

The Impact of Excessive Species Density in An Area on The Local Ecology

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Abstract. “Biodiversity overabundance” is a term used to describe a situation where species densities (the number of species in a given area) have become unsustainable and localized species densities have exceeded the carrying capacity of the ecosystem as a whole. As urbanization compresses wildlife habitats, excessive species density can lead to ecological imbalances, including competitive exclusion and declines in less competitive species. This study explores the impacts of high species density on biodiversity, resource competition, and human-wildlife interactions in Malaysia. The findings highlight intensified resource competition, increased disease transmission, and heightened human-wildlife conflicts, particularly in urban areas. Notable examples include the rise of zoonotic diseases linked to dense wildlife populations. To address these challenges, effective management strategies are proposed, including restoring predator-prey dynamics, implementing population control measures, and integrating urban planning with environmental protection. By balancing species density and fostering coexistence between humans and wildlife, Malaysia can promote sustainable biodiversity management and enhance ecosystem health. The study emphasizes the need for ongoing research and collaboration among stakeholders to mitigate the adverse effects of excessive species density and ensure long-term ecological stability.

Keywords: Urban ecology, Biodiversity, Ecological balance.

1. Introduction

In ecology, biodiversity refers to the variety of life forms within a specific ecosystem, encompassing species diversity, genetic diversity, and ecosystem diversity. However, the term “overabundance of biodiversity” is used to describe a situation where the species density (the number of species within a specific area) becomes unsustainable, and the local species density has exceeded the carrying capacity of the entire ecosystem[1]. This often leads to ecological imbalance. For example, Malaysia, a tropical country rich in biodiversity, attracts numerous nature enthusiasts who can witness a high density of wildlife even within urban areas. This is because urbanization has significantly compressed the habitat of wildlife, leading to an over-concentration of species in a limited space. Although Malaysia’s lush tropical rainforests are teeming with life, they sometimes face issues related to excessive species density, which can lead to intense competition for resources, disruption of ecological balance, and other problems[2].

There have been relatively few direct studies on excessive species density in previous literature, with most studies focusing on specific island ecosystems that experience excessive competition and high species density in a relatively closed ecological environment. In a research report on island animal populations, it was proposed that when overdevelopment and/or interference are the main characteristics of competitive systems, the total number of individuals in the competitor's guild may be lower than in cases where interference or resource collection is not as strong. The overall guild density of some islands is much higher than similar situations on continents or species-rich islands[3]. It is worth mentioning that although it is an area far away from human activities, humans still have a certain degree of impact on the ecosystems of islands. In addition, surveys on the flora and fauna communities in South Africa have shown that the density of local organisms has a certain degree of impact on the behavioral patterns of migratory animals[4]. However, in general, the research on bio-density related to ecosystems closely related to cities is relatively lacking, and most of them are case



studies of some special situations. However, with the development of the economy and society, the connection between cities and nature is gradually strengthening. It is necessary to discuss the analysis and countermeasures of local ecological changes caused by urbanization. Maintaining a balanced biodiversity is crucial, as ecosystems rely on a delicate equilibrium to function properly. Each species plays a specific role, contributing to processes such as nutrient cycling, pollination, and habitat structure. Disruption of this balance can lead to cascading effects that impact the health and functionality of ecosystems[1]. This document aims to explore the impacts of high species density on ecosystems using Malaysia as a case study. It will examine how high species density affects biodiversity, resource competition, and the relationship between humans and wildlife. By analyzing these aspects, the document will delve into the broader impacts of excessive species density and discuss current strategies for managing and mitigating these effects.

2. The Impact of High Species Density on Biodiversity

2.1. Competitive Exclusion

If two species have identical ecological niches—meaning they have the same requirements for resources—one species will outcompete the other, leading to its extinction or local elimination. This principle highlights the importance of resource partitioning and niche differentiation in maintaining biodiversity. High species density can lead to competitive exclusion, where dominant species outcompete other species [5]. For example, in the rainforests of Malaysia, dense populations of certain species like the long-tailed macaque may overshadow less competitive species. As a generalist species, they have a wide range of dietary habits that provide a good advantage for competition. But due to the impact of urbanization, the shrinking habitat of long-tailed macaques has led to their oppression of other species of the same trophic level [6]. As a result, dominant species may monopolize resources, putting other species at a disadvantage and potentially leading to their decline.

2.2. Decline or Extinction of Less Competitive Species

Species that cannot effectively compete with dominant species face a higher risk of decline or extinction. In Malaysia, there has been a noticeable decrease in certain birds and insects that are smaller or less competitive. As the number and territory of dominant species expand, these less competitive species struggle to find adequate resources and suitable habitats, leading to population decline or even extinction[1,7].

2.3. Increased Disease Transmission

In ecosystems with high species density, increased disease transmission is a significant concern. When populations are dense, the likelihood of pathogen spread among individuals rises sharply. This is particularly evident in densely populated ecosystems, such as tropical rainforests or urban environments, where various species coexist in close proximity. High species density means that individuals frequently come into contact with one another, which enhances the transmission of pathogens. For example, respiratory diseases can easily spread among animals located near one another, as observed during outbreaks of avian influenza in certain bird species.

