Review Article
DOI: https://doi.org/10.70749/ijbr.v3i3.835

INDUS JOURNAL OF BIOSCIENCE RESEARCH
https://induspublishers.com/IJBR
ISSN: 2960-2793/ 2960-2807

Wildlife Conservation and Various Reproductive Strategies, A Focus on Mice Population

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ARTICLE INFO

Keywords

Abundance, Habitat, Disease ecology, Biodiversity, Wildlife Disease Surveillance

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Declaration

Authors' Contribution: All authors equally contributed to the study and approved the final manuscript.
Conflict of Interest: No conflict of interest.
Funding: No funding received by the authors.

Article History

Received: 04-12-2024
Revised: 07-02-2025
Accepted: 02-03-2025

ABSTRACT

This review explores how disturbances (wildfire, urbanization) affecting rodent populations illustrate key ecological restoration, public health, and wildlife management aspects. Understanding rodent behavior in these novel post-fire ecosystems is critical as they play a key role in recovery processes (especially vegetation recovery, seed dispersal, and trophic interactions). Despite being able to adapt to changing environments rapidly, significant gaps remain in understanding how long-term responses to environmental changes are constrained. This review aims to provide an overview of current data on rodent population dynamics and behavior, their ecological consequences following a wildfire, and the role of urban rodents as potential disease vectors. Spanning the fields of reproductive biology, population genetics, ecology, and evolution, our review highlights key drivers, including fire severity, mating system interactions, and environmental effects on rodent behavioral and fitness responses. It also assesses the limited research barriers per ecological roles of rodents as prey and seed dispersers in degraded ecosystems. These results highlight the importance of further investigation of the longer-term effects of fires on rodent populations and rodent–human interactions (e.g., zoonotic disease transmission) in urban settings. Each statement discusses whether we are taking enough cues from ecology in managing wildlife in ways that may lead to effective rodent pest control. Rodent population dynamics in post-fire and urban spaces impact ecological restoration and public health. They influence vegetation, seed dispersal, and food webs but remain understudied in fire-affected habitats. Their role in zoonotic disease transmission makes control essential. Integrated management strategies are needed to balance ecological conservation, disease mitigation, and effective rodent population control.

INTRODUCTION

Wildfires are such powerful disturbances altering habitat structure and composition that they can potentially affect rodent communities. Wildfire, a biological war with fire that is common everywhere, can refashion the ecosystems in the area affected in minutes to hours and change the interspecies composition and interactions in the affected region (Lindenmayer et al., 2016). Rodent communities are an important component of the ecological response of fire-impacted landscapes, with their recovery being indicative of broader fauna recovery in these landscapes (Pascoe et al., 2020). Some recent papers emphasize the importance of rodent populations for post-fire recovery since these small mammals likely influence vegetation regrowth and seed

recruitment and are only a part of larger-scale interactions in the tropic's webs (Tingley et al., 2018). Relocation and behavior changes of species connected with wildfire trigger changes in the rodent community, which are significant factors in developing rodent population dynamics and defining ecosystem recovery. The high adaptive evolutionary potential and ecological relevance of rodents in the food web provide general utility for understanding post-fire ecological processes, with population-habitat relationships of rodents being beneficial (Lindenmayer et al., 2016).

Rodents are also influenced by many environmental and peri-domestic factors that interact with their populations (Xiao et al., 2018). Among factors influencing rodent community responses to fire are time since fire (TSF), fire frequency, and fire intensity, with the latter two capable of evoking different rodent group responses (Sharp Bowman et al., 2017). Rodents affect the structure and dynamics of vegetation due to seed dispersal and vegetation predation and thus play a role in plant-community recovery. Postfire rodent communities typically comprise some animals that survived locally and immigrants from surrounding areas. Previous studies of reproductive systems found that polygynous male rodents dispersed more widely as women and monogamous move differently. Such as dispersal and mate-finding processes, which in turn influence rodent life history dynamics in post-fire environments (Pascoe et al., 2020).

However, despite the knowledge of rodent behavior and their value as Early Indicators for post-fire recovery, considerable gaps remain on how specific aspects of the post-disturbance environment have the potential to drive rodent populations (Constant et al., 2020). Newer research on the global distribution of disease, seropositivity, and rodent competency suggests that places such as the tropics host increasingly important zoonoses – e.g., leptospirosis and plague (Cohen et al., 2018). In these efforts, however, critical knowledge gaps remain, particularly concerning how environmental stressors like fire and urbanization will directly affect rodent health and population survival across generations (Constant et al., 2020). Also, the consequences of rodent behavior on a larger ecological scale are poorly understood, such as their contributions to more enormous food webs or ecosystem function in disturbed environments (Tingley et al., 2018).

