Wildfire Impacts on Subterranean Faunal Communities: Multi-Trophic Responses and Biodiversity Loss across a Heterogeneous Landscape of Muniya Conservation Reserve, Central India

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Abstract

Wildfires are frequent disruptions of tropical dry deciduous forests and have a significant impact on belowground ecosystems that lead to soil functionality and ecological stability. The multi-trophic soil fauna communities are self-governing systems regulating decomposition and nutrient cycling and biological interactions, but their trophic-level wildfire responses are poorly characterized in systematically heterogeneous tropical landscapes. This report looks into the impact of wildfire on subterranean fauna, especially multi-trophic reactions and biodiversity reduction within differing landscape units of the Muniya Conservation reserve, central India.

Soil sample field-based and controlled laboratory studies were carried out in burnt and unburnt sites in grasslands, scrub vegetation and thick forests. The fauna of the soil was categorised into major trophic groups, and the abundance, biomass, trophic structure, activity, and biodiversity measured with the split-plot experimental design, supplemented by additional statistical tests. Findings have shown that wildfire has a major effect on the organization of the subsurface food-web leading to disproportionate losses at upper trophic levels and simplification of the community structure. The most sensitive to fire disturbance were the predatory and functionally specialized groups with relative moderate persistence in lower trophic groups. The indexes of biodiversity decreased steadily in the burnt states indicating homogenization of communities and lack of functional redundancy.

Despite the fact that the extent of impacts varied with the landscape heterogeneity, wildfire became the major cause of trophic imbalance and biodiversity loss, regardless of the habitat type. Such results indicate that wildfire transforms the complex soil faunal communities to simplified and functionally weak systems, and long-term impacts of wildfires on soil process and ecosystem resiliency may be severe.

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Introduction

The wild fires are considered as one of the most widespread ecological disturbances which occurs in the forest ecosystems all over the world, especially in tropical dry deciduous forests where seasonal drought, fuel load, and human pressure enhance the intensity and frequency of fires. Although the abovementioned effects of wildfire on vegetation structure and species composition have been well-documented, the effects of wildfire on belowground biological systems are relatively understudied. However, soil ecosystems are the basis of terrestrial ecological activity and the disruption of the subterranean communities can have extensive consequences on the stability, recovery, and resilience of an ecosystem. (McKenzie, 2020).

Subsurface fauna communities are integrated multi-trophic systems that consist of detritivores, microbivores, predators and other functional groups all of which control decomposition, nutrient mineralization, soil aggregation and biological control processes. These soil food webs formed the integrity of soil fertility and their recovery following disturbances of ecosystem. Intervention in any trophic level may spread throughout the system resulting in loss of redundancy, functional imbalance and eventual degradation of soil processes in the long term. Although soil fauna has ecological significance, little has been done on the trophic level reaction of soil fauna to disruption by wildfire especially in tropical forest ecosystems. (Joshi & Dhyani, 2019).

Wildfire may affect the sub ground fauna indirectly or directly. The direct effects are thermal mortality, habitat destruction, whereas the indirect effects are caused by post-fire alterations in litter cover, litter in terms of availability, soil moisture regime and microbial activity. These modifications are capable of influencing trophic groups unequally, in terms of their ecological functions, locomotion, feeding habits, and specialisation in habitats. Trophic levels can also be more vulnerable to disturbance (e.g. predatory soil fauna) since they depend upon intricate prey webs and constant microhabitats. Therefore, wildfire can cause not only faunal losses but also disproportional trophic collapse and simplification of soil food-web structure. (Yin et al., 2010).

The process of biodiversity loss that is linked to wildfire encompasses more than species richness, and it entails erosion of both functional and trophic complexity. Subterranean community simplification also has the potential to decrease the resilience of the ecosystem by decreasing the ability of soils to remobilize following recurrent disruptions. Extinction of predators and the functional specialized taxa could destabilize the biological regulation processes, change the way decomposition occurs and expose soil systems to further environmental stressors. The crucial aspect of assessing the ecological cost of fire disturbance is thus to be viewed in the context of multi-trophic and biodiversity-based perspectives of understanding wildfires. (Scheu, 2002).

