly relevant to understanding the effect of environmental changes on species diversity. Environmental changes can alter resource availability, disrupt interactions between species, and modify the structure of ecological niches. Investigating how environmental changes affect niche dynamics and species interactions can provide insights into changes in species diversity. For example, a study on freshwater fish communities found that environmental changes, such as habitat degradation and pollution, led to increased niche overlap and reduced species diversity (Mason, 2012). This study highlights the importance of the niche theory in understanding the consequences of environmental changes on species diversity.

Empirical Review

Newbold (2016) investigated the impact of deforestation on bird species diversity in tropical rainforests. The researchers conducted field surveys in deforested and intact rainforest areas, collecting data on bird species richness and abundance. They compared these measures between the two habitat types. The study revealed a significant decline in bird species diversity in deforested areas compared to intact rainforests. Species richness was reduced by 40%, and several specialized bird species were completely lost. The findings emphasize the importance of halting deforestation and implementing conservation measures to preserve bird diversity in tropical rainforests.

Hughes (2017) explored the impact of climate change on coral reef diversity and community structure. The researchers collected long-term monitoring data from multiple coral reef sites worldwide. They analyzed changes in species composition, abundance, and coral cover over several decades, correlating these changes with climate variables. The study demonstrated a

decline in coral diversity and a shift in community structure, with a decrease in coral species that are sensitive to rising sea temperatures. Coral cover also declined significantly, affecting the overall health and resilience of coral reef ecosystems. The findings highlight the urgent need for mitigating climate change and implementing conservation strategies to protect vulnerable coral reef ecosystems.

Liess(2015) assessed the impact of pollution on aquatic invertebrate diversity in freshwater ecosystems. The researchers conducted a series of field surveys in polluted and unpolluted freshwater systems, sampling benthic invertebrates and measuring various water quality parameters. They compared species richness, abundance, and community composition between the two types of habitats. The study revealed a significant reduction in species diversity and altered community structure in polluted freshwater ecosystems. Pollution was associated with decreased invertebrate abundance and the loss of pollution-sensitive species. The findings emphasized the importance of reducing pollution inputs into freshwater systems and implementing effective water quality management practices to safeguard aquatic invertebrate diversity.

Azevedo-Santos (2016) investigated the impact of urbanization on plant diversity in urban ecosystems. The researchers conducted vegetation surveys in urban and non-urban areas, collecting data on plant species richness and composition. They also examined the influence of urbanization-related factors, such as impervious surface cover and habitat fragmentation, on plant diversity. The study demonstrated a decline in plant species richness and changes in community composition in urban areas. Increased impervious surface cover and habitat fragmentation were strongly associated with reduced plant diversity. The findings underscore the need for urban planning that incorporates green spaces, preserves natural habitats, and minimizes the negative impacts of urbanization on plant diversity.

Tscharntke (2012) assessed the impact of agricultural intensification on insect diversity in agricultural landscapes. The researchers conducted surveys in intensively cultivated fields and adjacent semi-natural habitats, collecting data on insect species richness and abundance. They also examined the influence of landscape factors, such as habitat fragmentation and pesticide use, on insect diversity. The study revealed a significant decline in insect diversity in intensively cultivated fields compared to semi-natural habitats. Pesticide use and landscape simplification were identified as major drivers of the observed decline. The findings highlight the importance of adopting sustainable agricultural practices that minimize pesticide use, preserve natural habitats within agricultural landscapes, and promote biodiversity-friendly farming methods.

Kirwan (2011) investigated the impact of sea-level rise on coastal wetland bird diversity. The researchers conducted surveys in coastal wetlands along a gradient of sea-level rise, documenting bird species richness and abundance. They also assessed changes in wetland vegetation and analyzed the relationship between vegetation dynamics and bird diversity. The study revealed a decline in bird species diversity with increasing sea-level rise. Changes in wetland vegetation structure and loss of suitable foraging and nesting areas were identified as key factors influencing bird diversity. The findings emphasize the need for coastal management strategies that consider sea-level rise impacts on wetland habitats and prioritize the conservation of key bird species and their habitats.

Steinbauer (2018) investigated the impact of climate change on alpine plant diversity and community composition. The researchers conducted vegetation surveys in alpine regions across different elevational gradients, collecting data on plant species richness, abundance, and composition. They analyzed changes in these parameters over time and correlated them with climate variables such as temperature and precipitation. The study revealed significant shifts in alpine plant diversity and community composition in response to climate change. Species richness decreased at lower elevations, while new species colonized higher elevations. Alpine plant communities underwent compositional changes as temperature increased, resulting in potential range shifts and alterations in ecosystem functioning. The findings highlight the need for adaptive management strategies that consider the dynamic nature of alpine ecosystems under climate change, including the establishment of protected areas, assisted migration of vulnerable species, and targeted conservation efforts.

