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**RESEARCH ARTICLE**

## Investigation into the Impact of Pika Population Dynamics on Grassland Degradation and the Development of Management Strategies: A Case Study Conducted in Sanjiangyuan National Park

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**ABSTRACT**

This study focuses on the dynamic changes of pika and rabbit populations in Sanjiangyuan National Park and its impact on grassland degradation. The Sanjiangyuan region, as an important part of the Qinghai-Tibet Plateau, has a unique ecosystem and rich biodiversity. As a key species in the area, the pika's activities play an important role in loosening the grassland soil and retaining moisture. However, due to the dual impact of climate change and human activities, the excessive growth of the pika population has led to the severe degradation of the grassland ecosystem and the formation of "black soil beaches", which not only destroys the natural recovery ability of the grassland but also affects the livelihood of local herders had a negative impact. In the context of global sustainable development, this study proposes a series of scientific and reasonable management measures, including the implementation of dynamic rotational grazing, returning grazing to grassland, forage planting, and green prevention and control of pikas, etc., to achieve the goal of realizing cattle, sheep, and pasture and ecological coordination among pikas. At the same time, the study emphasizes the in-depth understanding of the role of pikas in the ecosystem and their relationship with grassland degradation through scientific research, providing a scientific basis for formulating effective ecological protection and restoration strategies. In addition, the study also puts forward suggestions for establishing a sound legal and regulatory system, strengthening protected area management institutions, and promoting public participation, publicity, and education. These measures aim to ensure that ecological protection work in Sanjiangyuan National Park is effectively implemented and to promote the sustainable development of local communities. The case of Sanjiangyuan National Park has important reference significance at the global level, demonstrating how to achieve a balance between economic development and environmental protection through ecological protection and restoration work. This has a guiding role for other regions around the world facing similar ecological problems and will help promote the implementation of the global sustainable development agenda. In short, the ecological protection and management of Sanjiangyuan National Park requires the joint efforts of the government, scientific research institutions, local communities, and the international community to achieve long-term ecological security and sustainable development.

**KEYWORDS**

Grassland degradation; biodiversity; sustainable development.

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**1. Introduction**

Sanjiangyuan National Park, located in the hinterland of the Qinghai-Tibet Plateau, has a unique ecosystem and rich biodiversity and is known as the "Chinese Water Tower". Pikas are small mammals endemic to the region, and they play an important role in

grassland ecosystems. By digging burrows, pikas help loosen the soil and retain moisture, playing a positive role in maintaining the ecological balance of the grassland Zhang and Wang (2018). However, in recent years, due to the impact of climate change and human activities, the grassland ecosystem in this region has faced serious degradation problems, and the excessive growth of the pika population will destroy vegetation, lead to grassland degradation, and form the so-called "black soil beach." This not only affects the natural resilience of grasslands but also affects the livelihoods of local herders.

In the context of global sustainable development, it is of great significance to study the population dynamics of pikas and formulate management strategies in Sanjiangyuan National Park (Wang, 2017). Because pikas are a food source for many carnivores, this is related to the protection of biodiversity. An imbalance in their numbers may affect the entire food chain, and grassland degradation will aggravate soil erosion and affect water conservation functions, thereby affecting water resources in downstream areas. Security is a threat. In addition, grassland degradation will exacerbate climate change because healthy grasslands can absorb and store large amounts of carbon, slowing the rate of global warming.

To achieve sustainable development, scientific and reasonable management measures need to be adopted, such as dynamic rotational grazing, returning grazing to grassland, pasture planting, and green prevention and control of pikas, etc., to maintain the ecological coordination of cattle, sheep, pastures, and pikas. At the same time, through scientific research, a better understanding of the role of pikas in the ecosystem and their relationship with grassland degradation can provide a scientific basis for formulating effective ecological protection and restoration strategies. At the global level, the case of Sanjiangyuan National Park also demonstrates how to achieve a balance between economic development and environmental protection through ecological protection and restoration work. This has reference significance for other regions around the world facing similar ecological problems and will help promote the implementation of the global sustainable development agenda.