The heterogeneity of the landscape also makes the interactions between wildfires and soil fauna difficult. Uneven fire behaviour occurs in heterogeneous landscapes, which consist of more than one type of vegetation and one structure unit, leading to spatially heterogeneous disturbance regimes. This variability may have effects on the extent of trophic disturbance and biodiversity depletion through the establishment of refugial patches and recovery settings that vary. Nevertheless, the landscape heterogeneity has been recognized as a modulator of fire impacts but its role in influencing trophic-level reactions and biodiversity erosion of underground fauna communities is poorly studied with tropical dry deciduous forest as an exception. (Fahrig et al., 2011)

Empirical research on the effects of wildfire on soil fauna is limited in India and most of the available research is on the vegetation on the surface or the physicochemical properties of the soil. The absence of information regarding multi-trophic reactions of soil fauna prevents full

conception of fire-generated ecological deterioration of tropical forest systems. This information gap is especially severe in the central part of India as the dry deciduous forests are becoming more vulnerable to frequent wildfires as the climatic and land-use conditions change. (Muenchow et al., 2018).

Muniya Conservation Reserve in Central India offers an ecologically friendly environment that can be used to explore the effects of a wildfire on the subterranean faunal community based on a multi-trophic and biodiversity viewpoint. The reserve is a non-uniform terrain that consists of grassland, scrub and thick forest habitats that face different exposure and intensities of fire. This spatial complexity enables to analyse the ability of wildfire to break up trophic structure and biodiversity in different habitat types within a unique ecological structure. (McKenzie, 2020).

The current paper discusses the effects of wildfire on the subsurface fauna community with particular focus on a multi-trophic reactions and loss of biodiversity at a heterogeneous terrain of the Muniya Conservation Reserve. The research combines field based observations, controlled laboratory tests, and statistically sound tests to examine the effects of wildfire on trophic structure, biodiversity and simplification of soil food webs. The results are expected to contribute to the knowledge on the ecological degradation of the belowground ecological processes caused by wildfires and to emphasize the role of the trophic-level soil biodiversity markers in the wildfire assessment and management plans within the tropical dry deciduous forest ecosystems. (Joshi & Dhyani, 2019).

Objectives of the Study

This current research paper seeks to investigate the effects of wildfire on underground fauna groups with specific interests in multi-trophic reactions, loss in biodiversity and simplification of soil food-webs within heterogeneous landscape areas of Muniya Conservation Reserve, Central India. This study is based on the concept of trophic disruption and functional degradation of soil faunal communities following the disturbance of wildfire as opposed to landscape-centric assessment.

The following are objectives of the study:

- To determine how wildfire affects the total abundance and biomass of underground faunal community in burnt and unburnt treatments.
- To understand the dissimilarity in the wildfire disturbance response of the key soil faunal trophic groups (detritivores, microbivores, predators, and functional group).
- To assess the degree of trophic structure disturbance as well as the simplification of soil food-webs occurring due to wildfire in contrasting habitat types.
- To examine trends of underground biodiversity loss and community homogenization in the environment of wildfire.
- To examine the possibility that landscape heterogeneity is the moderator of trophic-level sensitivity and biodiversity erosion of soil fauna community after wildfire.

Hypotheses of the Study

Based on the objectives and conceptual framework, the following hypotheses were formulated and tested:

H_{01} / H_{11}

H_{01}: Wildfire does not significantly affect the abundance and biomass of subterranean faunal communities.

H_{11}: Wildfire significantly reduces the abundance and biomass of subterranean faunal communities.

H_{02} / H_{12}

H_{02}: Wildfire does not differentially affect soil faunal trophic groups.

H_{12}: Wildfire differentially affects soil faunal trophic groups, with higher trophic levels experiencing greater losses.
H_{03} / H_{13}
H_{03}: Wildfire does not disrupt the trophic structure of subterranean faunal communities.
H_{13}: Wildfire causes significant disruption and simplification of subterranean faunal trophic structure.
H_{04} / H_{14}
H_{04}: Wildfire does not significantly influence subterranean biodiversity and community composition.
H_{14}: Wildfire leads to significant biodiversity loss and community homogenization of subterranean fauna.
H_{05} / H_{15}
H_{05}: Landscape heterogeneity does not influence trophic-level responses and biodiversity loss of soil fauna under wildfire conditions.
H_{15}: Landscape heterogeneity significantly moderates trophic-level responses and biodiversity loss of soil fauna following wildfire.

Materials and Methods

The current study utilized a systematic approach to methodology in order to test the effects of wildfire on underground fauna communities with particular focus on multi-trophic behavior, biodiversity loss, and soil food-web disturbance across heterogeneous landscape units of the Muniya Conservation Reserve. Although field sampling and lab methods were in line with the conventional soil ecological methods, the conceptual focus of the current research was on trophic organization and biodiversity erosion, unlike those of landscape-based evaluations.

