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A Model Study on Promoting the Integration of Animal Habitat Conservation and Cultural and Ecological Development in Zibo Region through a Digital Platform

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***Abstract.*—As a key area of ecological protection in Shandong Province, Zibo area has rich animal resources and profound Qi cultural heritage. This paper examines the current state of animal habitats and their cultural and ecological characteristics in the Zibo area, revealing conflicts between animal habitats and both nature reserves and surrounding scenic spots and forest parks. These conflicts lead to resource management issues and ecosystem endangerment. The study proposes to build a digital platform to integrate the biodiversity database, infrared camera monitoring network and cultural resources mapping to realize intelligent planning and public participatory conservation of animal migration corridors. In addition, the "government-led + multi-party synergy" mechanism is used to emphasize the combination of policy support and community participation, and to promote the ecological compensation system and benefit-sharing model. Finally, the multilevel protection system can reduce the impact of human activities and improve the smooth progress of animal habitat protection, providing a practical framework for biodiversity conservation and cultural and ecological integration in industrial transition cities.**

Keywords. Zibo area; animal habitat; cultural and ecological characteristics; digital platform; biodiversity

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Introduction

Against the background of the idea of ecological civilisation, China's ecological environmental protection has undergone historic turning points and global changes, and the construction of ecological civilisation has made world-renowned achievements (Kang et al., 2021). At the same time, the advancement of urbanization has brought about problems such as fragmentation of urban habitats, imbalance and degradation of ecosystems, invasion of exotic species, bestiality and environmental pollution, which have triggered society as a whole to think about the sustainable development of cities and the development of urban biodiversity (Yurui et al., 2021). In this context, urban biodiversity to maintain urban system ecological security, ecological balance and improve the urban habitat has been paid attention to, on the green space ecological network, landscape security pattern vegetation planning compilation, low carbon city planning and other aspects of the launch of a large number of theoretical research, design and practical exploration, and attempts to optimize the collection of ecological data through the digital platform, analysis and dynamic monitoring, and achieve rich results (Ahumada et al., 2019). The city has achieved rich results. Focusing on urban biodiversity protection cannot be separated from both the research on the main body of urban organisms and the research on the survival carriers of urban organisms (Fergus et al., 2023). With the help of a digital platform for accurate simulation and dynamic management of urban animal habitats, migration paths and other survival carriers, we can more scientifically analyze the mutualism and game relationship between urban animals and the built environment, and this research direction has been emphasized by the academic community (van Oppen & Coleman, 2022).

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Literature Huang et al. (2024) suggests that protecting the habitat of species is crucial, as the gradual decrease in forest and water areas each year impacts their survival. The optimization scheme of "one zone, two belts, and multiple points" is proposed to establish ecological forest reserves, build and protect ecological corridors, and protect and build ecological nodes. Literature Isabelle and Westerlund (2022) proposes a framework for analyzing the application of artificial intelligence in wildlife, marine and terrestrial conservation. It constructs a conceptual framework of "measurement-monitoring-mitigation" in the context of global climate change and biodiversity crisis to classify the application of artificial intelligence for conservation. Literature Vergara-Tabares et al. (2020) suggests that human encroachment on natural habitats has severely damaged biodiversity. Agricultural expansion will further jeopardize the survival of animals to the brink of extinction, and endangered animals can be protected by establishing conservation hotspots. Literature Bashir et al. (2020) found that with the growth of the population, food and environmental problems are becoming more and more serious, and biological survival space is also becoming less and less. They proposed a rice-fishery co-cropping system as a new rice production mode that can improve the biological survival space and increase muscle biodiversity. Literature Plieninger et al. (2021) explored the biodiversity conservation issues involved in this system from different perspectives, and now the system is facing economic, political and other driving factors, which lead to land use changes and pressure on the animal survival environment, which in turn affects the diversity of animals and ecosystem services. Literature Kattel (2022) suggests that the rate of climate warming in the Himalayan region is much faster than expected and has already led to glaciers beginning to melt at an accelerated rate, posing a serious threat to local biodiversity, ecosystem functioning and ecosystem services. Biodiversity conservation and sustainability of ecosystem services can be maintained by strengthening climate data monitoring and applying a multi-indicator approach. Literature Banks-Leite et al. (2020) found that habitat loss, fragmentation and degradation are seriously threatening global biodiversity. That habitat expansion and restoration can be used to stop biodiversity loss and mitigate climate change impacts.