## **2. Research Object**

Sanjiangyuan National Park is located on the Qinghai-Tibet Plateau (Li & Dong, 2019). The ecosystem here is unique and fragile, giving birth to rich biodiversity. The area is home to many rare and endangered species, such as Tibetan antelopes, snow leopards, black-necked cranes, etc. These species are vital to maintaining ecological balance. However, due to climate change, interference from human activities, and other factors, the living environment of these species is facing unprecedented threats. Studying the biodiversity of the Sanjiangyuan can help us better understand the ecological needs of these species, assess the threats they face, and formulate effective conservation measures. For example, by establishing protected areas and implementing species monitoring and habitat restoration projects, these species can be provided with a safer living space, thereby protecting biodiversity and maintaining the integrity and stability of the ecosystem (Chen, 2021).

The ecological environment of the Sanjiangyuan region has been severely degraded due to overgrazing, mining, climate change, and other factors. Problems such as grassland degradation, soil erosion, and lake drying not only affect the quality of life of residents but also pose a threat to the water security of downstream areas. Ecological restoration work has become the key to restoring the ecological functions of the Sanjiangyuan River. Studying the ecological degradation mechanism of Sanjiangyuan can provide a basis for formulating scientific and reasonable restoration plans. For example, through the implementation of ecological projects such as returning grazing land to grassland, soil and water conservation, and vegetation restoration, the soil structure can be improved, the vegetation coverage rate can be increased, and the water conservation function can be restored, thereby effectively curbing the trend of grassland degradation (Zhao, 2020). In addition, by establishing an ecological monitoring network, the progress of ecological restoration can be monitored in real-time, the restoration effect can be evaluated, and the long-term effectiveness of restoration measures can be ensured.

The research on Sanjiangyuan National Park not only has theoretical value but also has practical significance. Through scientific research, we can provide decision-making support to policymakers and help them better balance the relationship between ecological protection and economic development (Sun, 2016). For example, by studying the ecological carrying capacity of the Sanjiangyuan region, we can provide a scientific basis for rational planning of tourism development, agricultural and animal husbandry production, and other activities and avoid new damage to the ecological environment (Liu et al., 2018). At the same time, research can also help local communities develop eco-friendly industries, such as eco-tourism, organic agriculture, etc., providing new sources of income for residents and achieving a win-win situation between ecological protection and economic development (Wang & Chen, 2009).

## **3. Literature Review**

### ***3.1 Research on Pika and Rabbit Ecology***

Song and Mi (2022) salt content generally showed a trend of first low and then high ( $P < 0.05$ ), soil moisture decreased but not generally ( $P < 0.05$ ), species richness showed a trend of first high and then low but still not common ( $P < 0.05$ ), soil temperature was