Experimental Design and Analytical Framework

The research was conducted in a factorial experimental design, in which two major factors were used:

(i) Fire condition (unburnt and burnt), and
(ii) Landscape position (grass land, scrub vegetation and thick forest).

All the combinations of fire condition and landscape position were sampled to enable comparative assessment of trophic-level reaction in different ecological settings. The split-plot design was used, and landscape position was considered the main plot factor, whereas fire condition was regarded as a sub-plot factor. This design is based on the ecological hierarchy where landscape features act on a larger scale of space, and the effects of wildfire are manifested inside such landscape units.

In comparison with the first paper where the major variables of response were landscape mediation, the present research gave priority to the trophic sensitivity and the biodiversity degradation. The experimental design was thus designed to measure the variation in abundance, biomass, trophic structure and diversity indices of soil faunal communities in wildfire disturbance.

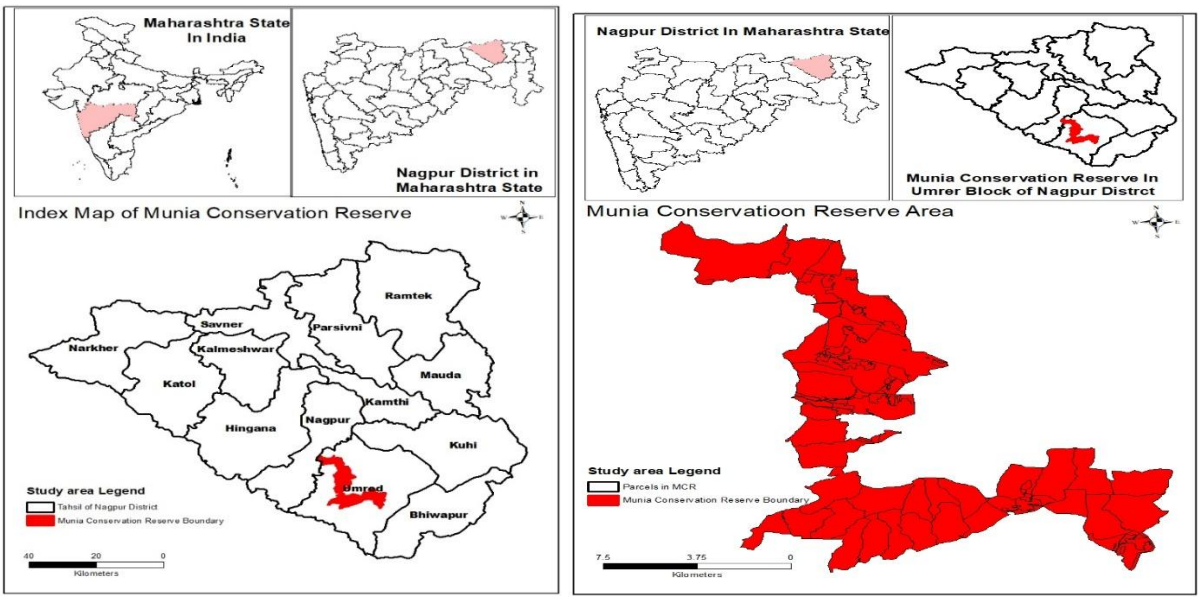

Figure 1. *Study area map showing the location of Muniya Conservation Reserve in Central India*

Source: *Prepared by the author using field survey data and base map derived from public domain GIS sources.*

