Dynamic Distribution Changes of Giant Pandas and Human Disturbance in the Habitat of Qionglai Mountains

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Abstract The giant panda (*Ailuropoda melanoleuca*), as a rare and endangered wild animal in China, has attracted wide attention from all walks of life. In this study, the changes of disturbances in the habitat of giant panda population in the Qionglai Mountains of Sichuan Province were studied and analyzed by comparing the data of two giant panda surveys in Qionglai Mountains and combining with the remote sensing (ES) data of related areas. The results showed that the number of general disturbances in the habitat of giant pandas in Qionglai Mountains greatly reduced in 10 years, and the types of disturbances also changed greatly. The logging disturbance which was most distributed in the third survey almost disappeared in the fourth survey, and the grazing disturbance in the habitat became the disturbance type with the highest encounter rate. The density of human activities in the whole mountain system greatly decreased, but the scope was slightly expanded. Baoxing and Lushan were areas with high density of giant panda activities, and the number of various human activities was relatively large. In the two surveys, the avoidance effect of giant pandas on logging, grazing, roads, hunting and other disturbances showed significant differences. The activity density of local small populations of giant pandas in Qionglai Mountains changed.

Key words Qionglai Mountains; Giant panda; Human disturbance; Dynamic distribution change

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Disturbance is a common phenomenon in nature. According to its origin, it can be divided into two types: human disturbance and natural disturbance. Disturbance occurs at any time and place in different ways, and the impact on the ecosystem may be slight or devastating. Each kind of disturbance has its own unique properties, such as disturbance intensity, disturbance range, action frequency, and continuous process. Disturbance is the main factor affecting species diversity. In natural ecosystems, natural disturbance generally includes climate change, forest fires, wind falling, earthquakes, pests and diseases, bamboo flowering, *etc.*, which are part of natural ecosystems[2]. Man-made disturbance refers to the phenomenon of natural system changes caused by human beings, in order to meet their own needs and utilization of natural resources, such as forest logging, traffic roads, hunting, grazing and tourism resource development[3]. Human disturbance has a strong color of the times, such as large-scale forest logging in the 20th century and large-scale tourism resources development today. Studying the distribution of all kinds of disturbances and its impact on animal and plant resources is conducive to grasping the current situation of animal and plant resources and carrying out targeted protection and management, so as to achieve the goal of maintaining ecological balance and sustainable development of species.

As an endangered species endemic to China, the giant panda (*Ailuropoda melanoleuca*) is known as a "national treasure" and a "living fossil" and listed as an endangered species by the International Union for Conservation of Nature (IUCN). In 1988, China listed the giant panda as a Class I key protected animal[4]. As the flagship species of biodiversity in the world, the giant panda, although it retains the digestive characteristics of carnivores, has gradually transformed into a herbivore with bamboo as its staple food in the long-term evolution process with the change of environment[5].

Small-scale ecological changes and strategies of individuals and populations under human disturbance and natural disturbance are an important part of the structural and functional changes of ecosystems[6]. Ecological changes and strategies are of great significance to the survival and reproduction of species. The research results of ecological effects of small-scale disturbance can also provide theoretical and scientific basis for the work of relevant protection and management institutions.

Research Method

The survey on general disturbances in the giant panda habitat was carried out simultaneously with the survey on giant panda population and vegetation transect. The route method was used for investigation. After a disturbance type was found, it was filled in a disturbance questionnaire. The general disturbance records of two giant panda surveys were vectorized using Arcgis10.2. All the general disturbance records in the research area of Qionglai Mountains were determined by connecting the vector areas of Qionglai Mountains, and the data analyzed in this chapter were further determined. In Arcgis, the field records of various types of disturbances in the two giant panda surveys were mapped, and the changes in the occurrence range and main occurrence areas of various types of disturbances in Qionglai Mountains during the two giant panda surveys were determined. Kernel density analysis was conducted on giant panda points and disturbance points using

