

# Urban and Rural Environmental Management Strategy Based on the Cause of Bird Death Investigation: The Context of Wumeng Mountainous Area

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## Research article

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# Abstract

With the continuous deterioration of the ecological environment in the Wumeng mountain area, the number of birds has gradually decreased in recent years. To find out the cause of bird death, the author team up with many bird lovers and zoologists to collect bird corpses in the Wumeng Mountain area with large topographic changes and rich geomorphic types from 2018 to 2020 in this area. With anatomical analysis and pathogen detection, the main findings include: (1) The number of bird deaths has not increased due to the extreme high temperature in 2020 in Wumeng mountainous area. (2) The main causes of bird deaths are pesticide, rodenticide and birds-building collision. (3) Most birds died in summer and winter, which are mainly poisoned by insecticide in summer and killed by glass impact and Rodenticide in winter. (4) The dead birds are mainly local dominant species (sparrows, white babblers, great tits and Northern Redstart). From the findings, we can infer that the main cause of bird death has little to do with weather changes and avian influenza virus in Wumeng Mountain area, but closely related to human agricultural production and construction activities. Accordingly, we put forward some suggestions and Strategies of urban and rural spatial environment management, hoping to provide reference for urban and rural ecological construction and bird protection in Wumeng Mountain area.

## 1. Background

With the global urbanization and industrialization, China's urban and rural spatial environment is also deteriorating, especially in the Wumeng Mountain area, many crisscross roads, railways and rural roads gradually insulate and fragment the habitat on which wildlife depends, and its species and quantity decrease significantly (Xu, Z C., 2019). Wild boar, rabbit and elk, which were common in the 1980s, are now hard to find (Shwartz A., 2014). There are only some birds that can be found in the field investigation, although the species and number of birds have decreased sharply, they are one of the most important indicator species in the ecosystem (Solange F G., 2021). The species of birds at the top of the ecological pyramid is one of the most disturbing species in the process of urbanization, they are extremely sensitive to habitat and environmental changes (Sulaiman, et al., 2013). The rise and fall of birds will also have a certain impact on the environment, which is an important factor to maintain the ecological balance of nature.

The Wumeng Mountain area is the largest karst continuous belt in the world (Wan, J. 2003), with a series of vulnerability characteristics such as low environmental capacity, high eco-environmental sensitivity, weak anti-interference ability and poor stability (Liu, SL., 2019). the mountains are steep, with many peaks, Urban construction land, cultivated land and mountains are intertwined, forming a typical intersection of natural environment and artificial environment, providing diversified habitats for birds (Rubén O Á., 2021). However, in recent years, bird corpses have been frequently found in these areas. There are robust indications of the increase of the intensity and frequency of extreme weather and climate events over the recent decades (Ummenhofer and Meehl, 2017), so some scholars believe that the frequent death of birds related to climate change exacerbates the survival pressure of migratory birds (Wilson et al., 2019). But in Wumeng mountainous area, most Many people believe that the decline of

birds is closely related to human activities, to confirm this hypothesis and find out the cause of bird death, the author team up with many bird lovers and zoologists to collect bird corpses and carry out anatomical analysis and pathogen detection, in order to provide a scientific basis for the protection of birds and Urban and rural spatial optimization.

## **2. Methods**

### **2.1 Materials**

#### **2.1.1 Research object**

The research selected Beipanjiang River Basin (Qujing and Liupanshui prefecture) in the Wumeng Mountain area at the junction of Yunnan and Guizhou Province as the representative, research area is about 3000 square kilometers(Fig. 1). Research object includes 181 bird corpses which were randomly collected in forest land, cultivated land, roadside, house side, roof and urban area as.

#### **2.1.2 Experimental materials**

Dissect the fresh bird corpses that have not deteriorated, aseptically collect the bird gastrointestinal secretions, gastric contents and different tissues such as heart, liver, spleen, lung, kidney and intestine, and store them in a refrigerator.