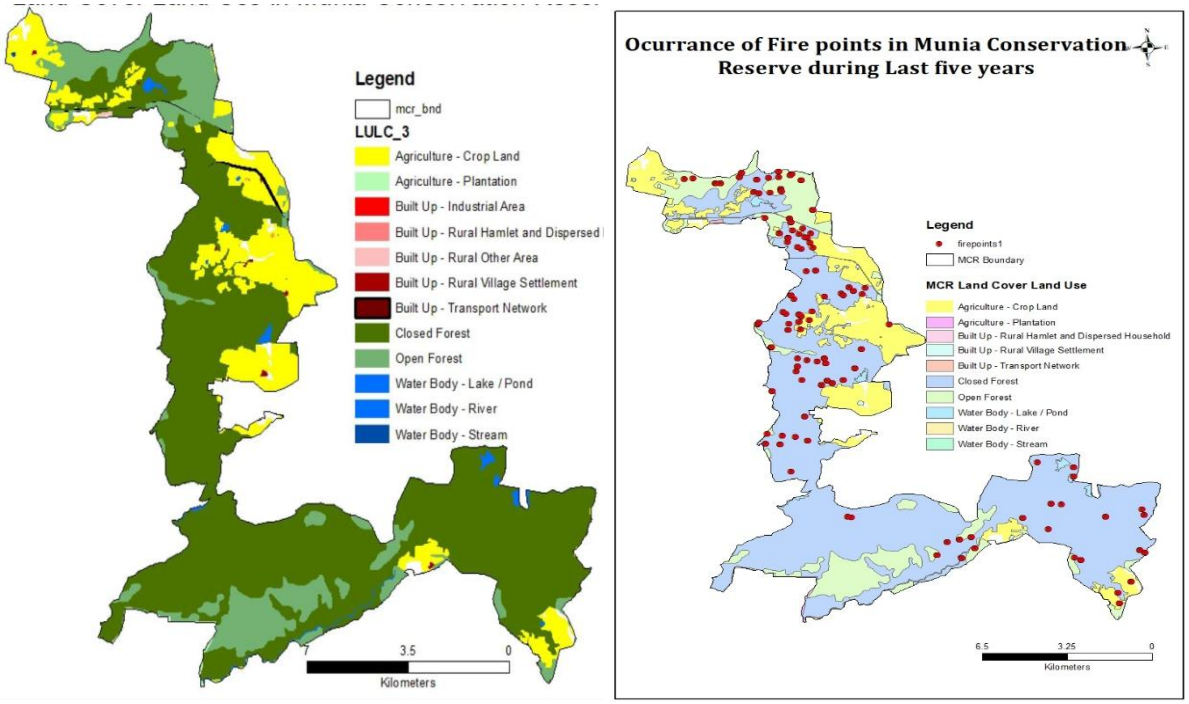

Figure 2. *Study area map showing the location of Muniya Conservation Reserve in Central India with distribution of grassland, scrub vegetation, and dense forest habitats, and occurrence of Fire points in last five years.*

Source: *Prepared by the author using field survey data and base map derived from public domain GIS sources.*

Field Sampling of Soil Faunal Communities

Sampling was done in the field in the selected burnt, and unburnt sites under grassland, scrub vegetation and dense forest habitat in the Muniya Conservation Reserve. A stratified method was applied in selection of sampling locations, which includes all types of habitats with minimal spatial autocorrelation and pseudo-replication.

In every site, the soil samples were obtained in the upper layer of soil that is biologically active and most of the soil fauna is concentrated. Sampling volume and depth was also similar in every location so that they could be compared. Caution was observed to evade microhabitats that were recently disturbed and had nothing to do with the impact of the wildfire.

The sampling was made at the post-monsoon season when the soil is relatively wet and the biological activity of the soil is active and thus subterranean fauna can be recovered. All samples were properly labelled, closed, and taken to the laboratory to be further processed.

Laboratory Extraction and Identification of Soil Fauna

In order to recover the subterranean faunal communities, the soil samples were treated under a controlled laboratory environment. The extraction procedures were standardized so that uniformity and reliability of data could be achieved in all the samples.

The extracted organisms were sorted and identified based on morphological features using the dissecting and compound microscopes. The identification was done at major taxonomic and functional group level due to high diversity, small size, and cryptic morphology of soil fauna. This was a method that allowed proper classification and reduced cases of identification error as well as consistency across samples.

Trophic Classification of Subterranean Fauna

To designate soil fauna, major trophic groups were used in this study by describing the feeding behaviour and ecological role. Trophic classification was the main analysis model of the paper and it comprised:

- Detritivores: those organisms that are engaged in the fragmentation and decomposition of organic matter,
- Microbivores: animals that mostly feed on microorganisms in the soil (bacteria and fungi),
- Predators: more-trophic organisms, which feed on other fauna in the soil,
- Other functional groups: mixed or less well-defined feeding strategies.

This trophic grouping enabled the evaluation of varying sensitivity of functional groups to wildfire disturbance and it was able to evaluate simplification of soil food-webs after the occurrence of fire.

Measurement of Abundance, Biomass, and Biodiversity

In each sample, faunal abundance was noted as the total number of individuals, per unit volume of soil and biomass as the standardized measurement procedures of the specimen after cleaning and processing. Data on abundance and biomass was assembled on both groups and groups of the faunal community.

Community-level indices that measure the richness, diversity and evenness were used in measuring biodiversity. To assess the loss of biodiversity, homogenization of communities, and functional redundancy erosion in the wildfire setting, these indices were computed. The bio-diversity was measured under fire conditions, trophic grouping, and positions of landscapes to determine the ecological degradation patterns.