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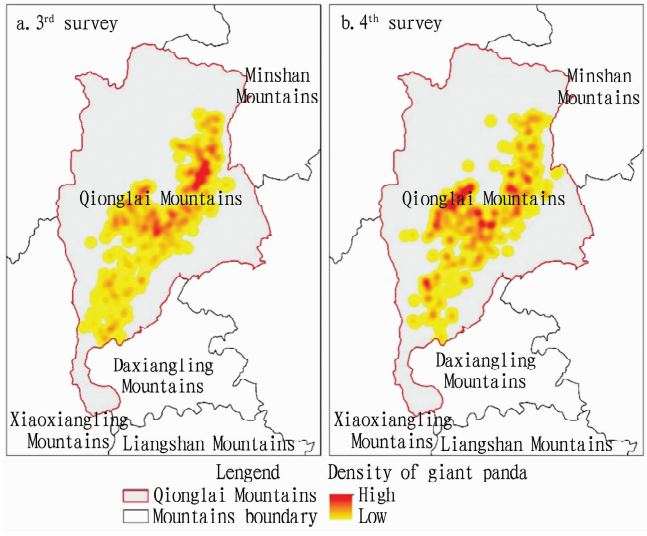
Arcgis10.2, and the panda points and disturbance points recorded in the two giant panda surveys were divided into high-, medium- and low-density areas according to their occurrence intensity. The positional relationship between various types of recorded disturbance points and the distribution of giant panda trace points was determined. Through the contingency table analysis of SPSS 22.0, independence tests were conducted on the avoidance effect of giant pandas on various kinds of disturbance in the third and fourth surveys. The significance level of all analyses was set to 0.05.

Research Results

Comparing the density of giant panda activity points in the two surveys (Fig. 1a), we could find that the high-density areas in the third survey were mainly concentrated in the following areas: Xiushuigou and Longchigou – Tongcaogou on the east side of Wolong Town, 303 Provincial Road, Yanwogou – Langjiagang area in the north of Hetaoping, Mahuanggou in Baoxing County, Fengtongzhai Township of Fengtongzhai Nature Reserve and Huangshuihe – Luchang area. Generally speaking, among the four local populations of the whole Qionglai mountain giant panda population, the lowest distribution density of giant pandas was the Sanhe local population bordering Daxiangling at the southernmost end, and the trace points of giant pandas in this local population mainly showed medium- and low-density distribution. The highest density was observed in the Xiling Snow Mountain – Jiajin Mountain local population, which spanned four nature reserves, namely Wolong, Anzi River, Heishui River and Fengtongzhai, and was the core distribution area of giant pandas in Qionglai Mountains. In addition, the Baisha River local population and Wolong – Caopo local population also had high activity density of giant pandas in some areas. As far as the whole Qionglai Mountains was concerned, the activities of giant pandas were relatively concentrated, and most of them were in the middle and northern sections of the mountain range.

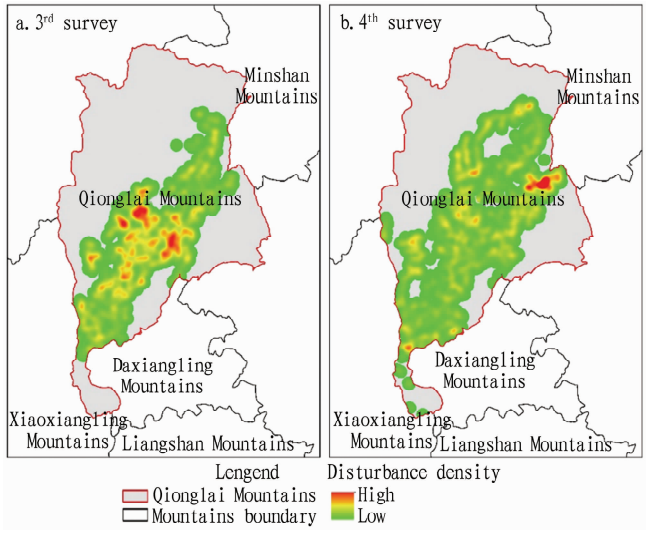
From the overall distribution of disturbances in the entire mountain range, the disturbance intensity decreased during the fourth survey, and high-density disturbance areas mainly appeared in the surrounding areas of Shuimo Ancient Town in Wenchuan County, while during the third survey, counties such as Baoxing, Lushan, and Tianquan in the middle of the mountain range were all areas with high frequency of disturbance. In addition, from the perspective of distribution range, the disturbance distribution range recorded in the fourth survey was larger than that of the previous survey, and it was connected to the south and east in the Siguniang Mountain Nature Reserve and Miyaluo Nature Reserve.

