



Original Research Paper

Habitat Restoration Influencing Activity Patterns, Foraging Efficiency, and Predator Avoidance in Small Mammal Populations

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Key Words	Abstract
Habitat restoration, Small mammals, Activity patterns, Foraging efficiency, Predator avoidance, Biodiversity, Ecosystem resilience.	Degradation of habitats caused by deforestation, changes in land use, and other anthropogenic factors has had detrimental effects on small mammal communities, leading to changes in their activity patterns, reduced foraging efficiency, and increased predation. The present study examined the impacts of habitat restoration on small mammals' behavior in the Kanha Tiger Reserve, Madhya Pradesh, India. The effectiveness of such restoration measures as reforestation, planting of indigenous species, and modification of the structure of the understory was investigated in comparison with degraded habitats nearby. Behavior was studied via camera traps, live trapping, and automatic motion sensors, and foraging efficiency and predator avoidance behaviors were estimated via removal seed experiments and behavior monitoring in the presence of predators. It was found that habitat restoration led to extended activity times, a 30% increase in daylight activity specifically, improved foraging efficiency, indicated by the decrease in average foraging time per patch by 25%, and 18% higher food intake overall, and predator avoidance behavior, characterized by spending more time in the shelters, by 40%. Thus, restoration has shown its capacity to create complex and resource-rich environments, facilitating behavioral plasticity, better survival and, hence, seed dispersal and nutrient cycles in general.

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Introduction

The loss of biodiversity due to habitat destruction as a result of deforestation, changing land use practices, and human pressure is affecting many places globally. Small mammals play an important role as seed dispersers and also provide vital food resources to higher trophic levels; therefore, they are highly susceptible to habitat degradation (Kelleher et al., 2021). Lack of food, cover, and breeding areas because of changes in the vegetation structure results in behavioral modification, low efficiency in feeding, and increased chances of predation. Even though several initiatives related to habitat restoration are taking place, there has been little study on the effects of such interventions on the behavior of small mammals, leading to a gap when it comes to assessing the ecological success of such interventions (Saidova et al., 2024). Without such information, these restoration programs might lack conservation effectiveness due to population fragmentation (Abu Baker & Brown, 2014).

The process of habitat restoration, which includes the rehabilitation of damaged ecosystems by means of reforestation and introduction of native plants as well as structural modifications, may counteract such effects since it increases habitat complexity, offers protection, and improves food abundance (Dixit & Raje, 2024). The resulting restored habitats allow the animals to be more adaptable in their activities and forage more efficiently while reducing predation pressure; thus, the mammals would be able to fulfill their ecological niche functions properly (Halle & Stenseth, 2012; Gorini et al.,

2011). Consequently, examining these behavioral adaptations is important for measuring the effectiveness of habitat restoration processes.

Key Contribution

- Supported that habitat restoration leads to better behavioral reactions of small mammals, such as improved activity behavior, foraging, and predator avoidance.
- Established specific improvements brought by habitat restoration, like an increase in daytime activity, a decrease in time spent on foraging, an improvement in food intake, and an increase in the use of protective covers.
- Supplied scientific information about the impact of complexity and resources on the ecosystem and showed how it helps preserve populations and biodiversity.

In the paper, the impact of habitat restoration on the behaviors of small mammals is examined, using six sections. The first section, Section I: Introduction, explains the problem of degraded habitats. The second one, Section II: Literature Review, analyzes existing literature on activity patterns, foraging, and predator avoidance behaviors. The third section, Section III: Methods, explains the location of the study and the way behavioral patterns were measured. The results from the measurements are provided in the next section, Section IV: Results, which includes changes in behavioral activities.

