



## Original Research Paper

# Trophic Rewilding Outcomes on Ecosystem Function and Biodiversity in Degraded Rangelands

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### Key Words

### Abstract

Trophic rewilding, Species diversity, Vegetation cover, Soil quality, ANOVA, Biodiversity, Ecosystem restoration.

This paper analyzes the impacts of trophic rewilding on rangeland biodiversity and ecology. Rewilding treatments, such as the introduction of herbivores, carnivores, and native plants, were applied in intervention sites, and those without treatment in control sites were compared. After two years (2024-2026), it was noticed that there were significant gains on the species diversity, vegetation cover, and soil quality. The species diversity (Shannon-Weiner Index: 3.5 represents standard error 0.2, vs. 2.8 represents standard error 0.3,  $p < 0.01$ ) and species richness significantly increased in the intervention sites compared to the control sites. Vegetation cover at intervention sites improved by 40 to 60 % ( $p < 0.05$ ), but at the control sites, there was no improvement. Intervention sites also had higher levels of soil quality (organic carbon and nitrogen 2.3% and 0.18 respectively) compared to the control sites of 1.5 and 0.12 respectively ( $p < 0.05$ ). The findings indicate that trophic rewilding is an effective intervention that has a beneficial effect on biodiversity and ecosystem functionality, and can be applied as an ecological restoration tool in perturbed landscapes. HSD test by Tukey statistical analysis indicated that variation between intervention and control sites was statistically significant in all the measured variables. The findings indicate that rewilding intervention activities help recover species, vegetation, and soil health and enhance ecosystem resilience. Although the study gives good evidence of the benefits of rewilding, the short period of the study and the variations in the environment need another study, as the long-term effects of the interventions were not clearly seen. Further research is needed to investigate the impact of trophic rewilding in the long term and to take into account a wider spectrum of environmental variables. Keywords: trophic rewilding, species diversity, vegetation cover, soil quality, ANOVA, biodiversity, ecosystem restoration.

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## Introduction

A concern on the world stage is the rangeland degradation triggered by overgrazing, deforestation, and climate change. Poor rangelands lead to loss of biodiversity, low soil fertility, and loss of ecosystem services, which are essential not only to ecological balance but also to human livelihoods. The difficult nature of these ecosystems' restoration has prompted the identification of new methods, including trophic rewilding, whereby key species are reintroduced to restore ecological processes. To come up with efficient measures to reverse the destruction of rangelands and preservation of biodiversity, it is necessary to understand the consequences of trophic rewilding.

Rangelands play important ecological roles by supporting a range of plant and animal species, biodiversity, and important ecological services. Nevertheless, overgrazing, deforestation, climate change and other human pressures have led to the degradation of many rangelands. This destruction has contributed to reduced biodiversity, soil fertility, and ecosystem resilience, which have had a significant impact on the capacity to deliver important ecosystem services. The reintroduction of keystone species to achieve ecological balance has developed as a possible measure to counter the adverse impacts of rangeland degradation as a process (trophic rewilding) (Atkinson et al., 2024).

Trophic rewilding is an ecological restoration approach that supposes that the release of apex predators or herbivores can reestablish ecological functions by regulating species populations,

improving vegetation regeneration, and boosting biodiversity. This practice has attracted attention as a way to enhance ecosystem functionality in regions where conventional management practices have not been effective. Natural trophic relationships, especially the reintroduction of big herbivores and predators, can be restored through rewilding of rangelands, which can be very critical in controlling habitat structures and in the ecological balance (Briske et al., 2026). Moreover, functional trait incorporation into trophic rewilding science offers data on the influence of certain species on ecological processes, facilitating the success of rewilding, in general (Atkinson et al., 2024).

It has been demonstrated that rangeland restoration can reduce the loss of biodiversity and enhance ecosystem resilience. To illustrate, research has also noted that pastoralism has the potential to decrease the loss of biodiversity and help to restore the ecosystem on the rangelands of the world, thus serving as a significant part of conservation work in the rangelands (Briske et al., 2026). Also, the vegetation adaptations to climate change in the long term are conditional upon the particular functions of rewilding and traditional grazing systems (Rincon-Madroñero et al., 2024). Research has also shown that digital ecosystems and technologies could be useful in controlling and tracking such rewilding efforts (Veerappan, 2023).