The trace points of giant pandas in the two field surveys were spatially connected with recorded disturbance points using Arcgis10.2, and the number of various general disturbance factors in each giant panda quadrat and the appearance of various general disturbance factors in control quadrats were recorded. All quadrats were divided into four categories: undisturbed panda quadrats, disturbed panda quadrats, undisturbed control quadrats and disturbed control quadrats, and the number of quadrats was counted. Independence tests was conducted to test the independence of the four kinds of quadrats in SPSS 22.0, to determine the avoidance effect of giant pandas on different types of disturbances in the two surveys and whether the avoidance effect of giant pandas on various types of disturbances changed between the two surveys (Fig. 2).



a. the density of giant panda trace points in the third survey; b. the density of giant panda trace points in the fourth survey.

Fig. 1 Density chart of giant panda trace points in Qionglai Mountains



a. the disturbance density the third survey; b. the disturbance density the fourth survey.

Fig. 2 Density map of general disturbance points in Qionglai Mountains

In Table 1, the comparative analysis on the disturbance avoidance effect of giant pandas in the two surveys included 11 types of general disturbances, which were recorded in both the two giant panda surveys. In addition, two kinds of natural disturbances, landslide and bamboo flowering, were only recorded in the

third survey, and five kinds of human disturbances, such as firewood cutting, fire trace, other collection, hydropower station and power transmission line, were only recorded in the fourth survey, so the seven kinds of disturbances were not compared and analyzed.

Table 1 Independence checklist on avoidance effect of giant pandas in Qionglai Mountains on some types of disturbances

Type of disturbance	Survey	Appearance of panda but no disturbance//%	Appearance of panda and disturbance//%	No panda and no disturbance//%	No panda but appearance of disturbance//%	X^2	P
Highway	3rd	16.73	0.29	72.30	10.68	9.306	0.025*
	4th	6.37	0.02	89.06	4.55		
Logging	3rd	12.29	2.85	53.09	31.77	43.927	0.000**
	4th	6.61	0.02	92.40	0.98		
Grazing	3rd	14.61	1.35	63.16	20.88	15.697	0.001**
	4th	6.19	0.14	86.54	7.14		
Hunting	3rd	17.95	1.10	77.56	3.39	8.151	0.043*
	4th	6.63	0.03	92.70	0.65		
Cutting of bamboo and bamboo shoots	3rd	17.85	0.92	77.14	4.09	9.131	0.028*
	4th	6.58	0.04	92.04	1.34		
Digging of medicinal herbs	3rd	17.75	1.13	76.71	4.40	8.971	0.030*
	4th	6.57	0.09	91.91	1.44		
Farming	3rd	17.30	0.07	74.77	7.86	9.309	0.025*
	4th	6.51	0.02	91.07	2.41		
Tourism and leisure	3rd	18.58	0.04	80.30	1.08	6.376	0.095
	4th	6.60	0.01	92.32	1.07		
Fire disaster	3rd	18.69	0.12	80.77	0.41	6.366	0.095
	4th	6.67	0.00	93.32	0.01		
Mining	3rd	18.13	0.05	78.33	3.49	7.137	0.068
	4th	6.61	0.01	92.47	0.91		
Others	3rd	17.88	0.09	77.27	4.76	9.008	0.029*
	4th	6.63	0.01	92.72	0.65		

The results showed that among the 11 kinds of common disturbances, the avoidance effect of giant pandas on logging disturbance ($P=0.000$) and grazing disturbance ($P=0.001$) was significantly different between the two surveys. The avoidance effect of giant pandas on highway disturbance ($P=0.025$), hunting disturbance ($P=0.043$), bamboo and bamboo shoot cutting disturbance ($P=0.028$) and medicinal herb digging disturbance ($P=0.030$) was extremely significant different between the two surveys. There was no significant difference between the two surveys in the avoidance effect on tourism and leisure disturbance ($P=0.095$), fire disaster disturbance ($P=0.095$) and mining disturbance ($P=0.068$).