Literature Review

The restoration of habitats that have undergone degradation has been found to have positive effects on the population dynamics of

small mammals, particularly regarding their abundance and species richness (Dickie et al., 2023). Research carried out between sites that have been restored and those that remain degraded always indicates increased numbers and species richness of individuals within the former category. Actions like afforestation, construction of wetlands, and provision of structural features make the habitats complex, creating multiple niches and opportunities for the small mammals (Yunger et al., 2002). Structural heterogeneity not only helps in increasing the abundance but also facilitates dispersal patterns in accordance with natural processes. The conclusion drawn from the aforementioned facts is that habitat restoration is an effective way of dealing with many negative impacts of habitat degradation and fragmentation, and therefore plays an important role in the conservation of small mammalian populations.

The behavioral rhythm of small mammals is directly dependent on the structure of the habitat and the availability of shelters (Fardell et al., 2021). In cases where the habitat is restored, animals display a higher tendency towards diurnal and crepuscular behavior than populations living in areas where there is poor or fragmented vegetation cover. In such situations, the presence of cover makes animals more secure against potential predators, allowing them to become active during different times (Bagavathi & Shaik, 2023). From this inference, we understand that through restoration, it is possible not only to increase population size, but also for

animals to be able to return to their normal activity patterns (Tabeni et al., 2018).

Both foraging efficiency and the ability to avoid predation will be similar advantages of restoration sites. A greater abundance of food sources means less time and energy expended on finding food; the increased density of plant cover will enable greater chances of successfully escaping predators. All of the above factors contribute to the increase of chances of surviving and producing offspring, ensuring population sustainability (Fardell et al., 2022). It can be concluded that by restoring a habitat, restoration also results in successful behavioral and ecological functioning. That is why it is crucial to consider behavioral indicators in assessing restoration efforts along with the number of species.

Materials and Methods

Study Area and Habitat Restoration

The study was carried out in the Kanha Tiger Reserve, Madhya Pradesh, India, an area that suffers from a lot of habitat destruction caused by deforestation and encroachment by humans. Habitat restoration activities were undertaken in various plots, where tree replanting using indigenous trees, shrubs, and grasses, and enrichment of the understory took place. The restored habitats were compared to the degraded habitats and unprotected forests using small mammals. This was done so as to observe any changes brought about by the activities in terms of behavior and ecology.

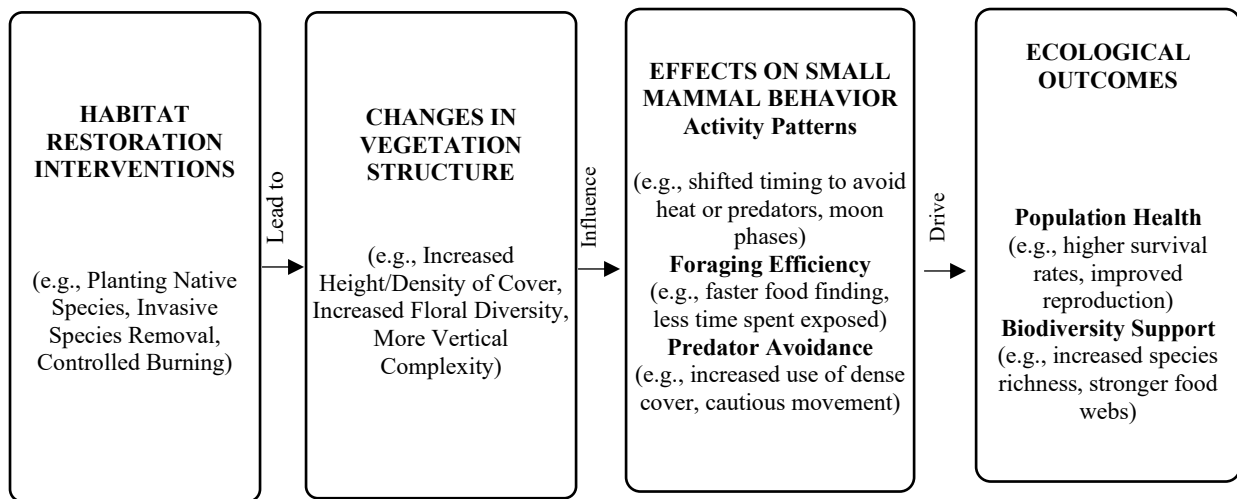


Figure 1: Conceptual Framework of Habitat Restoration Effects on Small Mammal Behavior