#### **2.1.3 Pesticide and Rodenticide testing materials**

20% ferrous sulfate solution, 5% ferric chloride solution, 10% sodium hydroxide solution, 5% sodium hydroxide solution, 1% resorcinol ethanol solution, alcohol lamp, alkali esterase test, glass slide and filter paper

#### **2.1.4 Identification materials of pathogens**

Agar powder, ordinary agar plate, blood agar plate, yeast extract, tryptone, biochemical coding identification tube of non-fermenting bacteria, biochemical coding identification tube of Enterobacteriaceae, PCR instrument, electron microscope, avian mycoplasma kit, avian pox kit, etc.

## **2.2 Methods**

### **2.2.1 Bird corpses collection**

Publicly publish the reward information of bird corpse report on the Internet and social media. After receiving the report information of bird corpses, the team members immediately rushed to the scene to number the location of the incident(Fig. 2), and recorded the time, location, coordinates, bird species and physical characteristics of bird corpses in detail according to the designed statistical questionnaire.

### **2.2.2 Characterization observation**

In combination with the on-site conditions, observe the characteristics of bird corpses, such as weight, feathers, skin, bleeding and salivation at the corners of the mouth, and judge whether birds die due to human shooting, predation, fighting, hail, dash against curtain wall or transparent glass and other mechanical injuries.

## 2.2.3 Anatomical analysis

Take the fresh bird corpses back to the laboratory for anatomy, observe whether the stomach, intestines and other organs are normal, and visually observe whether there are parasites. Gastric contents and intestinal secretions were collected and tested by Prussian blue reaction method to identify whether they died of hydrocyanic acid poisoning; Then the liver was tested by resorcinol method to identify whether it died of organophosphorus poisoning(Fig. 3).

## 2.2.4 Pathogen detection

The organs and tissues of birds that died of non-mechanical injury and non-poisoning were sent to the school of life sciences of Longyan University for pathogen detection. After aerobic culture and anaerobic culture with an ordinary agar medium, the dominant colonies were biochemically identified. RNA and DNA samples of dead birds were extracted, and the pathogen types of avian mycoplasma and avian poxvirus were detected by RT-PCR. If the test result is not avian influenza and Newcastle disease, it will be marked as "death from other causes".

## 3. Results

The research lasted for 3 years, and 181 bird corpses were collected. According to the time, season, place, cause and species of bird death, the statistical analysis of the results is as follows:

### 3.1 Deaths in different years

Table 1  
Statistics of bird deaths in different years

Year	Number of deaths	Proportion	Extreme climate
2018	57	31.49	
2019	59	32.60	Hail disaster (moderate hail)
2020	65	35.91	Extreme high temperature(may)
total	181	100	

It can be seen from the table that although moderate hail occurred in many places in Qujing in February, April, June and November 2019 (3 birds killed by hail were found), the number of bird deaths did not increase significantly compared with 2018; In May 2020, the highest temperature in 63 years occurred in Liupanshui. It was found that 4 young birds died in the nest due to high temperature and 3 nests failed to

hatch successfully (not included in the scope of this investigation and analysis), the number of bird deaths in 2020 increased by only about 3.3% over the previous year.

## 3.2 Deaths in different months

Table 2  
Statistics of bird deaths in different months

Month	Number of deaths	Proportion
Jan	19	10.5%
Feb	12	6.6%
Mar	5	2.8%
Apr	6	3.3%
May	17	9.4%
Jun	18	9.9%
Jul	28	15.5%
Aug	17	9.4%
Sept	10	5.5%
Oct	10	5.5%
Nov	10	5.5%
Dec	29	16%
Total	181	100%

It can be seen from the table that there are obvious differences in the number of bird deaths in different months. Bird deaths are mainly concentrated in January, February, May, June, July, August and December (i.e. summer and winter), accounting for 77.3%. Combined with the causes of death, it can be seen that most of the birds who died in winter died of hydrocyanic acid (Rodenticide) poisoning and mechanical injury (31.6% and 55% respectively), and most of the birds who died in summer died of organophosphorus (pesticide) poisoning (63.8%).