Discussion

Some research and analysis in the Qinling Mountains show that many important factors related to the giant panda habitat have an impact on a large scale, including the formulation and implementation of national policies (such as natural forest protection, and returning farmland to forests), the construction of roads and other infrastructure, and ecological processes (such as the flowering of bamboo, the staple food of giant pandas)[7-8]. In addition to the important factors listed above, combined with the analysis of Qionglai Mountains itself, the source of economic income of residents around the giant panda habitat, the infrastructure construction of residential areas around the habitat (such as roads and power transmission lines for every village) and the economic development demands of local governments (mining, tourism resources development and hydropower station construction) will all affect the living environment and growth of giant pandas to a certain extent.

During the 10 years of the two surveys, the disturbance of human activities faced by the giant panda habitat in Qionglai Mountains changed to a great extent. The first was logging, and the destruction of forests is the most direct and effective threat to the survival of giant pandas. Since the implementation of various ecological engineering projects at the end of the last century, logging disturbance has shown a significant reduction in large areas. At that time, forest industry enterprises even partially transformed and carried out the protection of giant pandas and achieved good results. However, it should be noted that logging disturbance accounted for 4.37% of the total disturbance in the fourth survey, and it is still not extinct. In addition, we should also attach great importance to poaching in the habitat. In the two surveys, poaching increased from 58 times to 116 times, with an obvious increase.

The results of the fourth giant panda survey showed that the activity density of giant pandas in Wolong Nature Reserve obviously

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exhibited moderate NPMS (1.71 million), and the individual differences were small. The ABSP of Nuogu pigs was lowest (6.6%), with great individual differences. The ABSPs of Kele pigs and Zongdi Hua pigs were higher, at 16.8% and 14.6% respectively, and the differences among individuals were small. Imported and bred breeds: Topigs showed highest sperm motility (61.7%), with smallest individual differences. Landrace pigs had the highest NPMS (177 million), but there were great individual differences. French Yorkshire performed the worst, and the individual differences were small. The ABSPs of Duroc and Large Yorkshire were 9.9% and 9.0%, respectively, showing stable performance. Topigs exhibited lowest ABSP (8.0%) and smallest individual differences. The ABSPs of other breeds were higher (18.1%), and they showed great individual differences. There were significant differences in sperm motility and ABSP among native breeds ($P < 0.05$), while imported breeds showed significant differences in NPMS and ABSP ($P < 0.05$). Imported and bred breeds with strict breeding and excellent genetic background showed significant advantages in sperm motility of frozen semen and have higher breeding efficiency. In contrast, native Guizhou breeds had strong adaptability in specific environment, but there were great differences among individuals. In order to improve semen quality and overall reproductive efficiency, breeding management and technical optimization should be strengthened, and long-term qualitative selection and domestication should be carried out. Molecular genetic methods can also be considered to improve pig breeds that are not tolerant to freezing[10]. In addition, because the age and daily management of boars also affect the quality of semen to a certain extent, the scale of experiments should be further expanded to reduce the influence caused by other factors, and frozen semen may have an impact on the genetic performance of pigs[12], so further relevant research can be carried out.

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decreased, while in the habitat outside the nature reserves such as Baoxing County, Xiaojin County and Tianquan County in the middle and south sections of the mountains, the activities of giant pandas were frequent. Therefore, it is necessary to expand the protected areas in these areas or build new protected areas of giant pandas, so as to prevent the impact of human activities on the giant panda population. The comparative analysis on the avoidance effect of giant pandas on partial disturbances showed that there were significant differences in the avoidance effect of partial disturbances between the two surveys, including logging, grazing, hunting, highways and other types of disturbances.

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