Study on wildlife protection technology of Xinjiang freeway in China

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Abstract: In this study, it first introduces the research progress of wildlife conservation technology in western countries and analyzes the limitations of wildlife conservation technology in China. Taking the construction project of Urumqi-Yuli freeway in Xinjiang as an example, the main wildlife species and habitats along the route are summarized, and the research contents of wildlife protection in the future are elaborated, including the ecological information of wildlife, the impact of highway construction on wildlife, the key technology of wildlife protection passages, the research of wildlife intelligent monitoring and security measures. Finally, it puts forward some suggestions to guide the road construction and wildlife protection in the future.

1. Introduction

Wildlife is an important part of the natural ecosystem and an essential resource of human society. Its protection and development has been widely concerned by the society[1].Previous studies have shown that the impacts of highway construction on wildlife include: road lethality, limited population movement and diffusion, reduced population settlement rate, increased risk of extinction, blocked genetic exchanges, and habitat fragmentation[2].As early as the 1950s and 1960s, some ecologists and non-governmental organizations began to pay attention to the impact of roads and railways on wildlife habitats and their direct damage to their lives. Some European countries have begun to design and use wildlife passages to protect limited biodiversity resources, especially in developed countries such as Britain, France, Germany, Switzerland and the Netherlands, which have a long history of research. At present, the research on wildlife in foreign countries mainly focuses on three aspects: the basic research of road ecology, the analysis of the effect of highway network on wildlife, the design method of wildlife protection channel and the formulation of standards and specifications. In 2002, Forman et al. published the huge book "Road Ecology: Science and Solutions"[3], which discussed in detail the formation basis and development process of road ecology and the relationship between roads and various landscape elements and flora interaction. In 2004, the Netherlands implemented the habitat connectivity program. Firstly, the fragmentation effect of wildlife habitats in the highway network was evaluated at the national level. Based on the evaluation results, the best location of wildlife corridors was identified, and the fundamental measures to solve the connectivity of wildlife habitats were proposed from the source. Setting up animal passage in freeway construction is one of the effective measures to alleviate the impact. In recent decades, the Netherlands, Belgium, Australia, Japan, South Korea, Malaysia, the United States and other countries have carried out in-depth research on the passage types, target species, passage site selection, passage design, passage monitoring and other aspects [4,5]. The first wildlife passage was built in the United States in 1955, and the first in Europe in 1974. The overpass wildlife passage built on the highway in Banff National Park in Canada in 1982 is still a model of highway wildlife protection project. The multifunctional up-span passage in Crailoo, the Netherlands, is the largest wildlife passage in the world. In the formulation and application research of the standards and specifications of wild animal protection passages. The Washington Department of Fish and Wildlife prepared a fish passage design manual in 2000.The "Handbook of Structural Design and Evaluation of Wild Animal Passages", "Safe Passages Highways, Wildlife, and Habitat Connectivity [6]" and "Wildlife Crossing Structure

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Handbook: Design and Evaluation in North America[7]"published in the United States proposes different design requirements for different animal passage types.

It wasn't until 2003 that some Chinese researchers conducted preliminary research on the protection of wildlife in the construction of the Qinghai-Tibet Railway, and specially built a Tibetan antelope animal channel, which means that China is in line with the international concept of "harmony between man and nature". In 2006, Dai Qiang et al studied the impact of roads and road construction on small mammals and birds in Zoige alpine wetland. According to Chen Aixia's review, the road construction will destroy the original soil and vegetation of the road habitat, and will produce noise and light pollution in the operation. The cutting of the road to the habitat will hinder the animals and reduce the range of animal activities. The review by Wu Shengde and others mentioned that the use of woodland in road construction will harm animals, especially amphibians and reptiles with poor mobility. The noise and vibration generated during construction will drive animals, making the density of animals increase in some areas, and then affect the survival of certain animals [8]. In recent years, in the construction of highways in ecologically fragile areas, some wildlife protection measures have emerged one after another. In December 2004, the Zhumadian-Xinyang Expressway in Henan Province set up several dedicated wildlife passages for the first time. In 2018, the Haikou Ring Expressway first introduced the concept of biodiversity passage. In terms of standards and specifications for wildlife passages, compared with foreign countries, China is still in its infancy. It still lacks specific technical requirements and parameter indicators, and has little guidance for engineering construction [9,10].

Table 1. The list of key species of possible wildlife along Urumqi-Yuli freeway [11]