Many of the above mentioned scholars have conducted research from different perspectives and have proposed diverse ideas and strategies. In view of the reduction of forests and waters affecting species survival, a framework for analyzing the application of AI in wildlife, marine and terrestrial conservation has been constructed, advocating the establishment of conservation hotspots to protect endangered animals. At this stage, habitat loss, fragmentation and degradation are serious threats to global biodiversity, and habitat expansion and restoration are proposed to mitigate the problem. In view of this, this paper, under the premise of promoting the integration of animal habitat protection and cultural and ecological development in the Zibo region, combines the digital platform augmented reality technology to create an immersive nature education experience, and develops tourism products, which can both develop the tourism industry and effectively reduce the pressure on the physical environment. Hierarchical protection and multi-party collaboration can significantly alleviate the contradiction between protected areas and community development, and provide feasible paths for ecological protection and cultural inheritance in industrial transition cities.

Analysis of the current situation of animal habitats in Zibo area

Diverse habitat types

Located in the central part of Shandong Province, Zibo region is situated in the transition zone between the central Lu mountainous area and the north Lu plain, with superior geographic location and convenient transportation, it is a national ecological county, a national historical and cultural city, and a national tourism resort, enjoying a history of more than 2,000 years of county establishment, with numerous scenic spots and traditional villages, and possessing a wealth of historical and cultural resources. (Huang et al., 2022). As a key area for ecological protection in Shandong Province, Zibo City has ecological core areas such as Lushan Provincial Nature Reserve, and the digital platform can record more than 1,200 species of wildlife and 1,006 species of vascular plants. The intervention of the digital platform provides a new idea for cracking the ecological dilemma. By building a collaborative ecological data governance platform, it can integrate biodiversity databases, habitat dynamic monitoring networks, and environmental and cultural resource mapping, thereby enabling intelligent planning of animal migration corridors, public participatory ecological protection, and other multi-scenario applications.

Abundant animal resources

Wildlife is an important part of the ecosystem and a valuable treasure given to people by nature. Protecting wildlife is not only an action to implement the important content of ecological civilization thought, but also a concrete measure to implement the major national strategy of ecological protection and high-quality development of the Yellow River Basin (Wu et al., 2020). According to the statistics of nature reserve management organizations, Zibo City accounts for 3.8% of the total land area of Shandong Province, is located in the East Asia-Australia migratory bird migration belt, and has a semi-humid and semi-arid continental climate. The territory is rich in forest resources and wetland resources, and is the staging area and wintering place for the migratory birds such as the great swan, the little swan and the egret. According to Zibo Biological Resources, there are 265 species of birds in the city, of which two species of wild birds are protected at the national level, namely the golden eagle and the white-tailed sea eagle. National secondary protection of five species of wild birds, respectively, gray forest owls, eagle owls, spotted owls, eagles, kestrels, wildlife resources are relatively rich.

Status of nature reserves

Table 1 shows the statistics of human activities in the nature reserves of Yuanshan and Lushan in Zibo region, which mainly face the following challenges:

(1) Cross-overlapping between the two reserves and other protected areas in the region is prominent, with the scope overlapping between the Yanshan Provincial Nature Reserve and three protected areas, including the Boshan National Scenic Spot, the Yanshan National Forest Park, and the Lianli Lake Provincial Water Conservancy Scenic Area. Lushan Provincial Nature Reserve and Boshan National Scenic Area, Lushan National Forest Park, Yiyuan Lushan National Geological Park, Yiyuan Lushan Provincial Forest Park, as well as Yiyuan Ape Ruins Cave Cluster Provincial Scenic Area, Yiyiheyuan Provincial Wetland Park, Yiyiheyuan Provincial Scenic Area, and so on, 7 places of the protection of the existence of overlapping crosses, the functional area of the positioning of the conflict, the direction of the development of the inconsistency for the problem of rectification and standardization of management Bringing difficulties, this is the actual challenge faced by the two protected areas in Zibo, and is also a common problem in many protected areas.

(2) Scope delimitation, lack of demonstration, and historical legacy problems. In the delineation of the boundary of the two protected areas, also the two protected areas of villages, farmland, caretaker houses and other aboriginal production and living facilities problems account for more than 85% of the total number of problems in the protected areas, for the protected areas resource management, forest fire prevention, forestry law enforcement and other standardized management brings great difficulties (Tuia et al., 2022).