## 3.3 Deaths at different locations

Table 3  
Statistics of bird deaths in different places

Locations	Number of deaths	Proportion
Construction land	88	48.6%
Woodland	10	5.5%
Wetland	12	6.6%
Cultivated land	46	25.4%
Orchard	25	13.8%
Total	181	100

It can be seen from the table that the most birds die in the construction land and the least in the forest land and wetland. Combined with the causes of death, it can be found that most of the birds who died in the construction land died of hydrocyanic acid (Rodenticide) poisoning and impact of transparent glass and curtain walls, and most of the birds in cultivated land and orchard died of organophosphorus (pesticide) poisoning.

### 3.4 Deaths from different causes

Table 4  
statistics of deaths caused by different causes

Cause	Number of deaths	Proportion
Mechanical injuries	38	21.0%
Hydrocyanic acid (Rodenticide) poisoning	45	24.9%
Organophosphorus (pesticide) poisoning	76	42.0%
Other reasons	22	12.2%
total	181	100.0%

It can be seen from the table that birds died of organophosphorus (pesticide) poisoning accounted for the highest proportion (42.0%), followed by hydrocyanic acid (Rodenticide) poisoning (24.9%) and mechanical injury (21.0%), while "other causes" such as disease were the least (12.2%), and avian influenza and Newcastle disease virus were not found.

### 3.5 Death of different species of birds

Table 5  
Statistics of death of different species of birds

Species	Number of deaths	Proportion
White babbler	26	14.4
Turtledove	8	4.4
Daurian Redstart	9	5.0
Shrike	8	4.4
Great tit	23	12.7
Yellow-vented Bulbul	10	5.5
Grey forest babbler	7	3.9
Goldfinch	8	4.4
Warbler	7	3.9
Sparrow	40	22.1
Babbler	9	5.0
White eye	12	6.6
Swallow	6	3.3
Other birds	8	4.4
total	181	100.00

It can be seen from the table that the highest proportion of dead birds is the sparrow, white babbler, great tit and white eye, accounting for 55.8% of the total number of dead individuals. Among them, sparrows mainly died of hydrocyanic acid (Rodenticide) poisoning, and great tits, white babblers and Hydrangea mainly died of organophosphorus (pesticide) poisoning.

## 4. Discussion

### 4.1 Analysis on the possibility of death causes of birds

(1) Although many studies have shown that tropical bird species' particular vulnerability to climate change, combined with habitat loss, may lead to the extinctions of hundreds of bird species (Şekercioğlu et al., 2008; Harris et al., 2011), and many species of migratory birds will decrease in distribution and population in the future climate scenarios, and may even face the risk of extinction (Pimm et al., 2014). But from the above experimental results, we can see that there were large hail and extreme high temperature once in 40 years in 2019 and 2020 respectively, the number of bird deaths did not increase

significantly in terms of years. Therefore, we can infer that the main cause of bird death has little to do with weather changes in Wumeng mountainous area.

(2) The number of migratory birds has declined dramatically worldwide since 1970. Some scholars believe that AIVs of the H5 subtype have been detected in domestic poultry and wild birds around the world. Furthermore, there were numerous outbreaks of H5 HPAI around the world, resulting in the deaths of large numbers of domestic poultry and wild birds and enormous economic loss in the poultry industry. (Nuñez and Ross, 2019). The disease may cause a large number of bird deaths, which will have a serious impact on bird populations, especially endangered bird populations. But from the above experimental results, we can see that most insect-eating birds such as the hydrangea, great tit and white babbler died of pesticide poisoning, and most of the death sites are located around large-scale planting areas, such as the planting areas of flowers, vegetables and fruits. Sparrows, turtledoves and other birds dominated by food crops mostly died of Rodenticide poisoning. In the field investigation, it was found that some farmers deliberately put Rodenticide to kill birds in order to prevent birds from stealing crop seeds. Therefore, we can infer that Few birds dead from avian influenza virus in Wumeng mountainous area.