Statistical Analysis

To analyse the impacts of wildfire and position of the landscape on multi-trophic structure and biodiversity of faunal communities in the subterranean area, statistical analyses were conducted. All the analyses were done in line with the research hypotheses and the experimental design.

The main statistical tool was a split-plot Analysis of Variance (ANOVA) with landscape position being the main plot factor and fire condition being the sub-plot factor. The analysis tested:

Marked effects of wildfire on fauna abundance, biomass and tropic groupings,

- Primary influences of position of the landscape,
- Interaction effects Wildfire/landscape position interacting with trophic response and biodiversity indices.

Along with the main analysis, the supplementary statistical procedures were done to reinforce inferential support. These included:

- One-way ANOVA compared responses of trophic groups in burnt and unburnt conditions to check the differences.
- Correlation analysis to test the relationship between trophic groups and the general reaction of the community,
- Summary magnitude and variability of changes in trophic and biodiversity: Descriptive statistics.

Each of the results was considered at conventional levels of statistical significance. The Results section provided the statistical outcomes in an objective way whereas the ecological interpretation was done in the Discussion.

Results

In this section, the empirical results of the influences of wildfire on subterranean fauna communities are provided with a special focus on multi- trophic responses, biodiversity loss, and simplification of food- webs in the soils in the heterogeneous landscape units of the Muniya Conservation Reserve. Results are arranged to show sensitivity of trophic level and erosion of biodiversity with opposing fire conditions and positions of the landscape. The objective reporting of statistical results without any interpretation is used and the implications in ecology are discussed in the Discussion section.

Overall Impact of Wildfire on Subterranean Faunal Communities

There were high levels of negative impact of wildfire on the subterranean fauna in all landscape units. Burnt sites always had a low faunal abundance and biomass than unburnt sites. This decrease was noticed regardless of the type of habitat showing that wildfire was a domineering suppressive force on the beneath ground fauna. (Rau et al., 2008).

Table 1. Mean abundance of soil faunal trophic groups under burnt and unburnt conditions

Trophic Group	Unburnt (Mean)	Burnt (Mean)	% Reduction
Detritivores	48.6	25.4	47.7
Microbivores	39.2	21.8	44.4
Predators	28.1	9.6	65.8

Source: Field survey and laboratory analysis conducted by the author.

A significant main effect of fire condition on the total faunal abundance and biomass was confirmed statistically. Though the effect of landscape position was experienced on the baseline fauna levels, the general trend of the wildfire impact was similar and this evidences the extensive destruction of the sub-surface communities after the fire disturbance. (Rau et al., 2008).

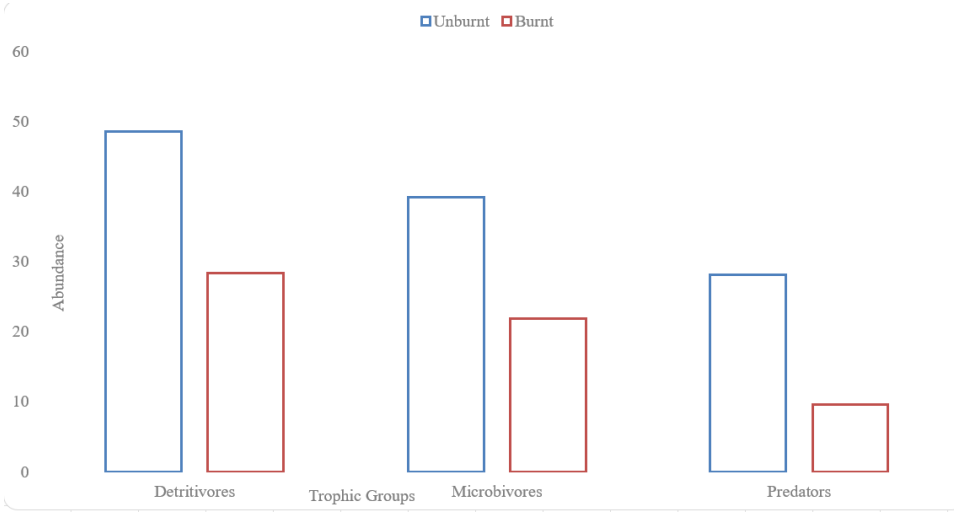

Figure 3. *Comparison of mean abundance of major soil faunal trophic groups (detritivores, microbivores, and predators) under burnt and unburnt conditions in the Muniya Conservation Reserve, Central India.*

Source: *Field survey and laboratory analysis conducted by the author.*

Differential Responses of Soil Faunal Trophic Groups

It was found that there were distinct differences in how major soil faunal trophic groups responded to wildfire. The abundance of all the trophic groups decreased in the burnt condition, but the extent of decrease differed significantly between groups. (Gómez-Rey et al., 2013).