To fill these knowledge gaps, this review aims to synthesize previous research on the population, behavioral, and ecological responses of rodents to wildfires (Lindenmayer et al., 2016). In this review, we will highlight our overall insights into rodent population dynamics across disturbed ecosystems, highlighting the significant processes driving rodent community dynamics and summarizing how both the direct effects of disturbance and indirect effects via other community members that drive population dynamics together shape rodent populations in disturbed ecosystems (Syphard et al., 2018). In this review, we will also describe these ecological roles, such as living prey resources for other terrestrial taxa and seed dispersers of some species of plants that are critical to the recovery and persistence of ecosystems largely impacted by rodents. Finally, this review synthesizes the outcomes of several studies with implications for future rodent control, habitat restoration, and managing disease in an increasingly fire-prone and urbanized landscape (Pascoe et al., 2020). This review aims to further the understanding of rodents as a key ecosystem recovery process and public health component to inform management and broaden the science of wildlife conservation in fire-prone ecosystems (Tingley et al., 2018).

Impact of Wildfires on Rodent Communities

Rodent communities are rapidly impacted by biological conflicts such as wildfires that alter the configuration and edifice of their habitat. To comprehend the rodent community, to adapt exhausted regions, remarkably post-fire relocating and existing animals, is critical factor to understanding how the tropic webs recuperate from perturbations (Horncastle et al., 2019).

Wildfire can directly and persist indirectly affect rodent populations, depending on fire severity, frequency, and landscape structure. High-intensity fires (that burn vegetation and soil) can dramatically reduce the number of rodents due to their removal of food supplies and cover (Foster et al., 2017). However, under specific scenarios, wildfire creates a patchwork of burnt and unburnt areas that allow some rodents to persist and even increase in abundance through the affected region (Silveira et al., 2021). For some species, the ability to successfully persist in fire-affected areas is often determined by behavioral adaptations like burrowing or being nocturnal, which allow some species to evade the direct effects of fire and predation risks in surface habitats (Steel et al., 2019).

In addition, the rodent species differ in their post-fire recovery strategies. Although obligatory specialists are often at risk of not returning after the fire, some species, such as habitat generalists, will readily re-inhabit burnt landscapes. The successful dispersal of surviving rodents into adjacent unburned areas is critical for maintaining genetic diversity and ecological equilibrium (Pascoe et al., 2020). Additionally, as they dig (which aerates the soil and allows seeds to disperse), these rodents help regenerate soil on burned landscapes and, in doing this, enable the natural succession of plant communities. The relationships between fire-induced changes and rodent community composition underscore the complexity of post-fire recovery. This warrants further research to understand the ecological roles of mice in these environments (Spano et al., 2021).

Environmental Factors Influencing Rodent Populations

Environmental and peri-domestic variables associated with rodent community Many aspects are rarely constrained; species TSF, life histories, intensity, and fire frequency can also pulse rodent assemblages (Torre et al., 2016). In addition, they influence vegetation structure and regeneration through seed dispersal and predation (Gordon & Letnic, 2019).

Outside these fire-related factors, seasonal temperature, food supply, and anthropogenic environmental alterations characterize even greater rodent development patterns. For instance, urbanization and intensive agriculture modify natural habitats and push certain rodent species to peri-domestic environments, where they thrive due to abundant nutrient sources and lower predation (Adduci et al., 2021). In addition, water availability is a critical factor post-fire because rats rely on moist environments to survive and reproduce. Predators may be absent in newly burned habitats, reducing predation and allowing rodent numbers to skyrocket, or predator numbers may be altered post-fire due to increased competition for prey release or competition (Velkers et al., 2017). The intrinsic and extrinsic interactions playing ecosystem illustrate the delicate balance between gov governing populations and their ability to adapt to the environment. Management and conservation plans may be developed to mitigate the negative influences of natural and anthropogenic disturbances on rodent populations, acknowledging that knowledge of these influences is necessary (Millán et al., 2018).

Environmental Factors Influencing Rodent Populations

Researchers like Banks et al. (2011) and Hale et al. (2022) indicate that local surviving fire fauna dominate the post-fire community. However, others contend that immigrants from surrounding areas are the primary fraction of post-fire inhabitants (Borchert & Borchert, 2013). Polygynous males are more likely to disperse, but the two sexes generally have even dispersal in most monogamous species. This suggests that the mating system may also influence the mice community (Favre et al., 1997).

Both intrinsic and extrinsic factors influence colonization in post-fire habitats; examples include habitat preference, competition, and reproduction. While some species of rodents rely on a survival mechanism in situ, others seek to disperse and search for suitable habitats. Adding to this complexity, in naturally patchy burnt–out environments, surviving populations could disperse into adjacent refuges before re-colonizing burnt areas. Polygynous species have a broader gene flow spectrum due to their departure from reproductive groups by dominating males. In contrast, monogamous species may rely on local pair bonding to keep their populations (Tingley et al., 2018). The balance between environmental stress and reproductive strategies governs the speed and effectiveness of rodent community recovery after fire. Recognition of these factors is vital for predicting population trajectories and developing sensible conservation strategies to assist ecosystem recovery (Oliveras & Malhi, 2016).