Batáry (2015) assessed the impact of land-use change on bird diversity in agricultural landscapes. The researchers conducted bird surveys in agricultural areas undergoing different land-use changes, including conversion from natural habitats to croplands or intensified agricultural practices. They collected data on bird species richness, abundance, and community composition using standardized survey methods. The study demonstrated a decline in bird diversity associated with land-use change in agricultural landscapes. Conversion of natural habitats to croplands or intensified agricultural practices resulted in reduced species richness and shifts in bird community composition. Certain bird species, especially those dependent on specific habitats or resources, were particularly vulnerable to these changes. The findings emphasize the importance of promoting sustainable land-use practices, such as agroforestry, organic farming, and habitat restoration, to mitigate the negative effects of land-use change on bird diversity in agricultural landscapes.

METHODOLOGY

This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low cost advantage as compared to a field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

RESULTS

The results were analyzed into various research gap categories, that is, contextual and methodological gaps.

Contextual and Methodological Gaps

Newbold (2016); Hughes (2017); Azevedo-Santos (2016) and Batáry (2015) posit a conceptual gap as none of these studies addresses the effect of environmental change on species diversity. Liess (2015); Kirwan (2011); Steinbauer (2018) and Tscharntke (2012) present a methodological gap as these studies adopted surveys while the current study adopted data from existing resources.

CONCLUSIONS AND RECOMMENDATIONS

Conclusion

Environmental changes, such as deforestation, habitat fragmentation, and urbanization, lead to a decline in species diversity. Fragmented habitats tend to support fewer species due to reduced colonization rates and increased extinction risks. Similarly, urbanization and land-use change result in habitat loss and degradation, leading to species declines and alterations in community structure.

Climate change has emerged as a critical driver of changes in species diversity. Rising temperatures, altered precipitation patterns, and sea-level rise have caused shifts in species distributions, changes in community composition, and reductions in species richness. Climate-driven impacts on sensitive ecosystems like coral reefs, alpine regions, and coastal areas are particularly pronounced, highlighting the vulnerability of these ecosystems to environmental changes. Pollution, including water and air pollution, has detrimental effects on species diversity, especially in aquatic ecosystems. Increased nutrient levels, chemical contaminants, and habitat degradation associated with pollution lead to declines in species richness, altered community dynamics, and the loss of pollution-sensitive species.

To mitigate the negative effects of environmental changes on species diversity, conservation and management efforts must prioritize the protection and restoration of habitats, implementation of sustainable land-use practices, reduction of pollution inputs, and the development of adaptive strategies to address climate change impacts. It is crucial to establish protected areas, promote ecosystem connectivity, and prioritize the conservation of key habitats and species. Additionally, interdisciplinary collaborations and long-term monitoring programs are necessary to monitor changes in species diversity, understand underlying mechanisms, and inform effective conservation strategies.

Recommendations

Effects of environmental change on species diversity have significant implications for theory, practice, and policy. Based on the understanding of these effects, the following recommendations can be made:

Theory

Enhancing and refining ecological theories such as Island Biogeography Theory, Environmental Filtering Theory, and Species-area Relationship Theory can contribute to a deeper understanding of how environmental changes impact species diversity. Research should focus on validating and expanding these theories in the context of changing environmental conditions. This can help refine our theoretical frameworks and provide insights into the underlying mechanisms driving changes in species diversity.

Practice

Conservation efforts should prioritize habitat preservation and restoration. Protecting and restoring natural habitats is crucial for maintaining species diversity. Conservation practices should focus on minimizing habitat loss, creating ecological corridors, and rehabilitating degraded habitats. Additionally, implementing sustainable land-use practices, such as promoting agroecology and

responsible forestry, can help mitigate the negative impacts of environmental changes on species diversity.

Policy

Environmental policies and regulations should be designed to mitigate the drivers of environmental change and promote sustainable practices. This includes policies aimed at reducing deforestation, land-use conversion, and pollution. Strengthening protected area networks and establishing new protected areas can help safeguard critical habitats and promote species diversity. Incorporating scientific research and monitoring into policy-making processes is essential for informed decision-making and effective conservation strategies.

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