Besides, rewilding in wilder rangelands has been cited as a chance to combine biodiversity conservation with climate action, which is beneficial to the environment and the local communities participating in the land

management (Simba et al., 2024). The studies on grazing systems in southern Africa have also provided useful information on the possibilities to adapt such an activity to the specific region and ecosystem (Morris, 2025). As these rewilding efforts grow, it is important to know about the ecological and social aspects. The article by Trophic Rewilding Outcomes on Ecosystem Function and Biodiversity in Degraded Rangelands can be compared to the system model of human behavior in urban environments presented by Abad & Nejad, (2019) due to the focus on the complexity of the study of the systems and the possibilities of restoration and enhancement under various environmental conditions.

Other ecosystem functions are also potentially affected by trophic rewilding, other than vegetation restoration. As an example, the reintroduction of species in an ecosystem such as the northern Sahel region has been associated with better insect-flower interactions, which translates to better ecosystems (Medina-Serrano et al., 2025). It has also been demonstrated in a related study that conservation of biodiversity has a positive influence on climate resilience by providing critical ecosystem properties, including carbon storage and regulating water, and has direct effects on climate mitigation (Shin et al., 2022).

Finally, recent studies on riparian ecosystems emphasize how biodiversity contributes to ecosystem functionality, supporting the idea that rewilding can improve not just species diversity but overall ecosystem health (Jiang et al., 2025). These findings underscore the importance of

trophic rewilding in the restoration of degraded rangelands and highlight its potential as a sustainable solution for addressing the growing challenges of biodiversity loss and climate change.

This research has added to this research area by demonstrating that ecological restoration is a growing field, as it assessed the effects of trophic rewilding on ecological functions and biodiversity in degraded rangelands. It gives a logical study of the effect of species reintroduction on trophic interactions, vegetation processes, and the resilience of the ecosystem in general. The study combines network and functional methodologies in order to determine changes in biodiversity and ecosystem restoration. This work, in contrast to traditional restoration techniques, focuses on the natural regulation of the species through interactions. The results provide practical insights into conservation planning and sustainable land management, namely that trophic rewilding is a viable and scalable remedy for the restoration of degraded ecosystems.

The paper is divided into several main sections to create clarity and logical flow. The introduction contains the problem of research, its purpose, and the importance of trophic rewilding. In the literature review, the current research is summarized, and the gaps in research are identified. The methodology section provides a description of the study area, data collection techniques, and analytical techniques employed. The findings are presented in the results section in the form of graphs and tables, and then a discussion is drawn to explain the results as

compared to the existing research. In the end, the conclusion summarizes the main findings, implications of the research on restoring ecosystems, and suggestions for future research in the area of trophic rewilding and biodiversity conservation.

## Literature Review

Some recent work on rangeland restoration and trophic rewilding has centered on the contribution of large herbivores and apex predators to ecosystem stability. These publications emphasize the renewal of ecological processes by rewilding, such as the control of vegetation and soil well-being. Numerous recent offerings speak of the impact of herbivory on vegetation recovery, biodiversity conservation and ecosystem long-term resilience. The literature on how to combine functional attributes and landscape connectivity to maximize the effectiveness of rewilding in degraded ecosystems is also growing.

One of the main world problems is the degradation of rangelands, and most rangelands face critical biodiversity loss and ecosystem services under anthropogenic pressure. A promising solution is the so-called trophic rewilding or reintroduction of selected species to achieve ecological balance. Its primary goal is to restore natural trophic relationships that govern the level of species and ecosystem components to improve biodiversity. It has been demonstrated that rewilding can enhance biodiversity conservation, particularly in Mediterranean landscapes, where it helps recreate cultural landscapes and ecosystem services (Bugalho et al., 2026). Also, large herbivores are important in

determining vegetation dynamic patterns, which has seen studies to show that heterogeneity of tree cover is related to herbivore biomass all over the world, therefore proving the ecological significance of herbivores in restoring the landscape (Wang et al., 2023).

Herbivory plays an essential role in the restoration of an ecosystem, as it may influence the success of vegetation regeneration. The problem of herbivory limits vegetation recovery worldwide, and it is necessary to consider herbivore populations in ecological recovery designs (Xu et al., 2023). Moreover, regenerative agriculture, centered on healing soil and biodiversity, has also been noted as an adjunct to rangeland healing. It is in favor of the fact that ecological restoration, which also incorporates trophic rewilding, may provide solutions to climate change and enhance soil health and biodiversity (Sher et al., 2024).