(3) Total breeding bird density is often higher in urban areas than in the surrounding native habitat (Beissinger and Osborne, 1982), with the continuous expansion of the city and the reduction of forest land, the number of urban birds in Wumeng Mountain area has been greater than that of forest birds. It can be seen from the experimental results that the dead birds are mainly urban birds, such as sparrow, white thrush, great tit and Hydrangea, and more than 20% of the birds died from the collision with transparent glass and curtain wall. It can be inferred that human agricultural production and construction activities are closely related to the survival of birds.

## 4.2 Limitations

Within the present study, we used a large number of bird carcasses collected on site, taking into account the high uncertainty in the following aspects: (1) the probability of bird carcasses being found is related to human activity areas, the discovery of carcasses is random, and most of the collected carcasses come from urban and rural construction areas or agricultural planting areas, There may be some bird carcasses in woodlands and slopes with poor accessibility that have not been found. (2) Some bird corpses cannot determine the specific time of death, and the deterioration of their corpses may have a certain impact on the accurate analysis of the cause of death. (3) The time span of corpse collection is only three years, and the range of climate change is small, while the impact of climate change on birds may be reflected in a wider time range.

## 5. Conclusions

Birds are excellent bellwethers of ecological environment change effects on biodiversity, their are also an important part of nature, a close friend of mankind and an important symbol of ecological environment

change (Prakhar R., 2021). Therefore, based on the above analysis, we propose to protect birds from the following aspects:

(1) Strengthen the construction of ecological civilization in urban and rural areas. Studies have shown that when birds see the reflection shadow in the mirror or glass during flight, they may mistakenly think that another bird of the same kind is grabbing territory and competing for partners to stimulate its fighting spirit, so they fly towards the bird in the mirror, resulting in injury or death (Christine D., 2019). At the same time, artificial night lighting not only interferes with the normal rest of the birds in the habitat but also misleads their judgment of seasons and migration timing. The increase of illumination hours can stimulate the pituitary gland to release gonadotropin (Sirena L., 2020), lead to its metabolic disorder and destroy the normal reproductive mechanism of birds (Jhih S W., 2021). It is suggested to minimize lighting projects in urban and rural planning and construction, and avoid the use of outdoor transparent glass and curtain walls. If necessary, frosted glass or colored glass shall be used.

(2) Strengthen environmental protection. Protect wild animals and put an end to poisoning and killing birds, Promote the use of farm manure and organic fertilizer (Mattia B., 2021), try to avoid the use of pesticides, advocate the use of comprehensive pest control measures such as physical control and biological control (Huang N. 2019), and use the power of nature to eliminate pests and diseases (Sandra G., 2018).

(3) Strengthen urban construction management. Avoid pruning trees during the breeding period of birds. Birds in cities begin to build nests after the Waking of Insects which is 3rd solar term in china (Han Y Q., 2019). At this time, pruning street trees and park plants often lead to the destruction of some bird nests and the casualties of young birds. At the same time, some shrub pruning in pursuit of uniformity will not only destroy the bird's nest but also reduce the food source of birds. Put an end to the use of herbicides and pesticides in the maintenance of urban green space. At the same time, the residual poison also directly affects the survival of birds and seriously destroys the urban ecological environment (Irene R O., 2017).

(4) Strengthen the optimization of urban and rural spatial layout. Build an ecological security pattern in mountainous areas, put an end to the disorderly expansion of construction land, avoid the fragmentation of ecological land, and protect bird habitats. Optimize the layout of land and space, clarify the boundaries of urban and rural construction land, protect ecological lands such as forest land and water area, and eliminate deforestation and reclamation. At the same time, increase the construction of forest land and wetland in urban construction to create more habitats for birds.