Rodent Population Density and Disease Studies

Scrutiny of a wild population, density is considered a key aspect in epidemiological exploration, majority of the epidemiological studies exclusively look at disease pervasiveness. Exploration on seropositivity rate and enthrall mark has focused on the effectiveness of contamination rather than the quantity of affected animals (Gamble et al., 2020; Lambert et al., 2008). Being extremely adaptive, rodents can quickly develop sizable populations in areas with plenty of resources and can even colonize human modifies habitat. Synanthropic rodents have harmful effects on human health and economy (Himsworth et al., 2014; Meerburg et al., 2009).

Because high-density populations raise the potential of pathogen dissemination by direct contact, fecal contamination, and vector-mediated transmission, rodent population density is directly connected with disease transmission risk. Rats are reservoirs for zoonotic illnesses, including leptospirosis, hantavirus, and plague in urban environments, thereby posing significant public health hazards (Rabiee et al., 2018). Furthermore, influencing illness frequency are variations in population density brought on by environmental changes such as seasonal food availability or habitat disturbance like wildfires. Rising resource competition during population booms could cause stress-induced immunosuppression, making rats more vulnerable to diseases inside and outside their habitats (Sokolow et al., 2019). Effective disease surveillance and rodent control plans must consider ecological and behavioral elements to reduce the hazards connected with rodent-borne diseases in both wild and urban settings (García-Peña et al., 2021).

Rodent Populations in Urban Environments

The wood mouse has a general habitat it favors high shrub cover. (Sunyer et al., 2016). Urban populations naturally distribute the ecological environments that help to increase the propagation of rodents (Awoniyi et al., 2021). Due to the increase of the urban population, it is particularly difficult to reduce the chances of rodents because of this reason most of the control methods have developed in the rural environment. In the ecosystem where other animals and humans are the part of environment, house and wild mouse are habitually unexceptional and incomparable (Angel et al., 2009; Harper & Cabrera, 2010).

Cities offer rodents plenty of food, water, and cover, which makes them perfect residences for creatures like the house mouse (Mus musculus) and the Norway rat (Rattus norvegicus). Using trash disposal sites, drains, and abandoned buildings for nesting and reproduction, these animals have evolved to survive with people (Diagne et al., 2017). Cities' absence of natural predators helps explain the explosive population increase even further. However, urban rodents represent significant public health hazards since they can spread leptospirosis, salmonellosis, and hantavirus. Their chewing habits can also harm infrastructure, resulting in pollution of food supply and electricity breakdowns (Rabiee et al., 2018). In cities, reasonable rodent control calls for an all-encompassing approach combining habitat alteration, sanitation enhancements, and focused pest control tactics. The development of sustainable and efficient management strategies that reduce the impact of urban rats on human populations and urban ecosystems depends on an awareness of their ecological and behavioral adaptations (Williams et al., 2018).

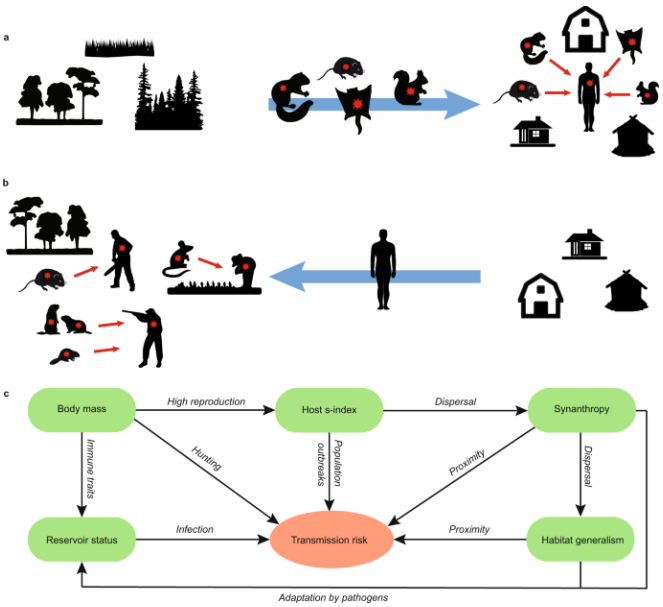
Rodent Control Methods and Population Management