In certain ecosystems, big game plays an important role in seed dispersal that facilitates plant community restoration. The research on the topics of seed dispersal in northern Iran has indicated that the large mammals and domestic sheep are very different in the seed dispersal mechanisms, with large mammals making a greater contribution to ecological restoration because of the seed dispersal of native plants (Shakoory et al., 2025). Equally, rewilding of the American West has demonstrated that reintroduced apex predators and herbivores can help to reestablish ecological processes, and as a result, trophic rewilding can be effective in restoring ecosystems (Ripple et al., 2022).

There is also a connection between trophic rewilding and managing landscape multifunctionality in conservation and restoration. It also helps in ecology services, e.g., in sequestration of carbon and maintaining biodiversity, hence supporting sustainability (Jay & Plieninger, 2025). Besides, studies on megaherbivores have demonstrated that are useful in curbing the supremacy of exotic plant species, which further supports the ecological importance towards the restoration of rangelands (Mungi et al., 2023). The reintroduction of these species can also be used to manage the plant communities by balancing the impact caused by invasive species and improving biodiversity (Lundgren et al., 2024).

Lastly, it is important to realize that endemic species are vulnerable to extinction in imperiled ecosystems when contemplating trophic rewilding in hotspots. These regions are highly vulnerable to the interference of the habitats and need to be rewilded in a well-thought-out manner so that native species cannot become extinct (Taylor et al., 2025). This body of literature

emphasizes the role of trophic rewilding in the recovery of ecosystem functions, enhancement of biodiversity, and offers a sustainable solution to rangeland degradation.

Significant implications of the literature are that trophic rewilding could be an important way of increasing biodiversity and ecosystem processes in downgraded rangelands. Major herbivores and apex predators contribute to population control of herbivores, regeneration of plants, and recovery of natural trophic relationships. Research underlines the importance of herbivory in the recovery of ecosystems, yet rewilding success is conditional upon the selection of species and the ecological processes. These results have a direct impact on the present study and indicate that trophic rewilding can enhance biodiversity and ecological performance of degraded rangelands and can provide new information on the effectiveness of conservation practices.

## Methodology

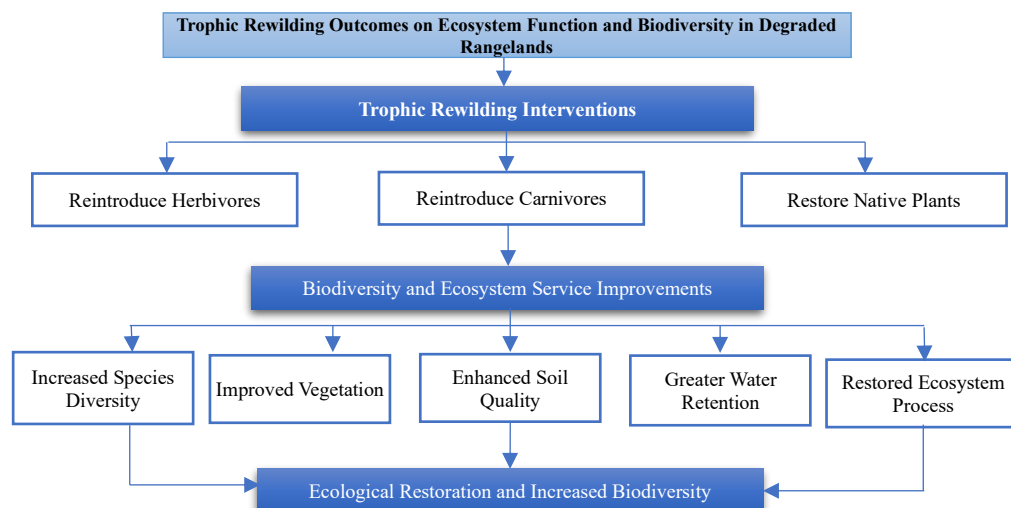


Figure 1: Trophic Rewilding Outcomes on Ecosystem Function and Biodiversity

Figure 1 shows how and where trophic rewilding takes place in degraded rangelands. It commences with three major interventions, which include reintroduction of herbivores, carnivores, and native plants. These interventions bring about beneficial changes in biodiversity and ecosystem services, such as species diversity, vegetation cover, soil quality, and water retention. The final result will be ecological restoration and a huge boost in biodiversity. This figure is a visual overview of the cascading impacts of rewilding interventions on the health of ecosystems and highlights a key role in long-term ecological recovery in degraded landscapes.