Family	Chinese name	Latin name	English name	Protection grade	Habitat Type	IUCN Red List Category
Bovidae	北山羊	*Capra sibirica*	Siberian Ibex	I	A,C	LC
Felidae	雪豹	*Panthera uncia*	Snow leopard	I	A,D	VU
Bovidae	盘羊	*Ovis ammon*	Wild Sheep	II	A	NT
Mustelidae	石貂	*Martes foina*	Stone marten	II	A,D,E	LC
Cervidae	马鹿	*Cervus elaphus*	Red Deer	II	B,C,D	LC
Ursidae	棕熊	*Ursus arctos*	Grizzly Bear	II	B,C	LC
Bovidae	鹅喉羚	*Gazella subgutturosa*	Gazelle	II	B,C,D	EN
Felidae	兔狲	*Felis manul*	Manul	II	B,D,F	NT
Mustelidae	狗獾	*Meles meles*	Eurasian Badger	II	A,D,E	LC
Leporisde	塔里木兔	*Lepus yarkandensis*	Tarim Rabbit	II	D	NT
Canidae	赤狐	*Vulpes vulpes*	Red Fox	II	A,B,C,D	LC
Mustelidae	白鼬	*Mustela erminea*	Stoat	II	A,D,E	LC
Mustelidae	香鼬	*Mustela altaica*	Mountain Weasel	II	A,D,E	NT
Cervidae	西伯利亚狍	*Capreolus pygargus*	Siberian Roe Deer	II	B,C,D	LC
Mustelidae	艾鼬	*Mustela eversmanii*	Ermine	II	A,D,E	LC
Ochotonidae	伊犁鼠兔	*Ochotona iliensis*	Ili pika	II	A,C	EN

Notes: “I” represents National First-class protective wildlife; “II” represents National Second-class protective wildlife; “A” represents Alpine bare rock and Plateau, “B” represents Forest and Shrubt, “C” represents Alpine stepped” represents Cold desert, “E” represents River, Lake, Swap and Wetland, “F” represents Oasis Agriculture Area; LC represents Least Concern, EN represents Endangered, NT represents Near Threatened, VU represents Vulnerable.

The Urumqi-Yuli freeway in Xinjiang is the main arterial route connecting the southern and Northern Xinjiang across the Tianshan Mountains. As the North-South resource and national defense channel, it plays an important role in China's national road network. The rare wild animals distributed along the Urumqi-Yuli freeway are abundant in variety and quantity, many wildlifes are listed on the IUCN Red List of endangered species and China red data book of endangered animals (CRDB). And so it has always been concerned by scholars and animal protectionists. It is valuable to carry out the research on animal protection, which can provide reference for the policy formulation, the establishment and improvement of laws and regulations of wildlife protection related management institutions. and it can provide scientific basis for wildlife protection theoretical research, channel construction, monitoring and maintenance, which is of great significance to solve the problems of wildlife protection in highway construction (Table 1).

2. The limitations of research on road-wildlife conservation in China

2.1 The research on the effect of road construction on wildlife is lack of theory and guidance

It refers to the research on the impact of highway on wildlife in is mainly based on engineering practice, and there is a lack of systematic research on road ecology, conservation biology and landscape ecology.

2.2 The site selection of wildlife passage is not scientific and applicable

The method of wildlife survey is relatively simple. The site selection of road animal passage is directly provided based on the experience of forestry department and environmental protection department. It lacks habitat connectivity analysis and scientific demonstration of site selection [12].

2.3 The types and specifications of wildlife passages are not scientific and innovative

At present, the types of wildlife passage in China are very single, which are basically combined with bridge and culvert design. It lacks of new special access and selection methods of different types of animal passage, such as considering the factors of habitat, terrain, species habits and so on. In addition, there are few domestic researches on passage design parameters, including channel number, spacing, size and so on.

2.4 The conservation and animal habitat design of wildlife passages are lack of pertinence and systematicity

Up to now, there are few studies on the induced habitat of animal passage in China, especially in the aspects of vegetation design, water system design, terrain design and micro environment construction; and there is almost no design for the protection facilities design of animal passage in terms of barrier design, noise reduction and visual interference reduction [12].

3. Research contents

3.1 Study on ecological information of wildlife

It mainly uses online data collection, on-site investigation, 3S technology extraction and other means to systematically collect and organize a series of ecological information such as the species, quantity, living conditions and migration patterns of wildlife in the project route corridor.

3.2 Study on the impact of road construction on wildlife

It mainly analyzes the lethal effect, avoidance effect and population isolation of wildlife along the Urumqi-Yuli freeway in Xinjiang to guide the planning and design of wildlife passages.

3.3 Study on key technology of wildlife protection passages on freeway

By analyzing channel characteristics (length, width, height, open rate, etc.), highway traffic characteristics (noise, traffic volume, etc.), and surrounding landscape characteristics (habitat types, human interference, etc.), etc., and using statistical analysis methods to establish different wildlife passages prediction model; We can analyze the life and migration characteristics of wild animals to optimize the design of animal passages, and summarize the technical parameters of animal passage design principles, passage location, quantity, size, type, surface design, monitoring system, supporting facilities, etc.

3.4 Study on intelligent monitoring of wildlife and safeguard measures for highway operation

It includes research on highway wildlife intelligent monitoring system and evaluation system, And we can study multiple measures to ensure the safety of highway operations, including warning signs, speed limit devices, channel sound barriers, isolation barriers and other auxiliary measures and induced habitat creation. Finally, we can combine the intelligent monitoring data of animal protection passages to comprehensively evaluate the effectiveness of induced habitats and auxiliary measures, and further propose optimization schemes.

4. Conclusion and recommendations

With the development of the society, more and more attention will be paid to wildlife protection. We propose that we should consider the current situation and characteristics of wildlife protection in China to carry out the following research, including carrying out more basic scientific research on wildlife protection, attaching importance to the research and development of highway wildlife access technology, strengthening the application and demonstration of technical achievements, and then forming standardized documents.

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Conflict of interest

The authors declare that there is no any conflict of interest regarding the publication of this article.

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