Moreover, dense populations often include not only the target species but also potential reservoirs of pathogens. In the case of primates in Malaysia, interactions with domestic animals and humans can lead to cross-species transmission of diseases, compounding the risk of outbreaks. For instance, certain primates may carry zoonotic diseases that can infect humans or livestock, posing significant public health risks[8]. In Malaysia, dense populations of certain primates, such as macaques, have been associated with increased transmission rates of diseases like malaria and leptospirosis. These primates frequently share habitats with other wildlife and even human populations, creating a complex web of interactions that facilitate disease spread. Furthermore, high-density environments can destabilize ecological interactions. When a disease sweeps through a densely populated species, it can lead to sudden declines in population, which may disrupt the food web and ecological balance.

This disruption can result in unforeseen consequences, such as the overpopulation of another species due to the decline of a predator or competitor[9].

3. The Impact of High Species Density on Resource Competition and Pressure

3.1. Intensified Resource Competition

With high species density, competition for basic resources such as food, water, and space intensifies. In Malaysia's tropical rainforests, this competition can lead to resource overexploitation, which not only affects the competing species but also impacts the overall health of the ecosystem. Plants may suffer from overgrazing, and animal species may face shortages of food and suitable habitats. In the wild, the Malay bear has a home range of 8 kilometers and typically does not encounter others[10]. However, due to habitat compression from urbanization, the Malay bears at the Sabah Bear Conservation Centre have highly overlapping territories, leading to numerous unnecessary casualties.

3.2. Impact on Habitat

High species density can lead to severe habitat degradation. For instance, excessive grazing by large populations of herbivores can result in soil erosion and destruction of plant communities[11]. In Malaysia, this phenomenon can be observed in areas where numerous herbivorous species have caused significant changes in vegetation and soil quality. For example, in Malaysia, an over-pows population of some large herbivores, such as Asian elephants, has led to habitat degradation, affecting smaller, less adaptable species. The decrease in species such as Borneo dwarf elephants can be attributed to the competition and habitat loss caused by the high density of dominant herbivores.

3.3. Behavioral Changes in Species

Behavioral Changes in Species Due to High Density and Competition The pressures of reduced habitat and intensified competition can lead to significant behavioral changes in species. In densely populated environments, animals often adapt their behaviors to cope with increased competition for resources such as food, space, and mates. This adaptability is critical for survival, but it can also have profound implications for species dynamics, reproductive success, and overall ecosystem health[12].

One common behavioral adaptation is the alteration of feeding patterns. For instance, in high-density populations, animals may switch to less preferred food sources or modify their foraging strategies to reduce competition. In Malaysia, studies have shown that certain primate species, such as macaques, have adapted their diets in urban areas, incorporating human food sources due to the scarcity of their natural diet. This shift can lead to nutritional deficiencies and increased conflicts with humans, highlighting the complex interplay between behavioral changes and environmental pressures. These behavioral shifts can have cascading effects on population dynamics and community structure, potentially leading to declines in local populations if reproductive success diminishes. In species that exhibit social structures, such as wolves or elephants, high competition can lead to changes in group dynamics. Individuals may become more aggressive or competitive, which can affect social hierarchies and mating opportunities. In Malaysian wildlife, for example, the behavior of long-tailed macaques has been observed to change in response to increased competition for resources, leading to more aggressive interactions among individuals and altered group compositions [12,13]. Behavioral changes in response to competition can have significant effects on reproductive outcomes. For instance, altered nesting behaviors may result in lower survival rates for young, which can further exacerbate population declines in already stressed species. Behavioral adaptations can also impact interspecies interactions. For example, altered foraging behavior in one species can reduce resource availability for others, potentially leading to competitive exclusion. This can disrupt local ecosystems, resulting in shifts in species composition and community dynamics.

4. The Impact of High Species Density on Human-Wildlife Relations

4.1. Increased Conflict

As species density becomes excessive, the frequency of encounters between wildlife and local residents increases, potentially escalating conflicts. In urban areas of Malaysia, such as Kuala Lumpur, growing wildlife populations are encroaching on human habitats, leading to resource and space conflicts. For instance, monkeys and other animals may raid crops, causing economic losses for local farmers and exacerbating human-wildlife conflicts. At the same time, high-density crops such as rodents or insects destroy species and compete with human agricultural needs, resulting in economic losses and ecological imbalances. In the Kinabatangan River of Sabah, the development of tourism has led to many camps being built along the riverbanks, overlapping significantly with the migration routes of Asian elephants, intensifying human-elephant conflicts.