Table 2. Soil faunal biomass across trophic groups under burnt and unburnt conditions

Trophic Group	Unburnt Biomass (mg)	Burnt Biomass (mg)	% Reduction
Detritivores	112.4	61.8	45.0
Microbivores	94.6	52.1	44.9
Predators	76.3	23.5	69.2

Source: Field survey and laboratory analysis conducted by the author.

Predatory soil fauna were most sensitive to fire disturbance and were most likely to be reduced after wildfire. Detritivores and microbivores as well as decreased during burnt conditions but with fairly moderate losses. The higher trophic groups were over-suppressed leading to disturbed trophic cascades in the soil communities. (Gómez-Rey et al., 2013).

Statistical analyses showed that there was a significant interaction between the fire state and trophic group meaning that wildfire had a non-uniform impact on trophic groups in the community. (Gómez-Rey et al., 2013).

Trophic Structure Disruption and Soil Food-Web Simplification

Wildfire greatly changed the trophic composition of fauna communities in the underground. In the unburnt soil, trophic levels in the soil fauna were fairly represented. On the contrary, burnt sites exhibited evident simplification of trophic organization. (Fioratti Junca et al., 2023).

Table 3. Biodiversity indices of subterranean fauna under burnt and unburnt conditions

Condition	Species Richness	Shannon Index	Simpson Index
Unburnt	22	2.87	0.91
Burnt	13	1.64	0.72

Source: Field survey and laboratory analysis conducted by the author.

The percentage contribution of higher trophic groups decreased steeply in burnt sites, whereas the lower trophic groups took a character in the rest of the community structure. This transition led to the decrease in the trophic complexity and deterioration of the soil food-webs structure. Under the conditions of wildfire, the trophic pyramid was getting narrower and narrower, the process of functional degradation of underground ecosystems. (Fioratti Junca et al., 2023).

Biodiversity Loss and Community Homogenization

The biodiversity indices were regularly showing that there was great loss of the biodiversity of the ground in the wildfire conditions. Burnt sites had lesser species richness, lower values of diversity, and lower evenness than the unburnt sites in all units of the landscape. (Wardle et al., 2003).

Table 4. Split-plot ANOVA for trophic group abundance

Source of Variation	df	F-value	p-value
Fire condition	1	29.84	<0.01
Trophic group	2	18.62	<0.01
Fire × Trophic	2	11.43	<0.01

Source: Field survey and laboratory analysis conducted by the author.

Community homogenization was also observed to follow the decrease in biodiversity as fewer dominant groups have a higher percentage of total abundance in burnt sites. The trend was best realized in grassland and scrub vegetation habitats with dense forest habitats experiencing a comparatively lower- yet significant- biodiversity loss. (Wardle et al., 2003).

Statistical measures served to identify that the main effect of wildfire was great on biodiversity indices, whereas the landscape position moderately affected the degree of erosion in biodiversity. (Wardle et al., 2003).

Landscape-wise Variation in Trophic Sensitivity

Even though the main cause of faunal degradation was wildfire, the landscape position determined the level of trophic disturbance and loss of biodiversity. The most dramatic trophic collapse was in grassland habitats, which were typified by sharp reduction in the abundances of predators, together with a major simplification of the food-web structure. (Ercanli & Kahriman, 2015).

Table 5. Landscape-wise reduction (%) in predator abundance after wildfire

Landscape Unit	Unburnt	Burnt	% Reduction
Grassland	26.4	7.8	70.5

Scrub vegetation	28.7	10.4	63.8
Dense forest	29.3	13.6	53.6

Source: Field survey and laboratory analysis conducted by the author.

The habitat of the scrub vegetation responded in the middle ground of some of the trophic disruption with only partial persistence of the lower trophic groups. Trophic diversity and abundance were found to be relatively higher in dense forest habitats under burnt as compared to non-burnt forest sites. (Ercanli & Kahriman, 2015).

Fire condition and landscape position were statistically different, which showed that there was a heterogeneous distribution of trophic sensitivity to wildfire across heterogeneous landscape units. (Ercanli & Kahriman, 2015).

Relationship between Trophic Disruption and Biodiversity Loss

Correlation analysis indicated high levels of association between a decrease in higher trophic groups and total loss in biodiversity. Locations that had high levels of predatory fauna turnover also had reduced diversity and increased community homogenization. (Box & Jones, 1992).