not significant ( $P < 0.05$ ). In terms of habitat selection in central and southern Tibet, plateau pika prefers places with relatively moist soil, low soil salt content, sufficient content at the next trophic level, and places far away from the previous trophic level. Road planning, grazing choices, distance from rivers, distance from modern facilities, and altitude are all factors that need to be considered when selecting pika habitats. Li (2019) believes that the frequent occurrence of rodent infestations in the Ruoergai Grassland is a typical ecological problem. Vulnerable zone. Comparing pika-affected areas with unaffected areas, it can be found that the land quality has declined significantly, with above-ground biomass decreasing by 48%-87%, underground root organisms decreasing by 17%-62%, and vegetation types decreasing by 24%. -88%, the grass layer height decreases by 38%-79%, and the vegetation coverage decreases by 18%-43%. The dominant populations in the grassland community changed from Poaceae and Cyperaceae to herbaceous grasses, and plant diversity values decreased significantly. The biomass of underground roots showed a very obvious positive correlation with the biomass of Gramineae and Cyperaceae, and the number of effective caves showed a significant negative correlation with the biomass of forbs. From the plant greening stage to the withering stage in the pika-infested area, soil urease, sucrase, alkaline phosphatase activities, and bacterial numbers showed a trend of first increasing and then decreasing. Taking the ecological protection of Sanjiangyuan National Park as an example, Liu et al. (2010) combined the findings of researchers in the cellular automatic diffusion model to simulate the spread of plateau pikas and believed that large vegetation biomass (height) can provide survival resources for more plateau pikas. However, as the vegetation biomass (height) continues to increase, the pika's limited vision cannot detect predators at the previous trophic level in time. Therefore, in an environment where the vegetation biomass (height) is too large, the pika will give up. This life. When the grazing intensity is small, the vegetation height is affected by the grazing system as follows: summer field (grazing from April to September), continuous grazing (grazing throughout the year), rotational grazing (grazing in even months), winter field (grazing from October to March) grazing) vegetation decreases in sequence. When the grazing intensity is relatively high, the continuous grazing pasture has the lowest vegetation. Because grazing intensity affects vegetation biomass (height), it can inhibit or promote the environmental capacity of pikas. Therefore, Sanjiangyuan National Park strictly controls grazing intensity; Yang (2017) believes that biological control is mainly carried out in Sanjiangyuan National Park. Experiments on *Eimeria* parasitism were carried out on plateau rats and rabbits, and it was found that as the dose of coccidia or synergist increases, the mortality rate of rats and rabbits increases. The cause of death is higher due to multi-factor infection than due to single-factor infection. Under experimental conditions, 1.6 million coccidias and synergist 400MLD, and synergist 2025MLD and 400,000 coccidias have the best effect. However, rodent eradication also requires choosing the right time. If rodent eradication is carried out during the non-breeding season of plateau pikas, then rodent eradication at any time will not have a major impact on the long-term development of the population. Therefore, for rodent control work related to Sanjiangyuan National Park, *Eimeria* parasitism is generally carried out during the breeding season of plateau pikas and rabbits.

### **3.2 Research on the Relationship Between Grassland Degradation and Pikas**

Song et al. (2018) believe that pikas are not the cause of grassland degradation but a manifestation of the result. She pointed out that the increase in the number of pikas is the result of grassland degradation, not the cause. Due to grassland degradation, vegetation coverage decreases, which is a reason for rats. Better conditions were provided for rabbits to survive and reproduce, increasing the pika population. Andrew Smith and George Schaller believe that the plateau pika is a "keystone species" in the alpine meadow area, and their existence is crucial to maintaining the health and biodiversity of the ecosystem. They emphasize that the pika's burrows provide space for a variety of animals. The activities of pikas help to renovate the soil and recycle materials. Qu et al. (2007) of the Northwest Plateau Institute of Biology, Chinese Academy of Sciences, combined with the fact that the pros and cons of pikas on grassland depend on their number and population density, suggested that overgrazing is the main cause of grassland degradation, and pikas may become Catalyst for further deterioration. Zhao Xiang believes that in the Sanjiangyuan region, the pika and rabbit extermination policy involves the interests of many parties, and the solution to the problem is relatively complex. He emphasized that conservation biologists, private conservation organizations, and government departments need to be open and honest to eliminate the barriers between science and policy. Form a plan that satisfies the demands of all parties. Professor Johannes Knops and Dr. Li Wenjin proposed that using high-cost, labor-intensive poisoning methods to eliminate small mammals in grasslands (such as plateau pikas) may cause potential harm to non-target species, reduce the number of natural enemies, and cause ecosystem imbalance. They recommend using nature-based control strategies, such as using natural enemies and other ecological factors, to maintain pika populations.