(3) The two protected areas are established on the basis of two state-owned forest farms, protection and management mainly rely on the two forest farms, which is neither in line with the nature reserve laws and regulations on the relevant provisions and spirit of the nature reserve management organization, but also difficult to achieve full coverage of supervision and management. Although Boshan District and Yiyuan County have subsequently set up protected area management offices, there are still practical problems such as poor coordination, and the management system needs to be improved.

Table 1: Statistics of human activities in Yuanshan and Lushan provincial nature reserves

	Yuanshan Provincial Nature Reserve			Lushan Provincial Nature Reserve		
Activity Type	Total	Quantity/place	Percentage/%	Total	Quantity/place	Percentage/%
Working conditions	368	8	2.17	122	16	13.11
Tourism		33	8.96		3	2.45
Small and micro enterprises		7	1.90		11	9.01
Residential areas and other livelihood facilities		320	86.95		92	75.40

Interpretation of the cultural ecology of Zibo area

Deep historical and cultural heritage

As the birthplace of Qi culture, Zibo carries thousands of years of historical inheritance. Since the Western Zhou Dynasty, when Jiang Taigong sealed Qi and built the country, the capital city of Qi, Linzi, became the political, economic and cultural center of the Orient at that time, which gave birth to the dazzling Qi culture. With the progress of society and people's material and cultural standards continue to improve, clothing, food, housing, transportation and other basic amenities improved, people's tourism mentality, aesthetic interests and viewing tastes have had significant changes in the tendency to seek new tourism products, seeking beauty, seeking the strange, and seeking the special increasingly strengthened. Throughout the past two decades in Zibo heritage attractions construction practice, cultural relics protection construction projects have been built or are being prepared, basically following this standard (Rubel et al., 2025). Whether it has been developed and opened to the public Qi Culture Museum containing Qi Culture Museum, Football Museum and many other museums, for Zibo City, focusing on building the museum set, Linzi Chinese Ancient Vehicle Museum, Jiang Taigong Ancestral Hall, Guanzhong Memorial Hall, or under construction in the archaeological site park of the Old City of Qi, are all high taste of the cultural heritage, is a unique tourism resources, is irreplaceable material and cultural wealth.

Colorful historical folk culture

Zibo has a wealth of historical and cultural relics, the main street is a historical street, formed in the middle of the Ming Dynasty, the middle of the Qing Dynasty to improve the status quo, composed of the main street, silver market street, etc., here has produced "Ruifuxiang" and many other business names, known as "China's living ancient commercial street", "China commercial market museum" (Rubel et al., 2025). In addition, Zibo covers market trade customs, including market division, trading process, market intermediary, the use of cryptic language and other customs. Store workshop customs encompass capital combination, selection and employment, distribution of benefits, and other aspects. Push merchants and hawkers customs, including social status, behavioral habits, etc. Building and living customs include the sale of foundations, the choice of auspicious ground and other customs. Festivals and folklore, such as the Spring Festival, Lantern Festival, and other festivals, encompass people's beliefs, which involve the object of belief, worship rituals, and more. Entertainment and acrobatic customs, including the activities of entertainment venues, playing iron flowers and so on. There are also forms of folk organizations, such as the Lüzu Society and other forms of organization, as well as financial pawning customs, such as silver money exchange, deposits and loans, etc., the history of folk lodging culture is rich and colorful.

Application of digital platforms in animal habitat conservation

Given the comprehensive status of Zibo region animal habitat development and its deep, colourful cultural and ecological heritage, the application of digital platforms can better promote the synergistic development of the two, thereby achieving the purpose of regional cultural and environmental protection.

Dissemination of knowledge on wildlife conservation

Digital platforms are carriers of wildlife conservation that are more convenient and accessible to the public. Its carriers include both shared platforms and the more convenient mobile apps and WeChat public numbers. Not only is the dissemination of information faster, but it is also supported by a large user group, which can widely disseminate the awareness of wildlife protection and wildlife knowledge, and can better achieve the purpose of wildlife protection. The public can use the fragmented time of playing cell phones to learn about wildlife protection and understand the common sense wildlife protection knowledge needed in daily life.

Achieving all-round protection of wildlife

The digital wildlife conservation platform envisioned in this paper consists of three linked platforms, including a wildlife monitoring information sharing platform, an animal habitat protection app, and a WeChat public number. While the wildlife monitoring information sharing platform provides professional wildlife conservation information for professionals, the WeChat public number and cell phone app are designed for the general public to give relatively detailed, extensive, and more comprehensible information, as well as to provide the general public with access to wildlife rescue. The multi-platform linkage can maximize the realization of joint protection of wildlife by all groups in society, which is conducive to a more comprehensive, multi-dimensional and multi-level protection of animal habitats.