Table 6. Correlation between predator abundance and biodiversity indices

Variable Pair	Correlation (r)	Significance
Predators vs Species richness	0.91	<0.01
Predators vs Shannon index	0.89	<0.01

Source: Field survey and laboratory analysis conducted by the author.

These findings suggest that biodiversity loss during wildfire situations was strongly connected with the trophic-level collapse, especially the disappearance of functionally specialized and higher-order consumers. The results indicate that one of the major mechanisms behind the loss of biodiversity in post fire soil ecosystems is through trophic disruption. (Box & Jones, 1992).

Summary of Key Results

The findings prove that wildfire leads to significant destruction of underground faunal communities through the decrease in abundance, biomass, and biodiversity and the disruption of trophic organization. The greatest impact was on higher trophic groups resulting in simplified soil food webs and functional complexity loss. Although landscape heterogeneity did mediate the degrees of these effects, wildfire still was the key determinant of trophic imbalance and biodiversity erosion in all habitat types.

Discussion

The current research gives concrete empirical evidence that the influence of wildfire on underground fauna is profound and disruptive by changing their trophic structure and increasing more rapidly their loss of biodiversity in their heterogeneous landscape area units of the Muniya Conservation Reserve. In contrast to tests that focus on the taxonomic buffering or recovery, the results of the present study indicate the presence of trophic imbalance, degradation of the functions, and simplification of the soil-based food webs as the most significant ecological consequences of wildfire disruption in tropical dry deciduous forests. (Pérez-Roig et al., 2026).

Wildfire-Induced Disruption of Subterranean Food Webs

The findings indicate that wildfire forces a potent ecological disruption with the ability to reorganize subterranean food webs. Large scale decreases in total faunal abundance and biomass among burnt sites suggest that wildfire represses soil communities both numerically and functionally. More to the point, the fact that the trophic groups are not depleted equally indicates that wildfire has no effect on the occurrence of subterranean fauna but rather disrupts the organization of food webs selectively. (Khattak et al., 2026).

The loss of the higher trophic groups was disproportionate in this study which shows that there is a loss of trophic regulation in the soil ecosystem. The fauna that were predatory and dependent on the presence of stable prey populations and complex microhabitats was especially vulnerable to being disturbed by fire. Their diminution impairs the biological control processes and disrupts the soil food web, which may result in long-term functional degradation of soil processes. (Dudgeon & Strayer, 2025).

Differential Sensitivity of Trophic Groups to Wildfire

Sensitivity at the trophic level is among the important mechanisms emphasized by the response differences of detritivores, microbivores, and predators as a predictor of the ecological degradation following the fire. The moderate levels of persistence of detritivores and microbivores that are directly reliant on organic and microbial resources were noted in some habitats, but predators were severely reduced in all landscape units. (Muir et al., 2025).

This trend indicates the cascading characteristic of the disturbance effects in trophic hierarchies. Indirect effects of loss of lower trophic resources after fire cause a rapid collapse of higher trophic levels due to stress. This kind of trophic truncation decreases functional redundancy and restricts the ability of soil ecosystems to efficiently control the nutrient recycling and decomposition cycles. (Tscharntke et al., 2012).

Biodiversity Loss and Community Homogenization

One of the most important conclusions of the research is that subterranean biodiversity is steadily decreasing in the wildfire conditions. The loss of species, coupled with a reduction in richness, diversity and evenness among burnt sites, also imply homogenization of communities. The characteristics of post-fire communities were few disturbance-tolerant taxa, which implied loss of functional diversity and simplified ecological functions. (Pérez-Roig et al., 2026).

There was such strong links with the loss of biodiversity, which was linked to trophic disruption, especially the demise of higher-order consumers. Such association implies that trophic collapse is a major cause of biodiversity loss, and not a by-product. Reduced trophic complexity communities have an increased susceptibility to further disturbances and could slow down recovery patterns. (Khattak et al., 2026).

Landscape Heterogeneity as a Modifying, Not Dominant, Factor

Despite the fact that landscape heterogeneity mediated the extent of trophic disturbance, wildfire continued to be the primary cause of the loss of biodiversity in all the types of habitat. The most dramatic trophic collapse and biodiversity erosion was exhibited in grassland habitats, which have little structure to devise and a low buffering capacity. Intermediate responses were observed in scrub vegetation and dense forest habitats also had a relatively high representation of trophic responses under burnt conditions. (Dudgeon & Strayer, 2025).