## Declarations

I would like to declare on behalf of my co-authors that we do not have any commercial or associative interest that represents a conflict of interest in connection with the work submitted, and no other author has reported a potential conflict of interest relevant to this article. 03/03/2022

## **Ethics approval and consent to participate**

Not applicable

## **Consent for publication**

I would like to declare on behalf of my co-authors that the work described was original research that has not been published previously, and not under consideration for publication elsewhere, in whole or in part. All the authors listed have approved the manuscript that is enclosed.

## **Availability of data and material**

The data sets supporting the results of this article are included within the article and its additional files. All the data in this paper are measured by the author himself, and can be freely used in academic exchange without involving confidentiality.

## **Competing interests**

The authors declare no competing non-financial/financial interests.

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## **Authors' contributions**

XB zhu: performed the data analyses and wrote the manuscript;

B Dong: performed the experiment; helped perform the analysis with constructive discussions.

XQ Chen: performed the data analyses and wrote the manuscript.

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**State:** All the map depicted in the manuscript are taken and drawn by the author himself.

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## Figures

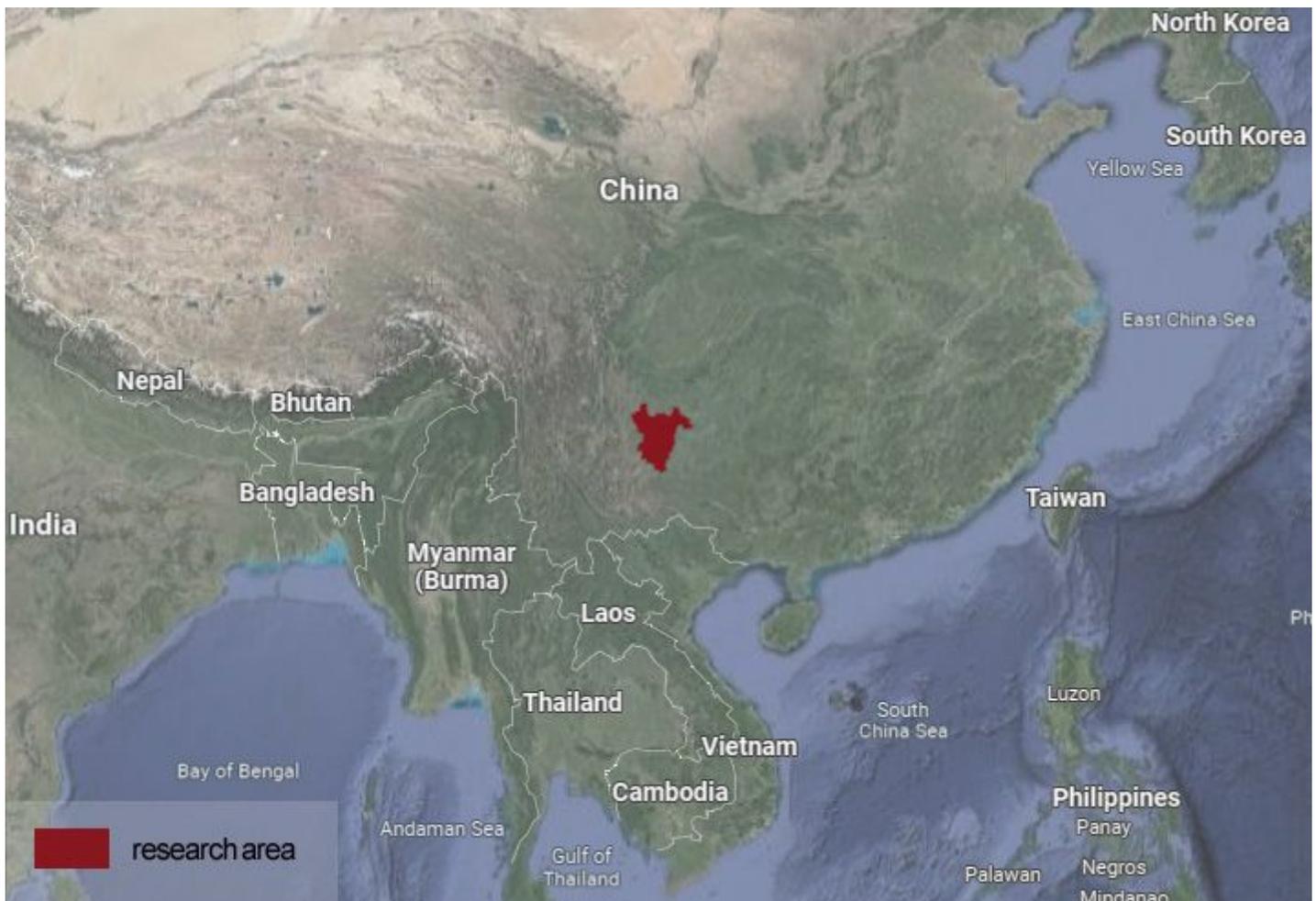


Figure 1

Location diagram of research area

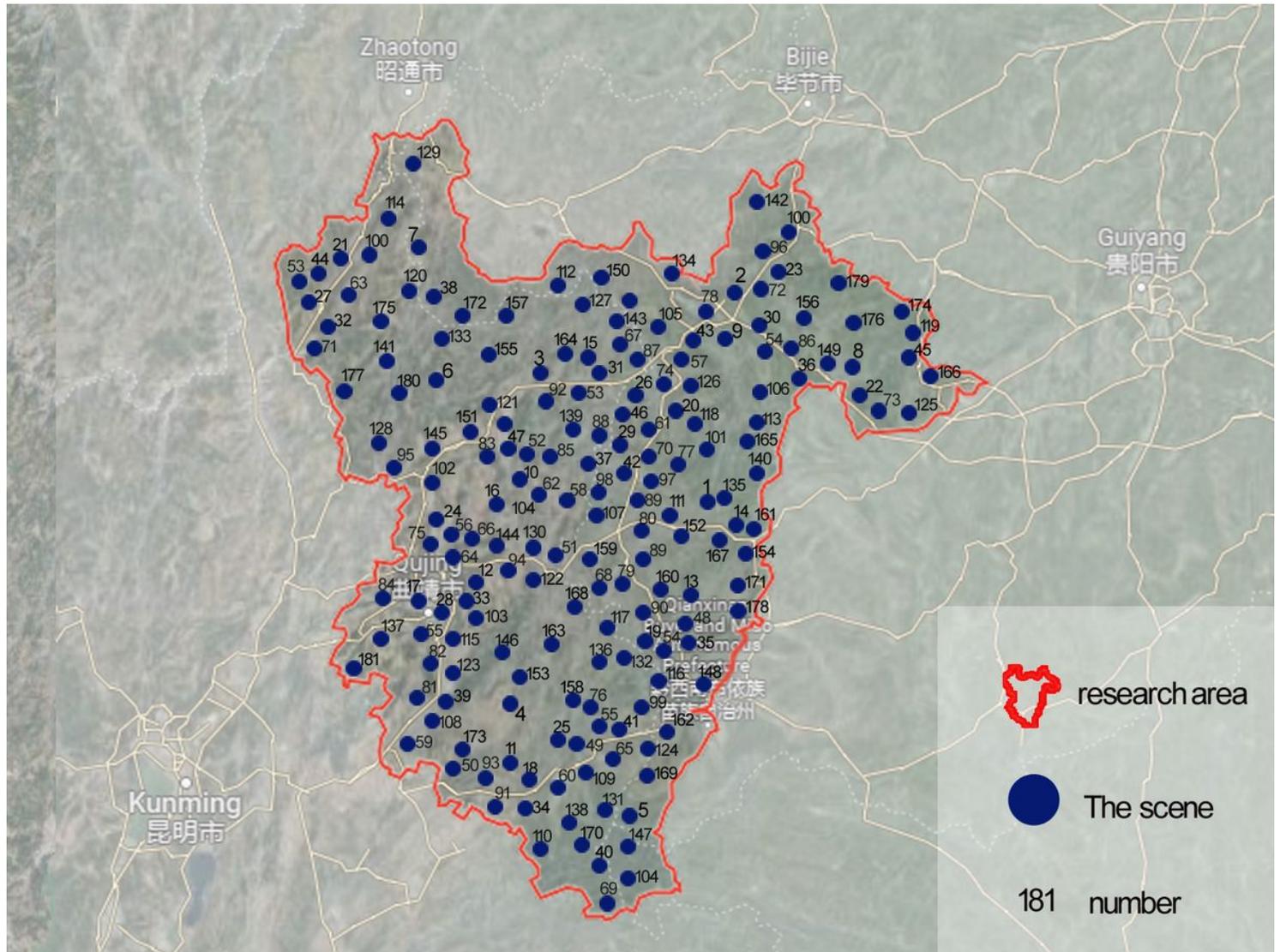


Figure 2

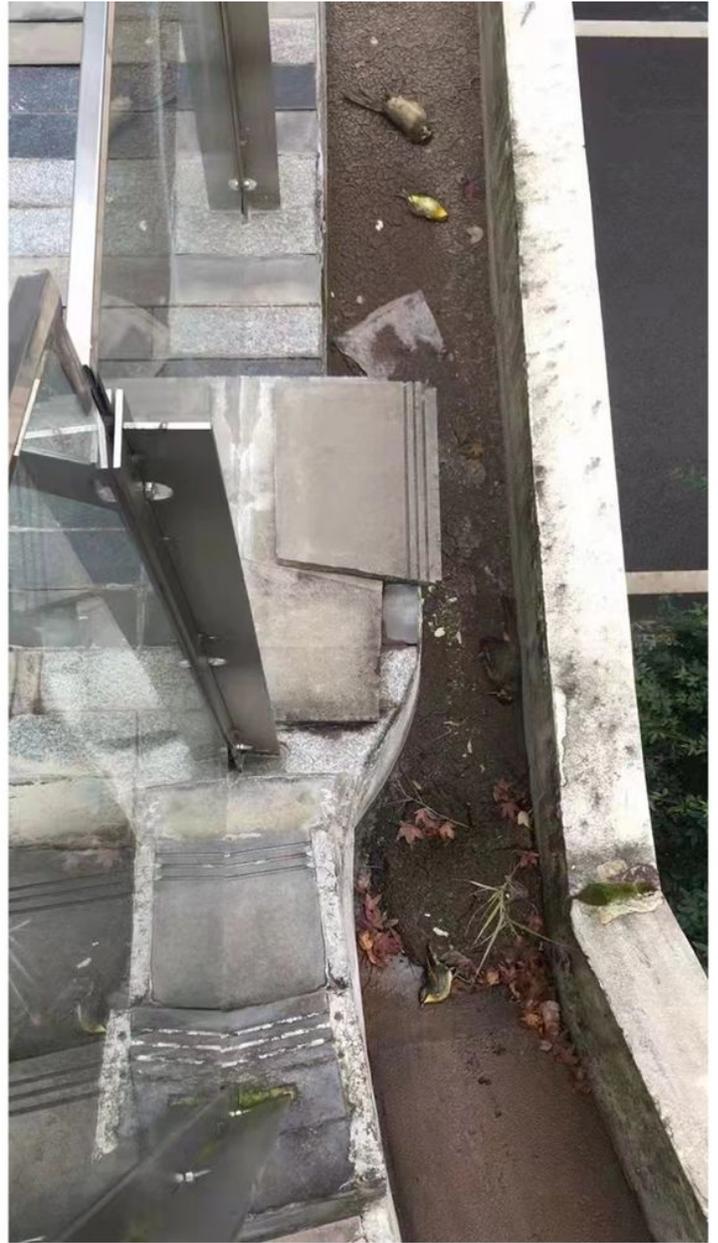
Number map of bird corpse discovery site



Stomach of pesticide poisoning



Bird autopsy



Bird-collision site

**Figure 3**

Bird-collision site and anatomical diagram