### Study Area

The study has been conducted in the degraded rangelands of Rajasthan, located in the west of Northern India a region having a semi-arid climate with 250 to 500 mm rainfall. Summers are hot, reaching temperatures as high as 45 °C, and winters reach temperatures as low as 5 C. It is predominantly covered by scrublands, thorny bushes, and patches of dry grasslands such as *Cenchrus ciliaris* (buffel grass), *Atriplex* (saltbush), and *Acacia nilotica* (babul tree). These rangelands have been significantly impacted by overgrazing, soil erosion, and unsustainable agricultural practices, leading to a loss of vegetation cover, soil loss, and a reduction in biodiversity. Ecological problems include excessive soil erosion, extinction of native plant and animal species, and the spread of alien ones such as *Prosopis juliflora* (mesquite).

The study area was estimated at 150 hectares of degraded land in the Thar desert region, and both intervention and control sites were selected

to establish the effect of the trophic rewilding intervention.

### Data Collection

In this study, data were collected through a combination of field surveys, remote sensing, and biodiversity indices to evaluate the impacts of trophic rewilding on ecosystem function and biodiversity. Two years (2024-2026) of field surveys were done on a quarterly basis with the vegetation cover being measured with quadrats (1m<sup>2</sup>) at intervals of 50-meter. Samples of soil were collected in order to assess soil quality, such as pH, soil texture, and organic carbon content. Presence of wildlife was documented via camera traps and direct observations. Landsat 8 satellite (30m resolution) and drone (10 cm resolution) remote sensing were applied to assess vegetation cover and landscape recovery. To monitor land cover trends together with vegetation growth, images were analyzed in QGIS and ArcGIS programs. The Shannon-Weiner Diversity Index ( $H'$ ) was used to measure the species diversity of a site, and the Simpson's Index to measure the species dominance and evenness. The ecological effects of the rewilding interventions were also assessed by species richness and evenness.

To explore the impacts of trophic rewilding, field surveys, remote sensing and biodiversity indices were used to collect the results in table 1. The field surveys were done after every quarter in a span of two years (2024-2026) in order to document the vegetation cover, soil quality, and wildlife activity. Remote sensing implied the use of Landsat 8 satellite images and high-resolution drone surveys that showed the vegetation change and the recovery of the landscape. In determining

the diversity of species, dominance, and evenness of species in the various sites, biodiversity indices, including the Shannon-Weiner Diversity

Index and the Simpson Index, were used. All these approaches yielded detailed information on the ecological effects of the rewilding activities.

Table 1: Data Collection Methodology

Method	Description	Tools/Techniques Used
Field Surveys	Quarterly observations (2024–2026) on vegetation cover, soil quality, and wildlife.	Quadrats (1m <sup>2</sup> ), Soil probes, Camera traps
Remote Sensing	Satellite and drone surveys to monitor vegetation and landscape changes.	Landsat 8, Drones, QGIS, ArcGIS
Biodiversity Indices	Calculation of species diversity (Shannon-Weiner H') and evenness (Simpson's Index).	Field surveys, Data analysis

### Trophic Rewilding Intervention

The main trophic rewilding actions were the restoration of ecological balance in the degraded rangelands by adjoining key species to control the pressure of grazing and improve the functioning of ecosystems. The reintroduction of herbivores included nilgai (*Boselaphus tragocamelus*), chital (*Axis axis*), and blackbuck (*Antilope cervicapra*). These herbivores were released to regulate plant growth, help in the dispersal of seeds, and keep the vegetation in good structural condition. The reintroduction of the Indian wolf (*Canis lupus pallipes*) was an

apex predator reintroduction. Wolves are important in controlling the population of herbivores, preventing overgrazing, and promoting plant rejuvenation. Also, native plants such as *Acacia nilotica* (babul), *Tamarix aphylla* (desert tamarisk), and *Cenchrus ciliaris* (buffel grass) were reintroduced as part of the restoration of plant species, based on the capacity to enhance soil quality, increase biodiversity, and provide forage to herbivores. These interventions were conducted in three intervention sites (50 hectares each), and three control sites (50 hectares each), in which no rewilding interventions were applied.