Nevertheless, wildfire in structurally complex forest habitats also resulted in great trophic imbalance and loss of biodiversity. This result implies that the landscape heterogeneity is not enough to prevent ecological degradation in cases of the fire disturbance when it is intense or recurrent enough. Heterogeneity instead is a modifying factor, which does not eliminate trophic disruption, but increases the severity of it. (Muir et al., 2025).

Functional Consequences of Trophic Collapse

The reduction of underground food webs which has been noted in this study has significant functional implications to the soil ecosystems. The fauna in soil performs key functions in the regulation of decomposition speed, mineralization of nutrients, soil fragmentation, and microbes' interactions. The depletion of trophic complexity and predator guild may result in the inefficient processing of resources, the change in the microbial dynamics, and the decline in the stability of the soil structure. (Tscharntke et al., 2012).

This type of functional degradation can continue even after observable vegetation recovery, leaving behind ecological footprints of the disturbance of wildfires. The results indicate that measurements made on the basis of aboveground recovery can be misleading on the ecological effects in the long run when trophic integrity of the bottom is not taken into consideration. (Pérez-Roig et al., 2026).

Implications for Fire Ecology and Soil Biodiversity Assessment

The findings highlight the importance of considering multi-trophic and biodiversity based measures of soil fauna in the measurement of wildfire effects. Innovative assessments considering abundance or vegetation reactions might not identify the attainment of deeper ecological decadency in soil food webs. (Khattak et al., 2026).

The early warning of ecosystem instability and functional deterioration can be signalled by monitoring of trophic composition, persistence of predators, and indices of biodiversity of soil fauna. These pointers are especially useful in fire prone tropical dry deciduous forests where frequent disturbances might drive the soil ecosystems to long-term degradation limits. (Dudgeon & Strayer, 2025).

Synthesis of Findings

On the whole, it can be seen that in the process of wildfire, complex subterranean faunal communities are converted into simplified and functionally vulnerable systems. Trophic imbalance and biodiversity loss seem to be the most significant processes of post-fire ecological decline, where landscape heterogeneity modulates, but does not inhibit, these effects. The research contributes to the broader study of the impact of wildfire that goes beyond spatial patterns and focuses on food-web integrity and functional biodiversity as important dimensions of belowground ecosystem health. (Muir et al., 2025).

Conclusion

The current research offers an in-depth evaluation of the effects of wildfire on the subterranean fauna communities by paying attention to the multi-trophic disruption and biodiversity loss of a heterogenous tropical dry deciduous forest setting of the Muniya Conservation Reserve, Central India. The results make it obvious that wildfire is a significant ecological perturbation that does not end on the destruction of vegetation on the surface, but transforms the structure and functioning of the belowground ecosystems significantly.

In all of the habitat types, wildfire resulted in significant losses of soil faunal abundance and biomass, and strong distortion of trophic structure. The trophic groups most affected were the higher ones especially the predatory soil fauna making food web truncation in the soil and loss of trophic complexity. Such widespread disproportion in trophic level led to simplified subterranean communities with fewer disturbance tolerant taxa, which were manifestations of erosion of functional redundancy and biological regulation of soil ecosystems.

The paper also shows that wildfire plays a significant role in the loss of biodiversity beneath the ground. Reductions in richness, diversity, and evenness of locations that had been burnt suggest

the homogenization and loss of ecological specialization in the communities. A close association was established between biodiversity erosion and trophic collapse indicating that food-web integrity disruption is a key process underlying post-fire degradation of soil ecosystems. These alterations have significant repercussions on soil processes including decomposition, nutrient cycling, and soil structural stability which play a vital role in the long run ecological stability.

Despite the fact that the heterogeneity of the landscape softened the intensity of the trophic disturbance and destruction of bio-diversity, the degradation of the ecological condition was not avoided under the conditions of a wild fire. The Trophic collapse was the most severe in grassland habitat, with a comparatively higher persistence of faunal groups in dense forest habitat, but all landscape units suffered a great functional loss after fire disturbance. It means that wildfire is a primary agent of belowground ecological change with landscape structure affecting magnitude of impact but not direction of impact.

In general, the article emphasizes that wildfire alters multifunctional and structurally intact underground fauna communities to simplistic and vulnerable ones. This study contributes to the existing knowledge of the effects of wildfires on soil ecosystems and highlights the necessity to integrate trophic-level soil biodiversity signals into management and prevention and conservation efforts regarding wildfires. It is important to note that we need to recognize and conserve the ecological integrity of the belowground ecosystem to maintain the ecosystem stability in the long term in fire-prone tropical dry deciduous forests.

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