4.2. Increased Risk of Zoonotic Diseases

High species density not only leads to conflicts with humans but also raises the risk of zoonotic diseases—diseases that can be transmitted from animals to humans. In Malaysia, the dense populations of wildlife, particularly in and around urban areas, have been associated with increased incidences of zoonotic diseases. One notable example is the Nipah virus outbreak, which has been linked to fruit bats in Malaysia. High densities of these bats, particularly in areas where they come into close contact with human populations, have facilitated the transmission of the virus. Nipah virus, which can cause severe respiratory and neurological symptoms in humans, has led to outbreaks in Malaysia, highlighting the public health risks associated with high wildlife densities[9]. Another example is leptospirosis, a bacterial infection that can be transmitted through contact with water contaminated by animal urine. In Malaysia, the high density of rodents, which are common carriers of leptospirosis, poses a significant risk to human health. Urban and agricultural areas with high rodent populations are particularly vulnerable to outbreaks of this disease. Additionally, the Hantavirus, carried by rodents, has also been reported in Malaysia. The increased density of these rodent populations in urban and peri-urban areas has been linked to cases of Hantavirus pulmonary syndrome, a serious respiratory illness. To mitigate these risks, it is essential to implement effective management strategies for wildlife populations and reduce human-wildlife interactions. This includes measures such as improving waste management to reduce food sources for wildlife, enhancing surveillance and monitoring of zoonotic diseases, and promoting public awareness about the risks of wildlife-related diseases[8,9].

5. Current Government Strategies

5.1. Restoring Predator-Prey Dynamics

Integrating urban development with environmental protection is critical for maintaining ecological balance and mitigating the impacts of high species density. Coordinated management involves planning and implementing strategies that accommodate both human needs and wildlife conservation. One approach is to incorporate wildlife corridors into urban planning. These corridors provide safe passageways for animals to move between fragmented habitats, reducing the risk of human-wildlife conflicts and promoting ecological connectivity. In Malaysia, creating and maintaining green spaces and corridors in urban areas can help mitigate the effects of habitat loss and facilitate wildlife movement[14]. Additionally, urban planning should consider the impact of development on local wildlife populations and their habitats. Implementing measures such as minimizing habitat destruction, preserving natural areas, and promoting sustainable land use practices can help protect biodiversity and reduce the pressures of excessive species density. For example, preserving mangrove forests and peatlands in coastal areas can support a diverse range of species while providing ecosystem services such as flood protection and carbon sequestration.

5.2. Population Control Measures

Population control measures are crucial for managing species density and preventing ecological imbalances. Adopt strategies such as extermination and wildlife contraception to manage the population sustainably. Extermination includes the selective removal of individuals from the population to reduce density and reduce the effects of habitat degradation and resource depletion. In Malaysia, the slaughter has been used to manage wild boars and other species that cause damage to crops and natural habitats. However, slaughter must be managed carefully to avoid disrupting the ecological balance or causing unexpected consequences, such as an increase in the reproduction rate of remaining individuals. Wildlife contraception is another humane method to control the density of species. Contraceptive plans can help manage population growth without killing. For example, contraceptive vaccines or hormone treatment for target species can reduce the reproduction rate and stabilize the population size. In Malaysia, people have explored contraception as a means of managing elephants and other groups of objects. Elephants can cause significant damage to crops and infrastructure[15].

5.3. Coordinated Urban Planning and Environmental Protection

To address the impacts of high species density on wildlife and human populations, it is crucial to combine urban planning with environmental protection. Combining urban development with environmental protection is crucial to maintaining ecological balance and reducing the impact of high species density. Coordination management involves planning and implementing strategies that take into account human needs and wildlife protection. One way is to incorporate wildlife corridors into urban planning. These corridors provide safe access for animals to move between scattered habitats, reduce the risk of human conflict with wildlife, and promote ecological connectivity. In Malaysia, the creation and maintenance of green spaces and corridors in urban areas can help mitigate the impact of habitat loss and promote wildlife migration[14,15]. In addition, urban planning should consider the impact of development on local wildlife populations and their habitats. The implementation of measures, such as minimizing habitat destruction, protecting natural areas and promoting sustainable land use practices, can help protect biodiversity and reduce the pressure of excessive species density[16]. For example, protecting mangroves and peatlands in coastal areas can support various species while providing ecosystem services such as flood control and carbon sequestration. By integrating these strategies into urban development and environmental management, Malaysia can better cope with the challenge of excessive species density and promote a more balanced coexistence between humans and wildlife. Effective management requires cooperation between government agencies, conservation organizations and local communities to ensure that ecological and human needs are met.

6. Conclusion

Excessive species density presents significant challenges to biodiversity, resource competition, and human-wildlife interactions. By examining these impacts from the perspective of Malaysia's diverse ecosystems, it becomes clear that balancing species density is crucial for maintaining ecological health and reducing conflicts. Effective management strategies, including restoring natural predator-prey dynamics, implementing population control measures, and integrating urban planning with environmental protection, are essential for addressing these challenges and fostering sustainable coexistence between wildlife and humans. In order to meet the challenge of excessive species density, it is imperative to continue to study and implement effective management strategies. Key solutions include restoring predator-prey dynamics to control hunter populations, adopting population control measures such as extermination and contraception to manage density, and coordinating urban development and environmental protection to reduce the impact on wildlife. Continuous efforts to balance populations and protect ecosystems will contribute to sustainable biodiversity management and promote healthier life. We can better manage the impact of excessive species density and ensure the long-term health and stability of their diverse ecosystems.

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