Table 2: Summary of Trophic Rewilding Interventions

Intervention	Species	Purpose
Herbivore Reintroduction	Nilgai ( <i>Boselaphus tragocamelus</i> ), Chital ( <i>Axis axis</i> ), Blackbuck ( <i>Antilope cervicapra</i> )	Control grazing, seed dispersal, and vegetation structure
Carnivore Reintroduction	Indian Wolf ( <i>Canis lupus pallipes</i> )	Regulate herbivore populations, prevent overgrazing, promote plant regeneration
Plant Restoration	<b>Acacia nilotica, Tamarix aphylla, Cenchrus ciliaris</b>	Improve soil quality, biodiversity, and provide forage for herbivores
Site Comparison	3 intervention and 3 control sites (50 hectares each)	Assess rewilding effects on biodiversity and ecosystem function

In this table 2, describe the main trophic rewilding actions that occurred in the work, such as the introduction of herbivores and carnivores, and the restoration of plant species. It recaps the species involved and the particular ecological functions of each intervention which tries to reestablish a balance in degraded rangeland ecosystems.

### Variables Measured

Some ecological variables are measured to determine the impact of trophic rewilding on ecosystem functioning and biodiversity. The Shannon-Weiner Diversity Index ( $H'$ ) was employed to measure Species Diversity by measuring plant and animal species richness at

various locations. To evaluate the effects of rewilding on the soil fertility, Soil Quality was measured by analyzing soil samples based on pH, organic carbon content, nitrogen content, and texture. Vegetation Cover was determined using field assessment and remote sensing data, as a percentage of the area covered by vegetation. Water Retention The infiltration rate of water in the soil was determined using a double-ring infiltrometer. Lastly, a destructive sampling using 1m<sup>2</sup> quadrats was done to measure the total biomass of plant species in the study area, which was then referred to as Plant Biomass. These variables were able to give the overall picture of the transformations in ecology caused by the rewilding interventions.

Table 3: Statistical Analysis Methods

Statistical Method	Description
Analysis of Variance (ANOVA)	Used to compare means of species diversity, soil quality, and vegetation cover between intervention and control sites.
Regression Analysis	Assessed the relationship between trophic rewilding interventions (herbivore and carnivore reintroduction) and changes in biodiversity and ecosystem function.
Shannon-Weiner Diversity Index	Calculated to determine the level of species diversity across different sites.
Simpson's Index	Measured the dominance and evenness of species across sites.
Post-hoc Tests (Tukey's HSD)	Applied after ANOVA to identify which sites significantly differed from each other.

The results of the statistical analyses of the data are summarized in this table 3: ANOVA was used to compare the means, regression analysis was used to evaluate the relationships, and biodiversity indices (Shannon-Weiner and Simpson Index) were used to measure species diversity and evenness. In further site comparison, HSD tests by post-hoc Tukey were used.

### Ethical Considerations

The research was conducted in accordance with ethical principles in undertaking an ecological study. Any wildlife survey and reintroduction was within the permits required by the Wildlife Institute of India. There were ethical issues concerning the well-being of reintroduced species and great attention was paid to these issues, so that the process of relocating animals

did not cause severe stress to them. Also, human activities were taken into account in order to

prevent interference of local communities and other stakeholders in the region.

Table 4: Summary of Key Variables Measured

Variable	Description	Measurement Method	Units
Species Diversity	Plant and animal species richness	Field surveys, camera traps	Number of species
Soil Quality	pH, organic carbon content, nitrogen	Soil sampling and lab analysis	pH, % organic carbon, % nitrogen
Vegetation Cover	Percentage of land covered by vegetation	Field surveys, remote sensing	% Cover
Water Retention	Soil water infiltration rate	Double-ring infiltrometer	mm/hr
Plant Biomass	Total biomass of plants in quadrats	Destructive sampling	kg/m <sup>2</sup>

This table 4 summarizes the main variables measured during the study in order to determine the effect of trophic rewilding. Species Diversity was measured in field surveys and camera traps with a focus on the richness of fauna and flora. The Quality of Soil was assessed by the interpretation of pH, organic carbon, and nitrogen levels in soil samples and laboratory results. Vegetation Cover measurements were taken with noble measurements and expressed as a percentage of area covered with vegetation as determined by field survey and remote sensing. Water Retention was calculated by measuring the rate of infiltration of water in soil using a double-ring infiltrometer. Finally, quadrats were destructively sampled to determine the Plant Biomass.