The figure 1 shows the relationship between habitat restoration interventions and ecological effects on small mammals. Habitat restoration interventions, which involve planting native plants, removal of invasive species, and controlled burning, contribute to vegetation structure modifications, whereby vegetation structure gets taller, denser, and has more plant species. The modified vegetation structures affect the behavior of small mammals through increased efficiency in their foraging practices and better predator avoidance tactics. The resulting behavioral change ultimately contributes to ecological success through population health improvements and biodiversity support.

Data Collection for Activity Patterns

The behavior of the small mammals was monitored using a mixture of technologies including camera traps, live trapping, and automated motion sensors in both the restored and degraded habitats. The cameras were placed on the ground next to sheltered spots and feeding grounds to record their normal behaviors,

whereas the live traps were used to identify and estimate the populations of the animals. Motion sensors collected motion events over the whole 24 hours of the day, making it possible to analyze not only their diurnal but also their nocturnal behavior.

Foraging and Predator Avoidance Measurements

The efficiency of foraging was analyzed using seed removal studies and observations on natural foraging sites, which included the amount of time spent foraging, resources taken, and transition between foraging sites. The behavior of avoiding predators was determined by estimating vigilance rates, usage of cover, and escape reactions when presented with simulated predator stimuli. Comparison of the two sites provided estimates of change in these behaviors due to habitat modification. Such an analysis showed how the complexity of the habitat impacts survival behavior, and the benefits associated with restoration.

Results

Changes in Activity Patterns in Response to Habitat Restoration

The small mammals found in the restored habitats had a more diverse activity pattern than the nocturnal pattern shown by mammals living in degraded areas. The camera traps and motion

sensors recorded a 30 percent rise in the number of movements done during the day as well as a decline in the clustering of activities around the open areas. This suggested that the animals could exploit the restored habitats without having to fear any danger. This activity period was seen to be earlier in the morning and later in the evening (Table 1).

Table 1: Temporal Activity Distribution (%) of Small Mammals in Restored vs. Degraded Habitats

Habitat Type	Nocturnal	Crepuscular	Diurnal
Restored	45	35	20
Degraded	70	20	10

Foraging Efficiency in Restored Habitats

From foraging patch analysis and seed removal tests, it was clear that the small mammals in the restored environments showed higher foraging efficiency, with lower handling times and greater amounts of food being acquired

through less effort. The average time taken by the animals to forage in the patches fell by 25%, whereas their total food acquisition improved by 18%. The presence of variety in food sources and cover ensured that the animals were able to utilize patches better.