### **3.3 Research on Pika Management Strategies and Policies in Sanjiangyuan Park**

The first phase of the Sanjiangyuan Ecological Protection and Construction Project, which was implemented in 2005, includes a pika management project with an investment of 157 million yuan. It aims to control the number of pikas through chemical, artificial, and other methods to protect grassland and water sources. The second phase of the Sanjiangyuan Ecological Protection Project was launched in 2014, with a planned investment of 650 million yuan to complete the prevention and control of pikas and rabbits on 46.7 million acres and plateau zokors on 7.63 million acres in the Sanjiangyuan area. As a patented invention of rodent control technology, the "secret-style artificial cave for wild animals" can effectively attract natural enemies of rodents to live and breed, thereby controlling the number of pikas and rabbits, helping to restore ecological balance and promote grassland restoration. This

technique is considered an eco-friendly method of rodent control. Wang (2023) believes that the construction practices of Sanjiangyuan National Park include systematic and comprehensive management, strengthening the construction of institutions and mechanisms, coordinating green and coordinated development, and promoting co-construction and sharing. These measures are designed to ensure the integrity and authenticity of the ecosystem while promoting human and Natural harmony and symbiosis. Zhang et al. (2023) from the Northwest Institute of Plateau Biology, Chinese Academy of Sciences, revealed a new mechanism for plateau pikas to adapt to the low-oxygen environment of the Tibetan Plateau. They found that there is a high content of homotetrameric hemoglobin in the lung surfactant of plateau pikas. This protein helps obtain oxygen from low-oxygen environments and is of great significance to understanding the adaptability of plateau pikas in alpine ecosystems.

#### **4. Research Suggestions and Countermeasures**

##### ***4.1 Establish a Sound Legal and Regulatory System***

First, special national park laws and regulations need to be formulated or revised, such as the “Sanjiangyuan National Park Regulations”, to clarify the national park’s protection objectives, management principles, functional zoning, and protection measures. These regulations should cover ecological protection, resource utilization, environmental education, scientific research, tourism management, etc., to ensure that all activities are conducted within the legal framework (Brown & White, 2017). Secondly, environmental supervision and law enforcement should be strengthened to ensure that laws and regulations are effectively implemented. This includes setting up specialized management agencies, such as the National Park Service, to be responsible for daily management and supervision, establishing an environmental law enforcement team to investigate and punish violations, and establishing a reporting and reward mechanism to encourage the public to participate in supervision. In addition, it is also necessary to strengthen the connection with international laws and regulations, such as the Convention on Biological Diversity and the Convention for the Protection of World Natural Heritage, to ensure that the protection of Sanjiangyuan National Park meets international standards. Through international cooperation, advanced protection concepts and technologies can be introduced to improve protection levels. Finally, the establishment of a legal and regulatory system should be a dynamic process. With the deepening of scientific research and the accumulation of conservation practices, laws and regulations should be continuously revised and improved to adapt to new conservation needs and challenges (Zhang & Wang, 2016). Through these measures, a solid legal foundation can be provided for the long-term protection of Sanjiangyuan National Park.

##### ***4.2 Strengthen Protected Area Management Institutions***

First, an efficient and professional management team should be established, composed of experts with multi-disciplinary backgrounds in ecology, environmental science, law, and management. This team is responsible for developing and implementing the park’s conservation plan, overseeing day-to-day operations, and responding to a variety of environmental issues (Li & Zhao, 2018). Secondly, the management agency should have sufficient resources and authority, including human, financial, and material resources, to support its implementation of protection tasks. This includes regular ecological monitoring, assessing the survival status of species in protected areas, and implementing necessary ecological restoration projects (Wang & Li, 2019). At the same time, management agencies should have the power to impose penalties for violations of conservation regulations to ensure that regulations are strictly enforced. In addition, management agencies should strengthen cooperation with local communities, encourage residents to participate in conservation work and improve their environmental awareness through education and training. Community participation not only helps improve conservation efficiency but also promotes local economic development and achieves a win-win situation between ecological protection and community interests. Finally, management agencies should establish cooperative relationships with domestic and foreign research institutions, non-governmental organizations, and international conservation organizations to share conservation experiences and introduce advanced conservation technologies and management methods (Zhao & Zhang, 2020). Through these measures, the management agency of Sanjiangyuan National Park will be more professional and efficient, providing a solid guarantee for the protection of this precious natural heritage.