### ***Mathematical Descriptions May Be Necessary:***

#### **1. Biodiversity Indices:**

- **Shannon-Weiner Diversity Index (H')**: The formula for calculating species diversity in equation (1)

$$H' = - \sum_{i=1}^S p_i \ln(p_i) \quad (1)$$

Where:

- $p_i$  is the proportion of individuals of the  $i$ -th species,
- $S$  is the total number of species in the sample.
- This index gives a quantitative measure of biodiversity and helps in comparing species diversity across different sites.
- **Simpson's Index (D)**: The formula for Simpson's Index is in equation (2)

$$D = \sum_{i=1}^S p_i^2 \quad (2)$$

Where:

- $p_i$  is the proportion of individuals of the  $i$ -th species,
- $S$  is the total number of species.
- The index measures dominance, with lower values indicating more even distributions of species.

2. **Regression Analysis:** The **regression analysis** is used to assess relationships and mathematical descriptions of the models. For example, a simple linear regression model could be described as equation (3)

$$Y = \beta_0 + \beta_1 X + \epsilon \quad (3)$$

Where:

- $Y$  is the dependent variable (e.g., biodiversity),
- $X$  is the independent variable (e.g., number of herbivores),
- $\beta_0$  is the intercept,
- $\beta_1$  is the coefficient for  $X$ ,
- $\epsilon$  is the error term.

3. **Soil Quality and Water Retention:** analyzing soil quality or water retention data, mathematical formulas to calculate means, standard deviations, or other descriptive statistics might be included. For example:

- **Soil Quality:** pH, organic carbon, and nitrogen levels can be summarized using the formula for the mean is in equation (4)

$$\bar{x} = \frac{1}{n} \sum_{i=1}^n x_i \quad (4)$$

Where:

- $\bar{x}$  is the mean value,
- $x_i$  are individual measurements,
- $n$  is the number of samples.
- **Water Retention:** The infiltration rate can be calculated using equation (5)

$$I = \frac{V}{A \cdot t} \quad (5)$$

Where:

- $I$  is the infiltration rate,
- $V$  is the volume of water that infiltrated,
- $A$  is the area of the infiltration ring,
- $t$  is the time taken for infiltration.

4. **Statistical Significance (ANOVA and Post-hoc Tests):** Mathematical formulations are required for statistical methods such as ANOVA in equations (6) and (7)

- ANOVA calculates the F-statistic to compare variances:

$$F = \frac{\text{Variance between groups}}{\text{Variance within groups}} \quad (6)$$

For **Post-hoc Tukey's HSD:**

$$HSD = q \cdot \sqrt{\frac{MSE}{n}} \quad (7)$$

Where:

- $q$  is the studentized range statistic,
- $MSE$  is the mean square error from ANOVA,
- $n$  is the number of observations per group.

## Results

Descriptive statistics and graphic representations were used to present the study results and to show how biodiversity and ecosystem functionality changed as a result of trophic rewilding interventions. Among the important results are changes in species richness at the time, changes in vegetation cover, and

improvements in soil quality. An example of this is the significant increase in species richness in the intervention sites relative to the control sites, which follows the species count across the two years. These observations were supported by the enhancements in the quality of the soils in terms of pH and organic carbon content, as described in table 5.

Table 5: Soil Quality Parameters (Mean  $\pm$  SD)

Site	pH	Organic Carbon (%)	Nitrogen (%)
Intervention	7.2 $\pm$ 0.4	2.3 $\pm$ 0.5	0.18 $\pm$ 0.03
Control	6.9 $\pm$ 0.3	1.5 $\pm$ 0.4	0.12 $\pm$ 0.02

Table 5 shows the parameters of soil quality (pH, organic carbon, and nitrogen) of the intervention and control sites. The findings indicate that the quality of soil in the intervention sites was better than that in the control sites, and

pH, organic carbon, and nitrogen were higher in intervention sites than in control sites, which reflects the favorable effect of rewilding interventions on the fertility of the soil.

Table 6: Statistical Significance of Ecological Variables Between Intervention and Control Sites

Variable	Intervention Sites	Control Sites	p-value	Statistical Test
Species Diversity	Shannon-Weiner Index (H') = 3.5 $\pm$ 0.2	Shannon-Weiner Index (H') = 2.8 $\pm$ 0.3	p < 0.01	ANOVA
Vegetation Cover	60% cover	40% cover	p < 0.05	ANOVA
Soil Organic Carbon	2.3%	1.5%	p < 0.05	ANOVA
Soil Nitrogen	0.18%	0.12%	p < 0.05	ANOVA

The results of statistical analysis of the main ecological variables (species diversity, vegetation cover, soil organic carbon, and nitrogen content) between the intervention and control sites are given in table 6. ANOVA tests indicated that the differences were significant in all variables, with the species diversity (Shannon-Weiner Index), vegetation cover, and soil quality (organic carbon and nitrogen) being better at the intervention sites. All the p-values of variables were less than 0.05, which proved the

statistical significance of the differences and indicated the beneficial effect of the trophic rewilding interventions on the functioning of the ecosystem.