Several aspects may work together to confine the size of mouse population. Norbury et al. (2013) showed that the numbers of mice increased with the experimental removal of predators. Some explorations have linked the rise in mouse community to work exploitative competition (Witmer et al., 2007). Mice communities are probable to be higher in urban areas than in rural areas, with harmful impact on human health (Bonnefoy et al., 2008). The presence of rats has measurable effects on the health people contact with them (Lam et al., 2018). Due to long correlation with humans, increasing inhabitants' growth and their bendable omnivorous diet, mice are considered among the world most extensive intimidating animal (AUFFRAY et al., 1990; Wilson et al., 2018). Rats flourish on human lands by using human resources and they characterize as abusing species (Feng & Himsworth, 2014). When their pillagers and mammalian opponents are absent they become profuse on oceanic islands (Choquenot & Ruscoe, 2000). However, ship rats (Bridgman et al., 2013) and Norway rats (O'Boyle, 1974) prey on mice. Vertebrate pillagers rely on rodents for food (Long & Smith, 2000). Seasonal deviations in food accessibility may cause progressive changes in female community. Mice also become abundant when food is magnanimous (Wilson & Lee, 2010). Males travel greater distance during the upbringing season to form dominate-submissive interactions. Since young males live in open ecosystem, they are more expose to pillagers. Both sexes and age may have an influence the mouse species (Godsall et al., 2014).

Rodent-Borne Diseases and Human Health Risks

Disease communication is a multidimensional process with different ways and methods that cannot be directly measured. Furthermore, epidemiological research on illnesses have found that mice is communal in countryside (Panti-May et al., 2016). Rats can move up to 90m distance even in a varied environment and pollute the area (Glass et al., 2016). Therefore, humans are more susceptible to rats and affected by various types of diseases transmitted by rats including bacterial, parasitic and viral infections. Rodents pollute various agricultural crops and abolish them, which cause loss with billions of dollars per year, while their outcomes affect the mice community (Parsons et al., 2020).

Figure 1



This diagram illustrates the complex dynamics of rodent populations in relation to their behavior, habitat interactions, and disease transmission risk. It highlights the movement of rodents from natural habitats to urban areas, emphasizing how environmental changes, such as wildfires, influence their dispersal and the potential spread of zoonotic diseases to humans. The figure also visually represents key factors such as body mass, high reproduction rates, proximity to humans, and habitat generalist, all of which contribute to the transmission risk of pathogens. By depicting these relationships, the diagram provides a clear overview of how rodent population dynamics intersect with disease ecology, emphasizing the role of rodents as vectors in both rural and urban environments (Ecke et al., 2022).

Plague and Rodent Control in Urban Areas

Widespread plague occurs due to lower rates of illness and rainfall in the wheat-growing areas (Krebs et al., 2004). To diminish the risk of disease transmission,

rodents' control is the common trial apply in the inner city (Lambert et al., 2022). There are different approaches to control rodents, mainly including chemicals in which we use rodenticide with instantaneous comeback. It has a less harmful effects on the population (Russell et al., 2008). With prompt increase in population, it is difficult to control rodent's invasion (Hansen et al., 2020). Therefore, the main method that engaged during rodents' control are poisonous chemical agents. Continuing control of rodent community, the actual method of inhibiting the growth of rodents is the amalgamation of non-chemical and chemical intrusion. Long-lasting use of chemicals intrusions is active in the mice community. It is typically model using either frequency dependent transmission or density dependent where low densities are expected -to result in low prevalence due to contract rates and transmission. According to frequency dependent models, changes in the percentage of affected people, as in the cases of STDs, have a greater influence on contract rates and transmission. Making the right model requires field observations, which might be difficult to decide on (Borremans et al., 2017). Panti-May et al. (2016) found that house mice with a high procreative percentage was the prevailing type in a rural Yucatan community.

CONCLUSION

Rodent population dynamics in post-fire and urban spaces are important for ecological restoration and public health. Because rodents play such important roles in post-fire ecosystem recovery, they influence vegetation composition, seed dispersal, and the structure of the food web dynamics; despite this plasticity, there are still marked deficiencies in our understanding of rodent response to habitat perturbations, especially those caused by fire. Rodent behavior, including movement, dispersal, and reproductive strategies, significantly affects population dynamics and recovery. Furthermore, rodents are an important source of zoonotic disease transmission, and when they interact with a human population in an urban setting, they represent a significant public health concern. Rodent control measures are a primary concern, especially in cities, because of their rapid population growth and difficulties in controlling infestation. While chemical interventions play a significant role in some cases, there is a tendency towards integrated management approaches that combine both chemical and non-chemical strategies. In addition, their ecological role as vectors and in the trophic chain in the disturbed habitats still needs improved insight. Filling these gaps with additional research is vital to move forward with wildlife conservation and disease mitigation strategies and to improve the management of rodents in natural and anthropogenic systems both in rural and urban environments. This review highlights the need for a more integrative approach to studying rodent communities and their ecological roles and management challenges in fire-affected and urban systems to inform future studies and assist with wildlife management and disease control initiative

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