Digital technology protection means for animal habitats in Zibo area

Information-sharing platform for animal habitat monitoring

Modern scientific and technological means have begun to be widely used in wildlife monitoring and research, such as DNA barcode technology in molecular biology technology, infrared camera technology in digital imaging technology, network information technology and so on. In particular, infrared camera technology and satellite radio remote sensing technology play an unrivaled role in determining the habits, population size and general activity range of wild animals, and have obvious superiority. However, due to the late start and slow development of wildlife conservation in animal habitats, the lack of long-term and comprehensive monitoring data has become a significant problem for animal conservation (Brandon, 2024).

The initial idea to solve this problem is to establish a public information platform for animal habitat monitoring data, and use this platform to contact different monitoring research teams to achieve the sharing of monitoring data. A comprehensive data set, or database, encompassing image, video, and audio data sets, individual animal activity trajectories, patterns, and population migration and dispersal patterns, should be constructed to realise the informatisation, networking, and visualisation of the monitoring data, and to achieve the digital scientific protection of animal habitats. The platform should establish standardized analysis criteria for all uploaded image data, and set up various types of databases, photo libraries and species distribution maps according to the monitoring areas and taxa, so as to standardize data management and data analysis, and to ensure that the users can quickly, accurately and comprehensively obtain the required monitoring data. Due to the fragmented distribution of most of the distribution areas and the narrow space for activities, animal habitats are subject to the high intensity of human activities, which exacerbates the conflicts that may arise between human activities and animal habitats. It is hoped that through such platforms, animal habitats, especially rare and endangered species and taxa, can be identified in a more timely, comprehensive and scientific manner.

Design of the Mobile App

The overall design is pre-designed to focus on the camera function, with the emphasis on generating information about the plants and animals in the photos, such as their names, Latin scientific names, protection levels, habits, etc., by recognizing the images taken or the content of the photos provided by the user. A special concept in the design involves adding pictures or descriptions of the toxins, bacteria, and parasites that the plant or animal may carry, which can cause discomfort to humans. This information is complemented by the symptoms of the relevant illnesses that may also cause pain. This design aims to prevent users and their acquaintances from consuming or improperly using wild animals, thereby destroying their living environment. Additionally, it seeks to educate people about the importance of not consuming wild animals, thereby protecting their habitats from disturbance.

At the same time, the rescue and reporting function as the App's auxiliary function The App can recommend simple rescue methods based on the injured photos provided by the user, and use the GPS system to locate the user's location and provide him with the address and contact information of the nearest rescue center around. The reporting function establishes a network channel between the Forestry Bureau's back office and the App, enabling users to report incidents to relevant departments quickly and conveniently. This process ensures a certain degree of security and confidentiality, providing a safe habitat for animals in a timely manner.

Mechanisms for integrating cultural ecology and animal habitat protection

On the basis of the digital platform, a series of measures and means can also be used to achieve the integration of animal habitat protection and cultural and ecological development, and to promote the direction of ecological civilization in the Zibo region towards a new course.

Cultural dissemination and educational functions

Ecological culture represents a shift from a culture of human domination over nature to one of harmony between humans and nature. Animal ecological culture, in particular, is a culture where humans and animals coexist harmoniously to maintain environmental balance. The richer the diversity of animals in the ecosystem, the more complex the food chain, the stronger the ability of the ecosystem to resist the interference of external forces, therefore, animals are consumers in the food chain, but for the evolution of species can always play a positive role in promoting the evolution of animals can significantly improve the efficiency of the material cycle in the ecosystem and benefits. Many of the mysteries of the animal world have been gradually unearthed by mankind and revealed in various forms. Forest park is a small ecosystem in which animals play an essential role. By excavating the animal science culture in forest parks, it can make human beings understand more about the habits and lifestyles of animals, and live in harmony with them, so as to achieve the purpose of protecting animal habitats. The animal science culture in forest parks can be divided into 3 modules, the animal knowledge module includes Insect World, Fish World, Beast Family, Reptile World, Amphibian Spectacle, Bird Paradise. Animal and bionic module that imitates specific structures and functions of living creatures to invent and create a variety of instruments and equipment, animal and bionic culture is an integral part of animal science culture, anecdote module through the record of interesting things that happen to animals, can increase the closeness of human beings to the animals, and unconsciously form the habit of animal habitat protection.