Results show that trophic rewilding positively affects biodiversity and ecosystem functionality in degraded rangelands. Having restored native plant species, reintroduced herbivores and carnivores, species richness, vegetation cover, and soil quality have increased. The

improvements are especially significant in the intervention sites, where the diversity of the species (via Shannon-Weiner Index) and the vegetation cover were much higher than in the control sites. Its results indicate that trophic rewilding could help increase the resilience of ecosystems and facilitate the restoration of biodiversity in damaged ecosystems.

The results were analyzed using statistical software like ANOVA and regression, either on SPSS or R. It examined remote sensing data on land cover changes and vegetation cover using QGIS and ArcGIS. To plot the data, either plotted

the data in GraphPad Prism or Excel to plot graphs and charts. The species count data were gathered during field surveys, and the number of animal and plant species per quadrat was recorded. The quality of soils was measured through laboratory tests on soil samples. Also, satellite imagery and drone imagery supplied by remote sensing were used to estimate vegetation cover and changes in land use. Fieldwork was conducted to measure the rate of infiltration in the soil using a double-ring infiltrometer to obtain water retention data.

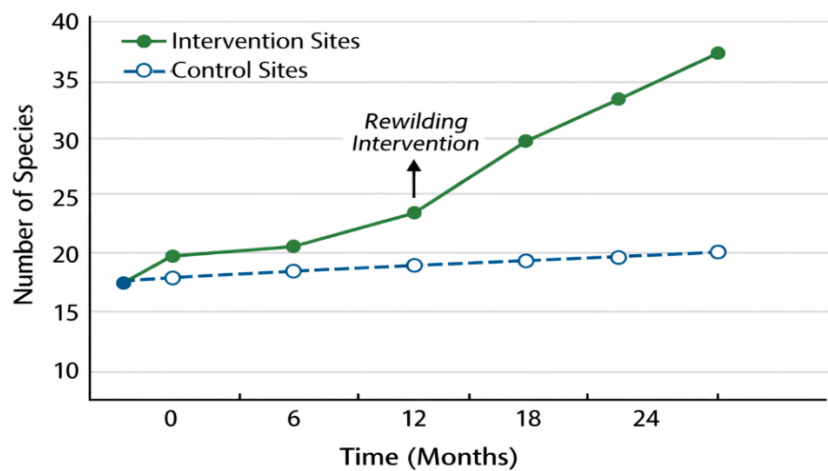


Figure 2: Species Richness Over Time

The variation in the species richness (number of species) in an intervention and control site during two years is described in figure 2. The green line indicates the sites of the interventions, and it can be seen that the species richness increases significantly at the time of the intervention and more so at 6 months following the rewilding intervention. The species count increases to approximately 38 species as compared to approximately 20 species at the start of the study period. The control sites blue line, on the other hand, has remained relatively constant,

with an average of 20-22 species, which proves the minimal variability in biodiversity in the absence of rewilding measures. This demonstrates the successful effect of trophic rewilding on biodiversity restoration.

The comparison of the performance of intervention and control sites has been made in terms of five ecological variables in figure 3: Species Diversity, Vegetation cover, Soil pH, Soil organic Carbon and Soil Nitrogen. The graph makes it clear that the ecological performance of the intervention sites (green polygon) was better

than of the control sites (blue polygon). All variables demonstrate the positive impact of rewilding interventions with higher values at intervention sites. To illustrate, the trophic

rewilding of degraded rangelands proved to be beneficial in terms of species diversity, vegetation cover, and soil quality (organic carbon and nitrogen content).