##### ***4.3 Promote Public Participation Publicity and Education***

First, information about the Sanjiangyuan ecosystem, biodiversity, and conservation efforts can be provided to the public by establishing education centers and visitor centers. These centers can hold exhibitions, lectures, interactive workshops, and other activities to enhance public awareness of the importance of the Three Rivers Source. Second, develop environmental education programs, especially in schools and communities (Li & Wang, 2016). Through courses, field trips, and volunteer service projects, we educate young people and residents about the importance of ecological protection and cultivate their environmental awareness and action. Additionally, educational materials and online resources can be developed to make relevant information easily accessible to more people. In addition, media and social platforms were used to promote the protection work of Sanjiangyuan and increase public attention (Zhang & Li, 2017). Through documentaries, news reports, social media posts, etc., we showcase the beauty and challenges of protected areas and inspire public enthusiasm for conservation. The public can also be encouraged to participate in conservation activities such as afforestation, clean-up operations, wildlife monitoring, etc. By participating in these activities, the public not only directly contributes to conservation efforts but also enhances their sense of identity and responsibility

for conservation efforts. Finally, public participation mechanisms, such as public consultation and crowdfunding for conservation projects, should be established to allow the public to play a role in the decision-making process. This sense of participation can promote public understanding and support for conservation work and create a good atmosphere for the whole society to participate in conservation (Wang & Zhang, 2018). Through these measures, we can effectively improve the public's environmental awareness and promote the sustainable development of Sanjiangyuan National Park.

## 5. Conclusion

In this study, we deeply explored the impact of pika population dynamics on grassland degradation in Sanjiangyuan National Park and proposed corresponding management strategies. As an important part of the Qinghai-Tibet Plateau, the health of the Sanjiangyuan region's ecosystem is not only related to the maintenance of regional biodiversity but also has a profound impact on global climate change and water resource security. As a key species in this ecosystem, fluctuations in its population directly affect the ecological balance and degradation process of the grassland.

By studying the population dynamics of pikas in Sanjiangyuan National Park, we found that there are complex interactions between excessive growth of pika populations and grassland degradation. Although the digging activities of pikas help loosen the soil and conserve moisture, when their numbers are out of control, they can cause vegetation damage and aggravate grassland degradation. Therefore, formulating reasonable pika management strategies is crucial to maintaining the ecological balance of the Sanjiangyuan region.

In formulating management strategies, we proposed a series of scientific and reasonable measures, including implementing dynamic rotational grazing, returning grazing to grassland, planting pasture, and green prevention and control of pikas. These measures aim to achieve ecological coordination between cattle, sheep, pastures, and pikas, and at the same time, through scientific research, better understand the role of pikas in the ecosystem and provide a scientific basis for ecological protection and restoration.

In addition, we also emphasized the importance of establishing a legal and regulatory system, strengthening protected area management institutions, and public participation and education. Through these measures, we can ensure that the ecological protection work of Sanjiangyuan National Park is effectively implemented while also promoting the sustainable development of local communities.

In the context of global sustainable development, the case of Sanjiangyuan National Park provides us with valuable experience. It shows how to achieve a balance between economic development and environmental protection through ecological protection and restoration efforts. This has important reference significance for other regions around the world facing similar ecological problems and will help promote the implementation of the global sustainable development agenda.

In short, the ecological protection and management of Sanjiangyuan National Park is a long-term and complex process that requires the joint efforts of the government, scientific research institutions, local communities, and the international community. Through scientific and reasonable management measures and continuous scientific research, we are confident that we can protect this precious ecological treasure.

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