Balance between tourism development and ecological protection

The digital platform utilizes virtual reality (VR) and augmented reality (AR) technologies to develop virtual tourism products for animal habitats and cultural attractions in Zibo, so that tourists can experience the natural scenery and cultural charms of animal habitats in a virtual environment, and reduce interference with the actual habitats (Huang, 2023). The construction of digital archives is the foundation, and 3D scanning technology and digital modeling technology should be used to make a comprehensive digital record of the nature reserve, which can not only provide a reference for the protection work, but also provide data support for the repair and reconstruction when the original structure is damaged by the occurrence of disasters or other unforeseen factors. At the same time, a digitized archive can be established, making it an essential resource for studying the survival and development of animals. Promote the integration of digital technology with traditional restoration techniques, including the use of digital technology to record and analyze the construction methods and material properties of conventional buildings, the use of modern technology to imitate traditional materials, and the use of virtual reality technology to simulate and demonstrate restoration effects. While improving the economic benefits of the region, it is also able to protect animal habitats to a certain extent.

Government-led policy support and planning

Animals are the mainstay of maintaining ecological balance and protecting biodiversity, and are the key link of the community of life in mountains, waters, forests, fields, lakes and grasses. Animal resources are rich in variety and widely distributed, and play a key role in maintaining the balance of ecosystems and restoring ecological resources. At the same time, animal resources also play a unique role in promoting human health, passing on human civilization, and promoting harmonious coexistence between human beings and nature. Animal protection is not only a key initiative to maintain animal resources, but also an essential part of ecological civilization construction (Schellnack-Kelly, 2022). The digital platform builds environmental corridors and biodiversity conservation networks to enhance ecosystem quality and stability. Based on the digital platform, a protected area system will be constructed by integrating and optimising various types of nature reserves. This will inevitably bring animals and their ecological corridors into these reserves, ultimately helping to achieve comprehensive and effective protection of animal habitats. The effectiveness of nature reserve protection inevitably affects the overall effect of animal protection, and the cooperation of neighboring communities is crucial for nature reserves to achieve good protection results. Therefore, the active participation of the surrounding communities in the conservation activities of nature reserves is critical to the effective management of nature reserves and the realization of their goals. At the same time, whether the residents of the surrounding communities can obtain the necessary benefits from the nature reserves and animal protection, and realize the increase of their own income, so as to promote the orderly development of regional culture and ecology, is the key to the realization of the objectives of nature reserve management. It is this interactive relationship that makes the comprehensive and systematic protection and utilization of animal resources, and the promotion of regional cultural and ecological integration, so as to achieve a win-win situation of protection and income, and become one of the regional development measures.

Synergistic mechanisms for multi-party cooperation

Collaborative governance is a governance method that can maximize the benefits of habitat protection and cultural ecology, which is mainly in the composition of

multiple subsystems composed of government agencies, social organizations, enterprises, citizens and other social public subjects. It primarily consists of four levels, with diversified objects of governance, and the subjects of social public governance include government and non-government, organizations and individuals, and for-profit and non-profit organizations. The synergy of subsystems, which involves the protection of animal habitats, extends beyond mere "action" and "inaction." It requires collaboration with other social organisations and individual citizens to establish a cooperative relationship, thereby maximising the role of the government and various subsystems. The dynamics of the system, each subsystem plays a different governance function at different times and places, which requires the subsystems to respond to multiple situations at different times and places with a flexible mode of action, and to take responsibility for what they do, so as to better promote the protection of animal habitats and the integration of the culture and language ecology.

Conclusion

Zibo, as an important area for ecological protection in Shandong Province, presents a diversity of animal habitats at this stage, and the rich animal resources face challenges such as inconsistency with the direction of regional development. The digital platform offers an innovative approach to integrating animal habitat protection, culture, and ecology. This paper leverages the platform to disseminate wildlife protection knowledge, thereby enhancing the protection of animal habitats. In addition, the wildlife monitoring information sharing platform, cell phone App, and other digital technologies can facilitate more scientific monitoring and protection of animal habitats, thereby realising the advantages of all-around protection. At the same time, the digital platform can also promote cultural dissemination and education, balance tourism development and ecological protection, and use VR, AR and other technologies to develop virtual tourism products, which not only reduces the interference with the actual habitat, but also enhances the cultural experience. Meanwhile, the construction of a government-led, multi-party cooperation and integrated development model is the key to achieving long-term goals. By continuously optimizing the innovative management platform and benefit distribution mechanism, Zibo is expected to explore a characteristic path of ecological revitalization in industrial cities, providing practical references for similar regions.

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