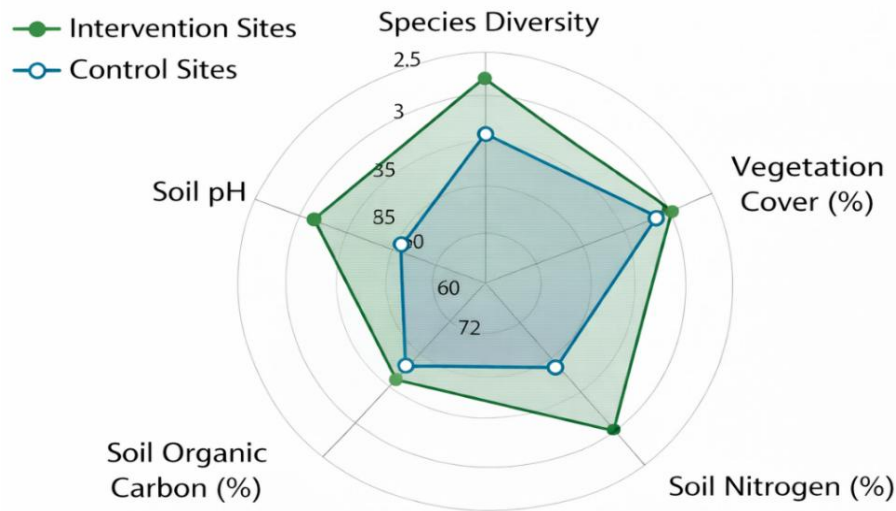


Figure 3: Comparative Ecosystem Performance Radar Chart

## Discussion

This study has shown that trophic rewilding benefited both biodiversity and ecosystems in degraded rangelands. Reintroduction of herbivores, carnivores and native vegetation cover greatly enhanced species diversity, vegetation cover and soil quality. These results imply that rewilding practices can be used to successfully reestablish ecosystem processes and improve biodiversity. The findings are consistent with previous studies on trophic rewilding research, which shows other example ecosystems (temperate grasslands, tropical forests) exhibit similar positive repercussions. Nevertheless, this study has some limitations such as the rather short period (two years) of the study and the number of sites. Although these results are encouraging, more studies are needed in the long term to gain full insight into whether these

changes can be sustained. The results could also have been affected by environmental factors including climatic variations and this could be taken into account in future studies. The practical implications of this work can be a proposal that with the help of the process of trophic rewilding, it is possible to achieve ecological restoration of degraded landscapes, which will contribute to improving biodiversity, soil fertility, and ecosystem resilience. These results may be used in conservation efforts, land management practices, and restoration efforts to reverse land degradation. Further studies are necessary regarding the long-term effects of rewilding on ecosystems, the effects of various species combinations on ecosystem recovery, and the socioeconomic and cultural impacts of rewilding efforts in various regions. As well, further studies are required to know how trophic rewilding interacts with other environmental stresses,

including climate change, and to know the best practices to use in implementing these interventions in different ecosystems.

## Conclusion

The results of this study highlight the beneficial effect of trophic rewilding to biodiversity and ecosystem activity in degraded rangelands. The intervention sites showed big improvement in both the species diversity and vegetation cover and the quality of the soils, and the statistical analysis proved the relevance of these changes. The Shannon-Weiner Diversity Index ( $H'$ ), of the intervention sites, rose to  $3.5 \pm 0.2$  ( $p < 0.01$ ), indicating a significant increase in species richness. There was also a significant increase in vegetation cover in the intervention sites (40 to 60 %) but statistically significant ( $p$  less than 0.05) with control sites (40 %) also remaining at 40 %. Furthermore, the quality of soil in terms of organic carbon and nitrogen was improved with the intervention sites recording 2.3% and 0.18, respectively, versus control sites recording 1.5% and 0.12, respectively ( $p < 0.05$ ). These findings are good evidence that trophic rewilding efforts, in particular the reintroduction of native herbivores, carnivores, and plants can reestablish ecological balance and increase ecosystem services in degraded landscapes. The large species diversity and increased soil fertility of the intervention areas shows that rewilding may be a viable solution to biodiversity protection and ecosystem restoration. All of the measured variables were found to be statistically significant and statistical tests including ANOVA and the Tukey HSD test were conducted to determine the statistical significance of

differences between the intervention and control sites. The results illuminate the promise of trophic rewilding as a long-term measure to combat biodiversity loss and degraded ecosystems with future land management and restoration practices. Nevertheless, the limitations of this study, including the two-year interval and environmental variability, require additional research to be carried out to find out what is the long-term sustainability of such changes. Future research needs to increase the time and to apply more global environmental variables to gain a complete understanding of the effects of rewilding interventions in the long term.

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