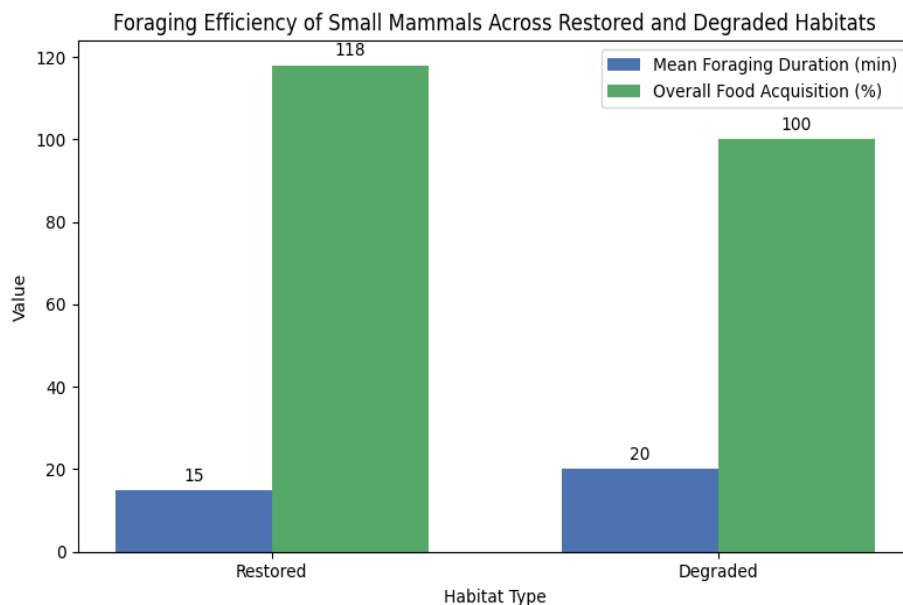


Figure 2: Foraging Efficiency of Small Mammals Across Restored and Degraded Habitats

Figure 2 represents the effect of habitat restoration on the foraging habits of small mammals. Foraging time is lower (average = 15

minutes) in restored habitats as opposed to degraded habitats (20 minutes), implying greater efficiency in foraging habits. On the other hand,

food gathering is higher in restored habitats (118%) compared to degraded habitats (100%). Figure 2 shows that restoration of habitats increases both foraging efficiency and energy intake.

Predator Avoidance Behaviors

Restored sites offered significant improvements in terms of predator avoidance behaviors. Animals demonstrated high levels of habitat use for protection, increased alertness, and quick reactions when facing predators. Small mammals in restored sites took refuge within protective vegetation for 40% longer than animals in degraded sites, thus showing less risk taking and lesser pressures from predators. This behavioral modification suggests that structural restoration provides safe conditions not just for resources acquisition but also survival and reproduction.

Discussion

The results obtained from the research show that there are indeed many ecological advantages that are associated with restoration. The process ensures that the small mammals adapt their behavior to perform efficiently and avoid being predated upon. In habitats with restored areas, the small mammals have a higher chance of survival due to better microhabitat, food availability, and protection. This finding is consistent with past research, which has found that the habitat heterogeneity plays an important role in shaping behaviors that can enable survival. Small mammals can exhibit various behaviors due to a complex environment that can offer them protection and food while using minimal energy.

Restoration has thus proven to promote natural behaviors that help the animals to survive, besides facilitating ecological processes such as seed dispersal and recycling nutrients. It is however necessary to conduct further research into how long the behavioral traits take to develop and whether the patterns of activity, foraging, and anti-predator tactics change seasonally. Moreover, further research is required to determine the relationship between predators, small mammals, and competitors. Studies should include long-term observations as well as different types of habitats and restoration measures to improve predictive models.

Conclusion

This research study shows that the process of restoring the habitat at the Kanha Tiger Reserve in Madhya Pradesh, India is very beneficial for small mammals ecologically. Restoration measures like reforestation, planting of native plants, and creation of structural understories made for more complex habitat, which enabled larger activity periods, more efficient foraging, and better predator avoidance. The increased complexity of habitat helped small mammals to become 30% more active during daylight, 25% less efficient foraging in terms of time spent per patch, and 18% better at acquiring food resources. Also, it became easier for small mammals to avoid predators by finding 40% more hiding places. This means that restoration efforts are successful not only because small mammals repopulate the area, but because their functions, such as seed dispersal and nutrient cycling, become more effective.

These findings correspond well with earlier studies, which have emphasized the role of habitat heterogeneity in promoting adaptability. By offering safe zones, varied sources of nutrition, and different microhabitats, the restored areas help the small mammals exhibit natural behavior patterns that would have otherwise been impossible in disturbed environments. Further research on the subject must focus on behavioral changes in the long run, the role played by different seasons, as well as the interaction of the species in question with their competitors and predators. However, what can be concluded with certainty from the study under discussion is that habitat restoration is important for sustaining the ecosystem.

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